PROCEEDINGS OF THE WORKSHOP:
Air Transportation Demand and
Systems Analysis

August 1975

DEPARTMENT
OF
AERONAUTICS
&
ASTRONAUTICS

FLIGHT TRANSPORTATION
LABORATORY
Cambridge, Mass. 02139

R75-8
August 1975
The workshop was jointly sponsored by the Civil Aeronautics Board, Department of Transportation, and National Aeronautics and Space Administration.
## TABLE OF CONTENTS

### Panel 1  Government Agencies

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Samuel L. Brown</td>
<td>The Elasticities of Air Transport</td>
<td>1</td>
</tr>
<tr>
<td>Civil Aeronautics Board</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Arthur L. Webster, III</td>
<td>Review of Aviation Forecasts and Forecasting Methodology</td>
<td>9</td>
</tr>
<tr>
<td>Dept. of Transportation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Donald Farmer</td>
<td>Fact and Fancy in Aviation Economics</td>
<td>68</td>
</tr>
<tr>
<td>Dept. of Justice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Jerome P. Mullin</td>
<td>Demand Estimation as a Factor in R&amp;D Program Planning</td>
<td>85</td>
</tr>
<tr>
<td>NASA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. John Schettino</td>
<td>The Role of EPA in Regulating Aircraft/Airport Noise</td>
<td>96</td>
</tr>
<tr>
<td>EPA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Panel 2  Airports

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. George P. Howard</td>
<td>The Critical Need for an Integrated Approach to Data Collection</td>
<td>138</td>
</tr>
<tr>
<td>Port Authority of NY&amp;NJ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. John L. Graham</td>
<td>Ground Access - The Key to Airport Development</td>
<td>142</td>
</tr>
<tr>
<td>Los Angeles Dept of Airports</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Jake O'Reagan</td>
<td>Items of Importance to the Future of Airports</td>
<td>151</td>
</tr>
<tr>
<td>Atlanta Int'l Airport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Paul Shaver</td>
<td>Basic Airport Data Assembly, Storage &amp; Access for Planning and Operational Use</td>
<td>155</td>
</tr>
<tr>
<td>Chicago Dept. of Aviation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Panel 3  Airlines

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Harry G. Lehr</td>
<td>Organized Soothsaying</td>
<td>160</td>
</tr>
<tr>
<td>United Airlines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. William M. Caldwell, IV</td>
<td>Research Needs of the U.S. Airfreight System</td>
<td>180</td>
</tr>
<tr>
<td>The Flying Tiger Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. A.C. Ford</td>
<td>The Identification of Service and the Contributions of Air Transportation to the Economy</td>
<td>194</td>
</tr>
<tr>
<td>Delta Air Lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Thomas McGilvery</td>
<td>Fares/Cost and the Outlook for Short Haul Air Transportation</td>
<td>210</td>
</tr>
<tr>
<td>Allegheny Airlines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Jack Reiter</td>
<td>Questions Airlines Ask</td>
<td>220</td>
</tr>
<tr>
<td>World Airways</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Thomas S. Miles</td>
<td>Are They or Are They Not? Are Commuter Airlines part of the Nations Air Transportation System, or Are They Not?</td>
<td>227</td>
</tr>
<tr>
<td>NATA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Panel 4  Financial Community

Mr. Harry E. Colwell, III
Chase Manhattan Bank

Mr. Robert J. Simmons
First National City Bank of New York

Mr. Harry Kimbriel
Alliance One

Mr. Ted Schlegel
National Aircraft Leasing

Dr. Julius Maldutis, Jr.
Salomon Brothers

Panel 5  Air Transportation Data

Mr. Jerold Coffee
Civil Aeronautics Board

Mr. James R. FitzGibbon
Civil Aeronautics Board

Mr. Evans Wiley
Civil Aeronautics Board

Mr. Lee R. Howard
Air Transport Association

Mr. R.D. Willy
Boeing Commercial Airplane Co.

Mr. R. Lawrence Hughes
Pan American World Airways

Mr. Alan E. Pisarski
Dept of Transportation

Panel 6  Manufacturers

Mr. R.D. Willy
Boeing Commercial Airplane Co

Mr. R.B. Ulvestad
Lockheed-California Co

Mr. Yves G. Aureille
Douglas Aircraft Company

Mr. John D. Karraker
General Electric

Mr. N. George Avram
Pratt & Whitney Aircraft

Mr. Louis J. Williams
Ms. Ann Wilson
NASA-Ames

The "Money Changers" Outlook 234
Airline Financing Requirements Through 1980 237
Transportation Policy Research and the Financial Community 248
What is the Future of Aircraft Leasing in the United States 259
Airline Mergers -- The Prospects For a New Airline Industry 275

Basic Financial and Traffic Data and Publication Summaries 281
Passenger O&D and Service Segment Data 289
Data in Process and Future Data Needs 297
Air Transportation Demand and System Analysis 313
Data -- A Status Report 326
International Traffic Forecasting and the Problem of Statistics 345
DOT Air Transportation Data Activities 360

Surplus Seat Management 362
Future Research in Air Transportation Demand and System Analysis 381
Domestic Passenger Forecasting
The Outlook for the U.S. Airline Industry (An Econometric Approach) 386
Forecasting for Planning 444
Air Transportation -- Directions for Future Research 452
Survey of Projected Growth and Problems Facing Air Transportation 1975-1985 472
THE ELASTICITIES OF AIR TRANSPORT

By Samuel Lovitt Brown
Civil Aeronautics Board

Introduction

This is a brief account of research by CAB staff. Appended is a descriptive bibliography of 28 research studies, and the numbered references which follow in the text are keyed to those works. Most of them are quite detailed and I think will answer most of the questions which may be raised.

The research had two coordinate ends. First, to devise methods for projecting the growth of air traffic, because such forecasts are critically important to the Board's and the industry's planning. Second, to learn everything we could from available data about the effect of fares on traffic, because this is a prime consideration, under the Federal Aviation Act, in Board decisions.

The studies go back 16 years, to 1959 (1). Most of them, however, were completed in the eight-year period from 1965 through 1972. They employed several different methods—whatever appeared to be suited to the problem in hand: study and interpretation of the historical record; regression analysis of time series of aggregate data; regression analysis of cross-sectional city-pair data; and on the occasion of our SST study, dichotomous regression and discriminant analysis.

Interpretation of the Historical Record

When we studied the interesting events which took place in that largest of all city-pair markets, Los Angeles - San Francisco, we assembled all the data we could find dating from 1948 through June, 1965, and we then
analyzed it, interpreted it, and drew conclusions (3). We believe that our conclusions stand: the great growth is attributable to vigorous competition in equipment, service, and in fares, as well as to the general expansion of the California economy. We used the same procedure when we studied the growth and development of coach service, in connection with our SST research (8). Frank M. Lewis' painstaking historical research was indispensable to that work.

**Multiple Regression of Time Series**

Multiple regression of time series of aggregate data was the basis of our several long and short-term forecasts (1, 5, 13, 21, 22, 25, 28). We thought, and still think, that the best projections can be made by relating traffic to certain determining factors, provided that the determinants can be projected better than the traffic. So we fitted simple difference equations of logarithms to air travel, real incomes, and fares, deriving elasticity coefficients. We had to employ a time trend, however, for changing tastes and improving quality of service, because our efforts were unavailing to derive a significant logical coefficient for reduced trip time due to faster aircraft. Our coefficient for fare-elasticity was almost invariably numerically somewhat above unity, no matter how we handled the data. The coefficient for income was also a bit greater than unity, but we think it is too low. Income and time trend are closely intercorrelated and what should be in income has, we think, gotten into the trend. This gives us trouble during periods of little or no growth of income—we get too-high projections because of the high trend-effect.
How have the projections fared? The early ones were too low. Most of the bias can be attributed to too-conservative projections of what might happen to incomes and fares. And the later ones have been too high, again because of projections of fares and incomes which were off the mark, this time on the optimistic side. Our year-by-year forecasts were quite good for four years, 1966 through 1969 (21). Since then, they have tended to be too high—we think because of the problem with the income-coefficient and the time trend.

Regression Analysis of City-Pair Data

Our experience with time series led us to try cross-section analyses of the leading city-pair markets (4, 8, 9, 14, 15, 24). We wanted to test our conclusions concerning fare-elasticity. More important, we needed a coefficient for improved speed or reduced trip time, in connection with our studies of demand for supersonic travel, and we had not been able to derive such a thing from time series. The cross-section studies were (and still are) badly handicapped by the lack of good data for fares in city-pair markets. But we went ahead anyhow, estimating average fares in such markets from all the bits of information we could find and piece together.

Statistically, at least, the cross-section studies were quite successful. We derived fairly complete explanations ($R^2 = .87$) of the variation of traffic among the larger city-pairs. We estimated significant, logical, and plausible coefficients for the elasticities of fares, trip time, competition in the markets, effect of stops, distance, and community
of interest. Size of place and level of income we handled by using an income-products variable. Our fare-elasticity was a bit higher (-1.7) than in the time series studies, but it was consistent with them. Our journey time elasticity was about unity, or perhaps a bit lower. We succeeded in deriving cross-elasticities for coach travel with respect to first class fares. However, a well-designed model to test whether fare-elasticity varies with distance showed nothing significant. We do not believe this; on a priori grounds, we still think fare-elasticities are smaller for longer journeys (15, 24).

Conclusion

For more progress in estimating the effect of fares and service improvements on traffic, the greatest need is for better data. Good data are needed for fares in city-pair markets. Data are needed for the segments of the market demand: most importantly for the great pieces of the market, business and nonbusiness travel. The more dynamic part is nonbusiness which can be further distinguished between discretionary and necessitous. We have little or no hard information on how these segments react. Until it becomes available, econometric studies are critically handicapped.
THE ELASTICITIES OF AIR TRANSPORT:

STUDIES BY CAB STAFF

(A Chronological Bibliography)


2. The Impact on the Balance of Payments of the Air Transport and Aircraft Industries, by S. R. L. Brown. Gives the historical record, the outlook, and shows prospective effects of different courses of action. (48 pages including 15 charts and 14 tables). Published by the Civil Aeronautics Board in April 1965.

3. Traffic, Fares, and Competition, Los Angeles-San Francisco Air Travel Corridor, by S. R. L. Brown, Wayne S. Watkins, and Joy Ronson. A time-series study of this largest air travel market with emphasis on the performance of PSA, a large, competitive, non-regulated carrier. (52 pages, including 11 charts, 9 tables, and 2 appendixes). Published by the Civil Aeronautics Board in August 1965.


8. CAB Research Effort: Supersonic Transport Economic Study, by S. R. L. Brown and Wayne S. Watkins. An effort, as part of a broader analysis of the economics of the proposed supersonic transport air plane, to determine factors important to a passenger when choosing one fare level or class of service over another, to determine sensitivity and passenger response to various fare levels and classes of service, and to determine the distribution of traffic between SST's and subsonic aircraft. (78 pages, including 16 tables, 4 charts, 3 appendixes). Prepared for an interagency task force studying the economics of the SST, completed in September 1966.


11. Recent Trends in Air Cargo, by John D. Coakley. Examines rates of growth of air cargo before and after the great 43-day strike of 1966. (5 pages, including 3 charts). Published by the Civil Aeronautics Board in May 1967.


16. Forecast for 1968 of Scheduled Domestic Passenger Traffic for the Trunk Airline Carriers, by Irving Saginor and Paul Eldridge. (9 pages, including 1 chart and 3 tables). Published by the Civil Aeronautics Board in March 1968.

17. Traffic and Revenue Trends in Scheduled Domestic Air Cargo, 1964-1968, by Irving Saginor. Provides data and trends for cargo traffic by class of airline, by belly or all-cargo, with data for capacity, load factors, yields. (35 pages, including 7 tables, 13 charts). Published by the Civil Aeronautics Board in June 1969.

18. Forecast for 1969 of Scheduled Domestic Passenger Traffic for the Trunk Carriers, by Irving Saginor. (6 pages, including 3 tables). Published by the Civil Aeronautics Board in March 1969.


22. Forecast of Scheduled Domestic Air Cargo for the 50 States, 1971-75, by Irving Saginor and David Richards. (28 pages, including 6 charts, 11 tables). Published by the Civil Aeronautics Board in February 1971.


REVIEW OF AVIATION FORECASTS
AND FORECASTING METHODOLOGY

U.S. DEPARTMENT OF TRANSPORTATION
The contents of this report reflect the views of the author, who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official position of the U.S. Department of Transportation. This report does not constitute a standard, specification, or regulation.
REVIEW OF AVIATION FORECASTS
AND FORECASTING METHODOLOGY

Prepared by
Arthur L. Webster, III.
PURPOSES OF AVIATION FORECASTING

This paper summarizes a special briefing dealing with a review of aviation forecasts and forecasting methodology. The briefing was delivered in February 1975 to a nine-member task force appointed by the Secretary of Transportation to study the organizational structure and management approach employed by the Federal Aviation Administration (FAA) in carrying out its missions.

Aviation forecasting activities are carried out by numerous agencies and organizations and for a number of different purposes. This chart summarizes the purposes of aviation forecasting as conducted by such agencies.

In the planning and procurement of new equipment, airlines, aircraft manufacturers, and engine manufacturers develop forecasts of future aviation activity in terms of such variables as revenue passenger miles and passenger enplanements.

Planning of airfield and terminal improvements to airports requires forecasting of a range of variables relating to the operation of the airport. Forecasts of passenger movements, aircraft movements, and airport access traffic are typically developed. Airport sponsors prepare such forecasts in the process of the development of airport master plans. Regional agencies such as councils of governments develop aviation forecasts as an essential element of regional airport system plans, and sometimes develop aviation forecasts as a part of their surface transportation efforts in order to develop an improved understanding of the airport as a major traffic generator in the urban area. The Department of Transportation (DOT) and the FAA also develop airport-related forecasts to assist in developing federal policies and evaluating federal funding of airport development.

Route assignments and route loading forecasts are another type of forecasts. The Civil Aeronautics Board (CAB) is active in this area (the CAB also undertakes forecasts in connection with rate cases and other policy matters). Airlines and DOT/FAA also forecast traffic levels in connection with route assignment matters.

Air Traffic Control (ATC) requirements depend on future aviation activity. As a result, FAA and equipment manufacturers undertake forecasts of various variables affecting ATC activity.

In developing safety and environmental regulations, a range of different forecasts have in the past been prepared by a number of agencies, including the FAA, the National Transportation Safety Board (NTSB), and the Environmental Protection Agency (EPA).
PURPOSES OF AVIATION FORECASTING

- **New Equipment** - Airlines and MFRs
- **Airfield and Terminal Improvements**
  - Airport Sponsors
  - Regional Agencies
  - DOT/FAA
- **Route Assignments**
  - CAB
  - Airlines
  - DOT/FAA
- **ATC Requirements**
  - FAA
  - Equipment MFRs
- **Safety and Environmental Regulations**
  - FAA
  - NTSB
  - EPA
This chart presents the typical variables that are forecast by the forecasting agencies and for the purposes listed previously.

Macro forecasts are forecasts of total United States activity or other aggregate levels of aviation activity. Micro forecasts deal with activity at individual airports or on individual routes.

Typical macro forecasts are made for such variables as revenue passenger miles, enplaned passengers, the number of aircraft operations (an operation is a landing or a takeoff), the number of aircraft in the fleet, and the number of airmen.

Micro forecasts for airport planning include such variables as passenger originations, passenger origin-destination (O&D) traffic, number of enplaned passengers (boarding passengers), and the number of aircraft operations. (On occasion, forecasts are separately made for cargo movement, commuter service, and airport-related vehicular traffic.)

The forecasts such as identified above are normally prepared to indicate annual levels of activity. In addition, to provide a basis for planning the required capacity of runways, terminal buildings, and other airport elements, forecasts of traffic peaking during the hours of the day, the day of the week, etc., are prepared.

As appropriate to the requirements of an airport planning study, general aviation forecasts of such variables as the number of aircraft based at an individual airport and the number of general aviation, as well as military aircraft operations, are also prepared.

The first part of this paper concentrates on the macro-type forecasts. A latter portion deals with forecasting efforts on a micro-scale, dealing with St. Louis.
## TYPICAL VARIABLES THAT ARE FORECAST

<table>
<thead>
<tr>
<th>Macro Forecasts</th>
<th>Micro Forecasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue Passenger Miles</td>
<td>Passenger Originations, O&amp;D</td>
</tr>
<tr>
<td>Enplaned Passengers</td>
<td>Enplaned Passengers</td>
</tr>
<tr>
<td>Aircraft Operations</td>
<td>Aircraft Operations</td>
</tr>
<tr>
<td>Aircraft Fleet</td>
<td>Peaking</td>
</tr>
<tr>
<td>Airmen</td>
<td>General Aviation</td>
</tr>
<tr>
<td></td>
<td>Based Aircraft Operations</td>
</tr>
<tr>
<td></td>
<td>Military Operations</td>
</tr>
</tbody>
</table>
ALTERNATIVE FORECAST METHODS

Alternative forecasting methods used in the forecasts of air carrier passengers, general aviation aircraft, and other variables are shown on this chart.

Professional judgment, based on extensive experience in the aviation field on the part of the forecaster, is an important element of any forecasting effort. In some cases, judgment is the principal approach used, with or without evaluation of economic and other factors that are believed to affect aviation activity.

Trend extrapolation deals with the examination of historical growth in aviation and projecting the growth rates into the future on the basis of past trends. Sometimes, statistical techniques are used to assist in developing the extrapolation.

Ratio methods of forecasting are used to develop micro forecasts. Here, ratios of local levels of activity to national levels of activity are developed based on past trends and these ratios are used to develop forecasts of local activity based on national forecasts developed by others.

Econometric models, which relate aviation activity to economic and social factors, are the most sophisticated methodologies available to the forecaster. Within this category, a wide variety of approaches and techniques have been used.

As is apparent, the listing of techniques shown on the chart is in order of increasing sophistication, but also usually entails increasing cost and complexity of the forecasting effort.

As will be seen later, it is important to note that increasing sophistication in modeling does not necessarily lead to better success in forecasting.
ALTERNATIVE FORECAST METHODS

AIR CARRIER PASSENGERS
GENERAL AVIATION AIRCRAFT

1. **Judgment**, with or without evaluation of economic and other factors

2. **Trend extrapolation**, sometimes using statistical techniques

3. **Ratio methods**, using ratios of local activity to national activity

4. **Econometric models**, which relate aviation activity to economic and social factors
AVAILABILITY OF FORECASTS

The availability of forecasts of future aviation activity differs substantially, depending on the type of forecast.

Forecasts of international aviation activity are published frequently by the International Civil Aviation Organization (ICAO) and by the International Air Transport Association (IATA). These forecasts cover total world aviation activity and regions of the world as well.

National forecasts of aviation activity are produced annually by the FAA. The Air Transport Association (ATA) also publishes forecasts with fair regularity but not on an annual basis.

Forecasts of activity at the regional and local level have been very spotty, as far as local agencies are concerned. The availability of FAA forecasts of regional and local activity is improving, and the FAA's Planning Grant Program for airports enabled by the 1970 Airport and Airway Development Act is providing improved consistency and availability of forecasts. At the present time, all forecasts being developed under this program are being reviewed at FAA headquarters.
**AVAILABILITY OF FORECASTS**

<table>
<thead>
<tr>
<th>Category</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td>ICAO and IATA publish frequently</td>
</tr>
<tr>
<td>National</td>
<td>FAA and ATA publish regularly</td>
</tr>
<tr>
<td>Regional and Local</td>
<td>Very spotty - by local agencies</td>
</tr>
<tr>
<td></td>
<td>Improving - by FAA</td>
</tr>
<tr>
<td></td>
<td>Planning grant program is improving consistency and availability</td>
</tr>
</tbody>
</table>
CURRENT ACTIVITY INDICATORS THAT ARE FORECAST BY FAA

This chart summarizes the major current activity indicators that are forecast by the FAA. The forecasting program in the FAA has been in existence for over 20 years. These forecasts are prepared annually, and are the most comprehensive of those produced by any forecasting agency. In the early years of the program, the forecasts projected growth for about five years into the future. Recently, FAA forecasts have gone up to ten years or so into the future. The 1974 forecasts provide data on a year-by-year basis up to seven years in the future, and "long-range" forecasts for 11-12 years into the future.

The forecast variables indicated on this chart are for macro activity. Other series of forecasts developed by the FAA deal with activity at individual hubs, which are cities or metropolitan areas requiring aviation services.
CURRENT ACTIVITY INDICATORS
THAT ARE FORECAST BY FAA

- Passenger enplanements
  - Domestic
  - International
- Revenue passenger miles
  - Domestic
  - International
- Aircraft in service
  - By type
- Aircraft hours
  - By type
- Aircraft miles
  - By type
- General aviation aircraft
  - By type
  - By FAA region
- General aviation aircraft hours
  - By type
- Fuel consumed
  - By type of fuel
  - By G.A. or Air carrier
- Civil aircraft production
  - Aircraft and engines
- Aircraft operations
  - Local and itinerant
  - At towered airports
  - Instrument operations
- Aircraft handled by ARTCC
- Flight services and aircraft contacted
- Active pilots
  - By type of certificate
FAA FORECASTING METHODOLOGY

FAA forecasting methodology has, until recently, not been documented for wide dissemination. Forecasts have been based largely on the expert judgment of experienced professionals in the FAA, and on extrapolation of trends in aviation growth in the past.

Apparently, FAA is moving toward the utilization of more sophisticated techniques. The 1974 aviation forecast report documents a number of econometric models that were used to forecast such variables as revenue passenger miles, air carrier operations, and general aviation aircraft. Furthermore, the FAA is sponsoring contract work to develop improved methods of forecasting.
Until recently, methods have not been documented for wide dissemination based largely on expert judgment.

1974 report documents econometric models used to forecast:
- Revenue passenger miles
- Air carrier operations
- General aviation aircraft
EFFECT OF RECENT HISTORY ON FORECASTS

This graph displays the effect of recent history on forecasts of the future. It deals with FAA long-term forecasts of domestic passenger enplanements.

The solid line traces the actual growth of passenger enplanements; the dashed lines show the forecasts of growth that were made at various points in time.

Forecasts made in 1953 and 1966 turned out to be relatively accurate for a short period of time because the rate of aviation growth did not change. In general, however, the history of aviation activity has shown substantial changes in the rate of growth. In the middle and late 1960s, the effects of introduction of the high-speed jet aircraft, reduced fare levels, and rapid economic growth of the U.S. led to increasing rates of aviation growth. However, as the economy turned down in 1969 and 1970, aviation activity growth rates declined substantially.

As suggested by this graph, FAA forecasters have been substantially influenced by the growth levels that have taken place in the years immediately prior to the year of release of the forecast. The 1960 and 1963 forecasts turned out to be substantially lower than actual, whereas the 1966 and 1968 forecasts turned out to be much higher. Between the 1960 forecast and the 1968 forecast there is roughly a five-to-one ratio in the forecast level of 1975 traffic. The forecasts of 1980 enplanements made in 1974 were down nearly 40% from those made in 1968.

FAA forecasters have experienced similar difficulties in forecasting other variables, such as itinerant aircraft operations at tower airports, and IFR aircraft handled.
EFFECT OF RECENT HISTORY ON FORECASTS
(FAA FORECASTS)

YEAR

PASSENGER ENPLANEMENTS (MILLIONS)

FAA aviation forecasting models that were recently reported in the 1974 forecast paper are described on this chart.

The model used to forecast revenue passenger miles (RPMs) is based on four independent variables: airline fares, income, the cost of automobile traffic, and industrial production. The econometric model relates historical levels of RPMs to historical levels of the independent variables, and forecasts of future RPMs were based on forecasts of the future levels of the independent variables.

Air carrier operations forecasts were based on judgments and discussions with individual carriers regarding their expectations of the future, and on the results of a mathematical model which was not documented in the report.

General aviation aircraft forecasts were made using a model which used real disposable income, population, real liquid assets, and a number of towers as independent variables. The results of the use of this model were adjusted by judgment to arrive at the final forecasts.
RPM = (FARES, INCOME, COST OF AUTO TRAVEL, INDUSTRIAL PRODUCTION)

Air Carrier Opns =

1. JUDGMENTS AND DISCUSSIONS WITH CARRIERS

2. MATHEMATICAL MODEL - NOT DOCUMENTED

Gen. Av. Aircraft = (REAL DISPOSABLE INCOME, POPULATION, REAL LIQUID ASSETS, NO. OF TOWERS)

ADJUSTED BY JUDGMENT
ATA FORECASTING ACTIVITY

Air Transport Association forecasting activities are summarized on this chart.

Forecasts of national levels of activity are developed with fair regularity. The ATA is attempting to produce forecasts on an annual basis.

Forecasts of future growth of aviation activity at specific airports are frequently made in reaction to specific planning problems. Therefore, comprehensive forecasts for all airports are not available. An important exception to this observation should be noted, however: a series of master plan forecasts were developed by the ATA in the late 1960s.

The production of forecasts by the ATA is a result of committee action, rather than utilizing specific forecasting models. A specially appointed ATA committee reviews forecasts of individual airlines and equipment manufacturers of future aviation activity, and discussions are undertaken regarding why the forecasts made by different organizations differ. On the basis of these discussions, consensus is achieved within the committee as to the formal forecast to be adopted by the ATA.

Generally, the forecasts of national activity developed by the ATA make projections substantially farther into the future than those made by the FAA. Recent ATA macro forecasts are to the year 2,000.
FORECASTS OF NATIONAL ACTIVITY DEVELOPED WITH FAIR REGULARITY

FORECASTS AT SPECIFIC AIRPORTS FREQUENTLY ARE IN REACTION TO A SPECIFIC PROBLEM

Production of forecasts are committee actions

- Utilizing forecasts of individual airlines & MFRS
- Developing consensus within committee
VARIATIONS IN ATA FORECASTS

Variations in ATA forecasts are presented on the graph on the facing page. The forecasts are of domestic passenger enplanements. Note that the vertical scale on this graph is different from that shown on the previous FAA forecast graph. Here, forecasts of enplanements made in 1969 and 1973 are compared. In 1969, the forecast reflected the high levels of aviation growth that took place in the middle and late 1960s. Some 669 million passenger enplanements were forecast for 1985. In 1973, with the substantial reduction in growth over recent years providing improved information, the forecasters envisaged a level of growth through 1985 of only about two-thirds of that envisioned four years earlier, or 413 million.

Thus, ATA forecasts have also differed substantially, and have been strongly reflective of recent past growth.
VARIATIONS IN ATA FORECASTS

Passenger Enplanements (Millions)

1960 65 70 75 80 85

1969
1973
CAB FORECASTING ACTIVITY

Forecasting activities of the CAB generally deal with projections for only a relatively few number of years into the future.

Recent forecasts developed by Civil Aeronautics Board staff have been oriented toward specific problems faced by the Board. No annual series of forecasts is available.

Forecasting methods used by the CAB staff utilize sophisticated econometric and statistical models. Within the federal government, the CAB has shown the greatest sophistication in forecasting techniques.

As a matter of policy, CAB staff do not comment on the forecasts of others. However, in particular cases brought before the Board there are exchanges of views regarding forecasts made by various parties, and the CAB staff will, on occasion, critique forecasts of others, as pertinent to the matter at hand.
Recent CAB forecasts have been oriented toward specific problems, no series of forecasts.

Methods usually utilize sophisticated econometric and statistical models.

As a matter of policy, CAB does not comment on forecasts of others.
VARIATIONS IN CAB FORECASTS

Variations in CAB forecasts shown on this graph relate to the domestic revenue passenger miles. Here, forecasts made in 1965 differ substantially from those made in 1967. In both cases, CAB staff projected a high and low estimate of future growth. The graph displays the fact that forecasts made in 1967 of 1975 RPMs were roughly 50% greater than those made two years earlier.

This graph illustrates the fact that even when relatively sophisticated techniques are used, rapidly changing trends in recent years can have a substantial impact on forecasts of the future.
VARIATIONS IN CAB FORECASTS

RPM (BILLIONS)

1967 RANGE

1965 RANGE

YEAR

300
200
100
0

1960 65 70 75 80
Variations in industrial forecasts in recent years have also been noted. This graph shows forecasts of ICAO world revenue passenger miles made by McDonnell Douglas Corporation. In a similar manner as the results of others, the McDonnell Douglas forecasts made in the early 1960s anticipated relatively low rates of growth, whereas those made in the late 1960s showed expectations of much higher rates of growth. The range between the 1968 forecast and the 1960 forecast of 1975 RPMs is very substantial, the 1968 level being about 2-1/2 times the 1960 level. Regarding forecasts of 1980 levels of activity, the 1973 forecast is down some 30% from that made in 1968.
VARIATIONS IN MC DONNELL DOUGLAS FORECASTS
EXAMPLE OF THE VARIATIONS IN FORECASTS MADE AT ONE TIME

This graph shows an example of the variations in forecasts made by a number of organizations at one time.

In about 1965, the organizations listed at the bottom of the graph prepared forecasts of domestic revenue passenger miles into the 1980-1985 future. The views that these organizations had about future growth in aviation activity differed substantially. For example, the highest forecast for 1980 was 79% higher than the lowest forecast. In general, the airplane manufacturers tended to be less optimistic about the growth of aviation than the others.
EXAMPLE OF THE VARIATIONS IN FORECASTS MADE AT ONE TIME

PERCENT THAT HIGH FORECAST EXCEEDS LOW

SOURCES: ATA, BOEING, CAB, DOUGLAS, FAA, GE, LOCKHEED, NORTH AMERICAN
USE OF FORECASTS IN MAJOR POLICY STUDIES

This chart illustrates the use of aviation forecasts in major policy studies undertaken by the government, starting with the Doolittle Report in 1952 through the various reports issued by the Aviation Advisory Commission during the period from 1971 through 1973. As indicated, some policy studies have utilized aviation forecasts as input to the development of their recommendations, whereas others have not. In the Civil Aviation Research and Development (CARD) study, which was released in 1971, a number of aviation forecasts were developed; however, those forecasts are not reflected in the final report.

In the cases where forecasts have been included in the policy study, they generally have not been used to develop a systematic analysis of benefits and costs to compare alternative courses of action. Rather, they simply provide a basis or background for judgments about the future policy actions that are being considered.

It is also interesting to note that major reports of congressional committee hearings with regard to aviation matters that have been released in recent years frequently do not include documentation of forecasts developed by the FAA and others.
<table>
<thead>
<tr>
<th>Study/Report</th>
<th>Year</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doolittle - 1952</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Aviation Facilities Study Group - 1955</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Harding Report - 1957</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Curtis Report - 1957</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Project Horizon - 1961</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Project Beacon - 1961</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>National Airspace System Study - 1962</td>
<td></td>
<td>Limited</td>
</tr>
<tr>
<td>NAE Study on Airports - 1968</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>NAE Study (ASEB) on Civil Aviation - 1968</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Airports and Airways Development Legislation - 1969-70</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Card Study - 1971</td>
<td></td>
<td>Limited</td>
</tr>
<tr>
<td>Aviation Advisory Commission - 1971-73</td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>
VARIABLES FORECASTED

Peat, Marwick, Mitchell & Co. has recently been engaged by the Department of Transportation to prepare aviation forecasts in connection with the controversial St. Louis airport problem. An important element of this work entailed a review of past forecasts made by consultants and others of St. Louis air traffic.

The St. Louis airport problem deals with whether a major new air carrier airport should be built to serve future needs, or whether the existing Lambert-St. Louis International Airport will be sufficient for service into the future.

Because of the magnitude of the costs and impacts associated with the alternatives, a major forecasting effort of wide scope appears warranted. Yet, as this chart shows, many of the forecasting studies that have been prepared for St. Louis did not address all aspects of airport planning that were suggested on an earlier chart.
<table>
<thead>
<tr>
<th>VARIABLES FORECASTED</th>
<th>ORIGI NATIONS</th>
<th>ENPLANEMENTS</th>
<th>A/C OPERATIONS</th>
<th>L.F./AIRCRAFT</th>
<th>CARGO</th>
<th>PEAKING</th>
<th>CITY PAIR</th>
<th>G.A. OPNS</th>
<th>MILITARY OPNS</th>
<th>TOTAL OPNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATA/TWA</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>AMV/CBR</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPEAS</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NADC</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>McD-D</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAC/SHE</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>FAA</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>SARC</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAA</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
A review of methodology used in prior forecasts for St. Louis revealed a multitude of problems.

The methods used by the forecasters were frequently not documented in sufficient detail to enable the reviewer to fully understand how the forecasts were developed. In other instances, relatively unsophisticated methods were used.

Backup data and input data were poorly documented, thus making it difficult for a reviewer to trace the work.

Even though St. Louis is a major transfer airport in the U.S., only minimal analysis had been devoted to the future in this regard. Similarly, the highly important aspects of the possible future changes in air carrier load factors and in aircraft technology was given minimal attention by most forecasters.

In a number of cases, the forecasters had difficulty in interpreting definitions of terms, or did not realize that definitions had changed over the years.

In no case was any attempt made by the forecasters to develop relationships between aviation growth and economic and demographic factors through the use of an econometric model.

Finally, even though the air carriers' selection of aircraft to serve individual routes is directly dependent on individual route traffic, no analyses of city-pair traffic had been accomplished.
APPRAISAL OF EXISTING FORECASTS

- METHODOLOGY - Undocumented or Unsophisticated
- BACKUP DATA - Poorly Documented
- TRANSFER PASSENGER ANALYSIS - Minimal Analysis
- LOAD FACTOR AND A/C TECHNOLOGY ANALYSIS - Minimal
- DEFINITION OF AVIATION TERMS - Apparent Confusion
- RELATIONSHIPS TO ECON/DEMO FACTORS - None
- CITY-PAIR ANALYSIS - None
A review of forecasts of air carrier enplanements made by the organizations who were retained to address themselves to the future traffic growth in St. Louis revealed a similar pattern to that found for macro forecasts shown in earlier charts: the forecasts appeared to be strongly influenced by the recent past history of growth.

Interestingly, forecasters who were on opposite sides of the struggle do not appear to have been biased on the part of their clients nearly as much as they were influenced by recent history.

Similar variations were found in forecasts of other variables.
<table>
<thead>
<tr>
<th>Organization/Date</th>
<th>Actual 1970</th>
<th>Forecast</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ATA/TWA 1968</td>
<td>2.8</td>
<td>9.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMV/CBR 1969</td>
<td>2.8</td>
<td>10.1</td>
<td>28.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPEAS 1970</td>
<td>2.8</td>
<td>8.1</td>
<td>17.5</td>
<td>30.7</td>
<td></td>
</tr>
<tr>
<td>NADC 1971</td>
<td>2.8</td>
<td>6.8</td>
<td>15.8</td>
<td>31.0</td>
<td></td>
</tr>
<tr>
<td>McD-D 1971</td>
<td>2.8</td>
<td>8.7</td>
<td>21.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAC/SHE 1972</td>
<td>2.8</td>
<td>6.9</td>
<td>12.8</td>
<td>23.1</td>
<td></td>
</tr>
<tr>
<td>SARC 1972</td>
<td>2.8</td>
<td>6.5</td>
<td>14.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAA 1973</td>
<td>2.8</td>
<td>6.8</td>
<td>10.0 (1985)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VARIATIONS IN ST. LOUIS PASSENGER FORECASTS

The illustration shown here displays the data on the previous chart in graphical form: past forecasts have declined directly in response to the decline in passenger enplanement growth from 1969 to the present time.

The graph also shows the Peat, Marwick, Mitchell & Co. forecast developed in 1974. Again, recent history seems to have a major impact on the expectations of the future.
VARIATIONS IN ST. LOUIS PASSENGER FORECASTS

Passenger Enplanements (Millions)


1969

1972

1974

0 5 10 15 20 25 30
Examples of forecasting models used in St. Louis are presented on this chart. The top-down model is a type of ratio model referred to earlier. The bottom-up models are of the econometric type. All three models replicate historical data very well, yet they produced substantially different forecasts. Judgment was used to determine the most likely forecast.
"TOP DOWN" MODEL

\[ \text{PAX} = -0.0087 + 0.01689 \text{ USPAX} \]
\[ r^2 = 0.993 \]

"BOTTOM UP" MODELS

\[ \text{PAX} = -0.499 + 1.352 \text{ TPO} + 0.2969 \text{ INC} -0.336 \text{ FAR} \]
\[ r^2 = 0.987 \]

\[ \log \text{PAX} = -1.768 + 2.465 \log \text{POP} + 1.635 \log \text{EMP} \]
\[ +0.874 \log \text{INC} -0.800 \log \text{FAR} \]
\[ r^2 = 0.997 \]
An important element of any forecasting study should be sensitivity analysis.

In the St. Louis forecasting study by Peat, Marwick, Mitchell & Co., the sensitivity of future air carrier passenger enplanements to variations in input variables was calculated for a number of future conditions.

Based on this analysis, high forecasts and low forecasts of 17.0 and 11.0 million passengers, respectively, were chosen, based on an assessment of the probability of occurrence of the events indicated on the chart.

Such an approach can permit those charged with evaluating alternative courses of action to appraise the impact of uncertainty on various decisions.
## SENSITIVITY ANALYSIS
### AIR CARRIER ENPLANEMENTS

<table>
<thead>
<tr>
<th>Case</th>
<th>Year 2000 Enplanements*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLOW GROWTH IN PERSONAL INCOME</td>
<td>9.1</td>
</tr>
<tr>
<td>AIR FARES INCREASE--1% PER YEAR</td>
<td>11.1</td>
</tr>
<tr>
<td>TRANSFER PASSENGERS REMAIN AT 37%</td>
<td>11.8</td>
</tr>
<tr>
<td>GREATER DECREASE IN TRAVEL THAN ANTICIPATED</td>
<td>12.2</td>
</tr>
<tr>
<td>SLOW POPULATION AND ECONOMIC GROWTH</td>
<td>12.2</td>
</tr>
<tr>
<td>SEPARATE SHORT-HAUL AIR SYSTEM</td>
<td>12.8</td>
</tr>
<tr>
<td>IMPROVED AUTO FUEL ECONOMY</td>
<td>13.0</td>
</tr>
<tr>
<td>CRUDE OIL PRICE AT $11.00</td>
<td>13.1</td>
</tr>
<tr>
<td>CRUDE OIL PRICE AT $9.00</td>
<td>13.5</td>
</tr>
<tr>
<td>IMPROVED RAIL PASSENGER SERVICE</td>
<td>13.7</td>
</tr>
</tbody>
</table>

**Most Likely Forecast**

<table>
<thead>
<tr>
<th>Case</th>
<th>Enplanements*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST. LOUIS BECOMES AN INTERNATIONAL GATEWAY</td>
<td>13.8</td>
</tr>
<tr>
<td>NO LONG-HAUL/SHORT-HAUL ADJUSTMENTS</td>
<td>13.9</td>
</tr>
<tr>
<td>AIR FARES DECREASE--1% PER YEAR</td>
<td>17.1</td>
</tr>
<tr>
<td>RAPID POPULATION AND ECONOMIC GROWTH</td>
<td>21.1</td>
</tr>
<tr>
<td>TRANSFER PASSENGERS INCREASE TO 66%</td>
<td>22.5</td>
</tr>
</tbody>
</table>

*Millions of passengers
AREAS OF IMPROVEMENT

Some areas of improvement of aviation forecasting are suggested on this chart.

Improvements in the availability and consistency of historical data regarding aviation activity are needed. Regarding consistency, it is important to note that recent changes in definitions of variables have caused substantial problems to those charged with developing aviation forecasts.

Improvements in methodology should continually be sought, and those who achieve improvements should be encouraged to search for ways in which to make the achievement widely known through publications and presentations.

More agencies and organizations need to establish policies that will produce annual series of forecasts.

Where appropriate, multimodal forecasts of transportation demands need to be considered. Situations in which these types of forecasts may be appropriate include those in which the resource usage (and prices) of competing modes or the travel speed and service offered by competing modes may change in the future, and such changes may lead to changes in modal usage.

More use of sensitivity analysis and development of forecast ranges is recommended. In this regard, reflection of the forecaster's uncertainty regarding the future can be made explicit, and those utilizing the forecaster's results can explore the implications of different rates of growth.

Improved documentation of forecasting activities is badly needed. Here, the forecaster's report should include not only results of his forecasting activity, but the methods, data input, and assumptions, as well.

Finally, a number of specific studies should be undertaken. Included in this category of recommended areas of improvement are studies to provide a better understanding of the interactions between the demand for and the supply of transportation, studies of improved definitions of terms and the development of a syllabus of aviation terms to achieve consistency within the industry, development of guidelines for presentation of forecasting efforts, and improved data on aviation travel demand in terms of different types of travelers and different trip purposes.
AREAS OF IMPROVEMENT

- **IMPROVEMENTS IN DATA**
  - AVAILABILITY
  - CONSISTENCY
- **IMPROVEMENTS IN METHODS**
- **CONTINUED SERIES OF FORECASTS**
- **CONSIDERATION OF NEED FOR MULTIMODAL FORECASTS**
- **MORE USE OF SENSITIVITY ANALYSIS AND DEVELOPMENT OF FORECAST RANGES**

- **IMPROVED DOCUMENTATION**
  - METHODS
  - DATA INPUT
  - ASSUMPTIONS
- **UNDERTAKE SPECIFIC STUDIES**
  - DEMAND/SUPPLY INTERACTION
  - DEFINITIONS, SYLLABUS
  - GUIDELINES FOR PRESENTATIONS
  - DATA ON TYPES OF TRAVELERS AND TRIPS
  - MANY MORE
Summary

This paper documents the relatively wide variations in methodology used in the past by aviation forecasters, as well as the substantial variability in their forecasts.

With such problems, why attempt to forecast the future at all?

The objective of forecasting should not be to predict the future. If that is the objective, such efforts are doomed to failure.

The objective of forecasting should be to provide information that can be used to evaluate the impacts of our uncertainty about the future. We should be making forecasts of plausible, relatively high levels of growth, and of plausible, relatively low levels of growth. We should then evaluate the implications of alternative decisions in a planning context, should the growth turn out to be either high or low. We should be evaluating the risks, the opportunities foregone, and the costs of erroneous decisions associated with our high and low levels of growth.

Within this context, forecasting is an essential element of the process of reaching sound decisions.
BIBLIOGRAPHY


2. Air Transport Association of America. A.T.A. Airline Airport Demand Forecasts. July 1969. Also see forecasts for individual cities; for example, see Chicago Report, January 1971.


Bibliography (Cont.)


Bibliography (Cont.)


69. Loubal, Peter S. A Mathematical Model for Traffic Forecasting. Graduate Report, the Institute of Transportation and Traffic Engineering, University of California, May 1968.


Bibliography (Cont.)


Bibliography (Cont.)


89. R. Dixon Speas Associates. Site Selection Study, Second Air Carrier Airport, St. Louis Metropolitan Region, October 1970.


100. ______. Airports Service, Department of Transportation. *Aviation Demand and Airport Facility Requirement Forecasts for Large Air Transportation Hubs through 1980*, 1967.

101. ______. *Aviation Forecasts*. Various years.


Bibliography (Cont.)


111. ________ . National Aviation Goals, 1961. (Also referred to as Project Horizon.)


Because as a lawyer I represent a more philosophical perspective upon questions that most of this audience deals with in a scientific context, I would like to share with you the philosophical observations of a noted scientist:

False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for everyone takes a salutary pleasure in proving their falseness. (Charles Robert Darwin, The Descent of Man, Chapter 21.)

We lawyers at the Justice Department, of course, do not directly perform factual research on air transportation demand and systems analysis. We do, however, use those facts in connection with a number of our responsibilities. I will try to explain a little bit about the Justice Department's involvement with those facts, and give you some of my own views on the subject.

First, a word about the Justice Department. The Department is interested in air transport facts because, of course, the antitrust laws apply to the aviation industry in many respects, because the Department participates in litigation in CAB proceedings where competitive issues are raised, and because the Department plays a role in the formation of Executive Branch policy. The Department's general perspective in all these roles is that an increased reliance on free market competition would bring better results than tight controls on market structure and conduct by the Government or private parties. Contrary to the perceptions of some, the Department, in the aviation area as elsewhere, has not sought to subject businesses to many new and different types of constraints, but on the contrary has tried to remove or reduce regulatory constraints which presently confine private enterprises in the air transport industry and elsewhere. Similarly, we don't always support the plaintiff's side in antitrust litigation, and we do not oppose large enterprises
simply because they are large. As one example, the Department issued a business review some months ago indicating that it did not intend to challenge under the antitrust laws the plans of a group of private electric utilities to jointly purchase standardized nuclear power plants whose aggregate value probably will exceed two or three billion dollars. The goal of the Department's antitrust policy is efficient operations by private enterprises, and we cannot meet that goal by being "antibusiness."

From my perspective, the most useful research in the air transport area is that which allows economic analysis of competitive relationships. I will try to talk a little bit about the kinds of research that have been useful in the past, and make a few suggestions for the future.

Most of the research that I believe has been useful in this respect has grown out of university research, although not all of it was performed on the campus. The first category of useful work is what I would call synthesizing analytical works oriented toward broad policy questions. The comparative studies of commercial air transportation by Jordan, Keeler and others have been essential to an evaluation of the broad outlines of Government economic policy. The studies of service to smaller communities by the CAB's Bureau of Operating Rights and by George Eads have been very valuable in evaluating the Government's various programs for local service carriers and other intended specialists in low density air transportation. The new book by Douglas and Miller helps identify, analyze and to a rough extent quantify the results of Federal economic regulation of air carriers. For many years the basic industry study of air transportation by Richard Caves, and similar
works have, I think, made informed opinion somewhat suspicious of the utility of large airline mergers. On the other hand, none of these broad works created much of an impetus for freer pricing or entry in the industry. The Douglas and Miller book might have done so, but it was published after the trend toward support for pricing freedom in the industry had begun, largely supported by Douglas and Miller's research and analytical work in a much more specific context, that of the Domestic Passenger Fare Investigation (DPFI).

That work is an example of a different type of factfinding that is vital to the formation of intelligent policy; and as is frequently true of such narrowly focused analytical work, it was performed in the context of litigation. In the DPFI proceeding, the analyses of elasticity of demand with respect to fares and capacity, the value of travellers' time, and the extent of present competition vastly improved analysis of airline pricing, and led to load factor standards for CAB rate making. If these standards are, in fact, followed, they should lead to a substantial improvement in the industry's well-known tendency to generate excess capacity. This was a very significant change in long-standing regulatory policy of the Civil Aeronautics Board; and I believe it would not have taken place, or at least would not have taken such a basically constructive track, if research of the kind and quality that the DPFI produced had not been done. I believe a great many people believe strongly that passengers were and are required by Government policy to pay for a higher level of availability of airline capacity than they want to. But it was economic research and analysis that showed why this took place, roughly how much of it was taking place, and pointed the way to what to do about it.
Another example of work on specific competitive relationships took place in the domestic capacity agreement proceeding at the Civil Aeronautics Board. One of the issues that generated the most controversy there was whether there is a positive relationship between change and market share and change in capacity share in specific kinds of airline city-pair markets; whether loss equilibrium situations are characteristic of such markets, and the application of game theory to competition in airline markets. I represented the Department in that case, and I hope it provides a good example of a trend in the type of evidence taken into account on such issues. I hope this trend is away from very heavy reliance upon what I think of as the parade of venerable experts—a series of distinguished participants in the industry who testify at length as to their beliefs on specific issues within their expertise, which, of course, is also their livelihood. I hope the trend is toward the collection, analysis and testing of specific facts on the economic relationships at issue.

In the capacity case, the airlines who favored the agreements relied primarily upon opinion testimony of airline schedulers as to competitive relationships in airline markets. As a minor theme in their presentation, they also relied upon the application of game theory to airline scheduling by Professor Fruhan and others, but like Fruhan's book, this part of their case was based upon the logical appeal of the theory rather than an array of data to support it. On the other hand, various parties, primarily the Transportation Department, presented what George Eads, the Justice witness in the case, called the most complex body of formal economic evidence ever introduced before the CAB—or perhaps any regulatory agency. This included
a very extensive analysis of comprehensive data on airline market shares and capacity shares, and several different studies designed to the extent possible to quantify the very conventional theories of economic competition which were the major arguments of the opponents of capacity agreements, and to verify whether they appeared consistent with the facts. I hope the result will be not just a rather inconclusive ruling that one side or the other wins on the basis of a subjective weighing of the opinions of the parties, but a resolution of very important competitive issues on the basis of systematic analysis of the facts within an intelligent framework.

The capacity case reinforces the conclusion I have drawn from other similar proceedings that the amount of economic research performed on a controversial question certainly does not reduce the amount of controversy on that question; but by "factualizing" the dispute, such research usually improves the quality of the debate in the controversy. Ideally, factualization of a dispute removes facts from controversy and allows the parties to approach the remaining disputed or uncertain facts with greater precision and validity. Please don't interpret this as the naive belief that econometrics holds the answers to all economic controversies. I am merely saying that it can assume a central role in the resolution of some important controversies that have never been thought of as subject to "scientific" or quantitative analysis.

After that brief sample of the kind of research and analysis of historical data that I believe have been helpful, let me venture a few comments about upcoming events that I believe will heavily influence the need for research and analysis in this area. I am not as well equipped as most of you in the audience to speculate on the technical and economic changes that may be in
the wind in the air transport industry at present. It looks as though the picture is one of a stable technology with increasing pressures from costs, the maintenance of safety, and the elimination of pollution.

Everyone understands that technical developments can rather quickly change all the perceptions and established wisdom in a particular field, and make it necessary to reorient a great deal of the research that is done in that field. What I would like to talk about today is the kind of revision of existing methods and assumptions that can be brought about through law. An example of this is the change in environmental control laws from rather primitive concepts of public nuisance prevention to the extremely complex and demanding requirements for data research and analysis created by environmental protection statutes. All of this change took place in a comparatively brief period of time. These changes brought about new rules of law, new attitudes, and new means of analyzing and communicating on issues never before considered. I hope that we have arrived at a similar point in the economic regulation of air transportation in this country.

Economic relationships in air transportation in this country have almost from the beginning of the industry been subject to very comprehensive Government control. That system of control is based upon a number of important and deep-rooted assumptions, attitudes, rules and analytical techniques; and recently many of these have been subject to very persuasive challenges. Indeed, in the realm of economic regulation of air transportation, the emperor, if not naked, is at least indecently exposed. Our statutory system is, to use one of the kinder adjectives I can think of, very quaint. It was devised in the Thirties, during a period when air mail considerations dominated Government
policy making in air transportation. And yet by the time the original Civil Aeronautics Act was passed, creating economic regulation of interstate air carriers, revenues from commercial operations exceeded those from air mail.

The statutory scheme also was passed at a time when the mystique and glamor of air transportation, which still survives today, were perhaps at their highest point, and accentuated the belief that the air transportation industry possessed unique characteristics unknown to other economic activities, and therefore should be subject to an unusual form of government control. Perhaps equally important was the fact that the Civil Aeronautics Act, like many other economic regulatory statutes, was in a sense a product of the Depression, which had destroyed faith in free enterprise competition on the part of many, and led to a perhaps almost desperate belief in Government regulation and planning as the answer to if not all economic problems, at least those which were capable of solution.

Today, it is my view that the systematic studies of air transportation economic regulation, many of which I have mentioned already, lead us to newer and I think more defensible perspectives. To summarize, it appears that Government economic regulation is seldom necessary for consumer protection. For example, the evidence indicates that only very minimal economic regulation -- actually just financial responsibility regulation -- is necessary to protect consumers from unsafe airlines. A second principle is that in the absence of very rare circumstances economic regulation generally produces inefficiency and waste because of its tendency to protect poor performers, and transfers resources from other parts of the economy to the beneficiaries of government regulatory protection. In the air transportation industry, the very heated debate that has been going on for several months on economic regulation has
produced no significant instances I am aware of, and I have been following the
debate closely, indicating that economic regulation is justified. I think the
real issues in the regulatory reform debate are not "whether" to have reform,
but "how" and "how much."

Several agencies in the Executive Branch are working hard to answer those
questions, but as one participant in that process I would like to give you my
personal views as to what is necessary. First, and perhaps most importantly, I
believe route regulation should be reduced so as to allow significantly freer
entry onto individual routes and into the air transportation industry. There seems
very little doubt at this point that route restrictions by the CAB have cost
the economy a great deal by encouraging inefficiency and unresponsiveness of
carriers through route protection, and that restricted entry probably is a very
powerful narcotic to the protected firms' innovative instincts.

But the innovation point should not be overstated. In the railroad industry,
there appears to be very good evidence that regulatory protection has resulted
in near hostility to cost-reducing innovations. Frankly, I don't believe the
evidence in the air transportation industry is quite so clear on the effects of
regulation on innovative attitudes. The industry has certainly adopted new flight
equipment and hardware at an impressively rapid rate, in many respects perhaps
too rapid a rate. In the past, military procurement policies have probably had
more to do with the rate of adoption of new aircraft technology than economic
regulation; but this situation shows every prospect of changing quite rapidly.
My own view as an unscientific observer of airline competition in recent years
is that airlines subject to regulatory protection from competition are not as
likely to develop and adopt innovative marketing ideas that consumers want as an
airline without regulatory protection. In short, there is an impressive case for
substantially reducing if not eliminating regulatory route protection.
There is one issue related to route protection on which I have some reservations, and that is: What would the pattern of service be in the nation's air transportation system without route protection? What would the changes be in the pattern of service? I think it is now old hat that an airline with a very small fleet of small aircraft can operate as economically as a larger airline, and that in fact some of the largest airlines probably experience increased unit costs due to their large size. This does not lead one to believe that smaller communities are inherently less profitable than larger communities, particularly when profitability is considered in proportion to the size of the capital and risk requirements for the enterprise. Many small airlines provide high quality, efficient and profitable service to small communities. But testimony of United Air Lines in the recent Kennedy subcommittee hearings on airline regulation, and a study performed by the Air Transport Association, claim that without route protection the larger airlines would terminate service to numerous small communities; and that the result would be less satisfactory service to those communities.

First, even assuming that removing of route protection would lead the larger carriers to terminate service to small communities, it does not always follow that service quality at that community deteriorates. It appears just as likely that service quality would remain the same or improve, and it is probable that service at a small community would be more closely tailored to the demand and market characteristics of that community when provided by a smaller carrier. However, I believe that United and the ATA fell far short of
proving their claim that route regulation would lead to termination of service to small points by the larger carriers. I don't believe the ATA effort merits very much discussion, because it purports to represent the pattern of service which would be produced by a monopoly carrier on the routes analyzed. There are simply too many unrealistic assumptions between this conclusion and the starting point of route deregulation.

The United study is a more serious effort to portray what service pattern United Air Lines would operate if subjected to free entry and exit throughout its system. Although we are still studying it, I think the United study considerably overstates the service terminations it would make under deregulation, because it does not properly represent the value of these routes in terms of traffic feed to the remainder of United's system. But this area is a troublesome one that requires serious objective analysis. What are the advantages to system integration in air transportation? What would competitive route systems look like? This is a question that research and systems analysis can help answer, and I hope those of you who are involved in that sort of work will consider this subject.

By the way, an analysis of the most efficient route systems possible should by no means be limited to the domestic scene; very substantial changes are taking place and will continue to take place in international route systems, and I hope that it will be possible to analyze those changes in the light of information on how to devise efficient competitive route structures. Some air carrier proposals for restructuring route systems have been of this type, but a distressingly high percentage of the larger proposals in this area have been simply designed to reduce competition and increase monopoly power, regardless of the effect on efficiency. The staff of the Civil Aeronautics Board has
typically done very high quality analysis of this transaction in the past, but for institutional and statutory reasons, their efforts have been, in my opinion, directed more to the welfare of existing air carriers than the maximization of efficiency and responsiveness in the air transportation system.

I believe the questions I have mentioned will be the subject of very serious controversy in the Congress in the next few months or years, and I don't believe they can be satisfactorily answered without a very substantial effort in the academic community to provide the necessary research and analysis. It also appears certain that we can expect the best work of this kind to be done in the future, as it has been in the past, by independent scholars with no particular ax to grind.

One important example of this kind of work is that of Douglas and Miller on the extent of cross-subsidy in the regulated air transportation industry. As a result of this work it appears that cross-subsidy does not take place to a significant degree in the air transportation industry. Thus even if one believes cross-subsidy to be a justifiable reason for economic regulation, the fact that regulation has failed to accomplish cross-subsidization to a significant degree makes it even clearer that present restrictions on entry are unjustified.

Research of the kind I have discussed has led many careful observers to the conclusion that the pricing system in regulated air transportation also needs to be reformed. At times, the historical policy seems to contain an almost intentional disregard for the laws of supply and demand. In this connection, I am not referring to absolute demand far in the future, but the elasticity of demand at present. The result has been a pricing policy that is
probably bad for everyone it affects. It is only recently that rate regulation has recognized the relevance of load factor and capacity costs in intelligent rate regulation. On the other hand, the recent series of fare increases purportedly based on the increased costs of fuel and other components of airline services far exceeded those cost increases. Perhaps a greater proportion of those fare increases is actually designed to offset the deadening effect on traffic of the fare increase than goes to cover actual cost increases. My own feeling is that these fare increases have been counterproductive simply because they are based on an underestimate of the elasticity of demand. This observation is not based on any rigorous analysis of demand elasticity; the problem is that the Board's decisions do not appear to be based on such an analysis either. The problem here is not so much getting the research and analysis done, because it has been done quite well in several different places. The problem is inducing policy makers to take demand elasticity information into account.

There are two other important areas where research and analysis already point the way to improvement of present policies, and where even more such work would be desirable. One is a reconciliation of claims from the industry that the rate of return is insufficient to attract sufficient capital into the air transportation industry, with the frequent complaint from roughly the same quarters that the industry is burdened with severe overinvestment. Of course, as many people have pointed out, when there is overinvestment in an industry, economic theory tells us that its rate of return should fall below average, so that new investment will be made elsewhere and resources will tend to flow away from that industry, resulting in the optimal allocation of resources that is familiar to all of you. The surprising thing is that familiar as these ideas are, there has been little writing of which I am aware which attempts to relate
theoretical problems with the investment adjustment model to the facts and prove whether this conventional adjustment model describes what is going on.

The possibilities of and extent of predatory pricing in air transportation are an extremely important factual question when we consider increasing interstate air carriers' competitive freedom in pricing. Opponents of free price competition in the airline industry have been very vocal in claiming that predatory pricing would occur under fare deregulation. But leaving aside the question of whether antitrust enforcement can effectively prevent predatory pricing in the airline industry, or indeed anywhere, the factual evidence of predatory price competition in the airline industry is very sparse even at the anecdotal level. The mobility of air transportation assets, the absence of economies of scale, and the relatively low entry costs in the absence of restrictive economic regulation indicate that predatory pricing is not likely to be rewarding in the air transportation industry, and the facts seem to bear the theory out. But there is a real need for systematic examination of air carrier pricing practices on this point, and there is certainly nowhere near enough evidence to warrant taking the possibility of predatory pricing seriously as a defense of Government rate regulation. Until other evidence comes in, it seems clear that performance of the industry would be better with pricing freedom.

I will only comment briefly on the last important segment of airline regulatory reform, air carrier agreements and mergers. I believe the key piece of evidence here is the absence of significant economies of scale beyond a rather small minimum firm size. Because of this, we have no particular reason to believe that combining firms--particularly the larger firms--will increase efficiency rather than decrease it. The analyses that I have seen of specific economies achievable through merger have mostly been in the context of specific merger
cases, and my own view is that they have been uniformly very flaky. It would be useful for someone to test the specific kinds of cost-saving claims and other advantages that have been advanced in merger cases in a less adversary context and under less time pressure. The present state of the evidence convinces me that there is no reason to apply a different standard to airline mergers than that which applies to any other merger in the economy.

I feel much the same way about air carrier agreements; although, as I have mentioned, one specific kind of agreement, capacity agreements, has been subject to some very detailed scrutiny. I believe the evidence on capacity agreements relates to a good many air carrier agreements, at least agreements limiting normal competition among firms. And on the basis of that evidence, it is almost impossible for me to conceive of circumstances under which agreements to limit competition are necessary in the airline industry. But the airline industry also requires a vast array of cooperative agreements standardizing procedures and equipment, and performing tasks that could not be performed as efficiently or economically by each competing firm acting alone. At least as far as these agreements affect the price or quantity of service, I think they probably should be held per se illegal, as they would be under the antitrust laws. Where other components of airline service are affected by agreements, it appears that there should be a balancing of the benefits of those agreements against the detriments; and one cannot rely on rigid rules to predict the outcome of that balancing test, one must proceed in a case by case manner. The best way to do this is to insure that decisions are made under generally applicable standards by an objective and competent body. To perform this function, I would prefer the courts to a regulatory agency in most instances, and in particular in the case of the airline industry.
Before concluding, let me make a few remarks on the commercial aircraft market, from the viewpoint of an interested bystander. It seems to me that there is far less research and analysis of economic relationships in the commercial aircraft market than there is in the air transportation market. The reason for this difference may shed light on research policy. I may simply be ignorant of a large body of economic research related to the aircraft industry, but it seems to me there are three reasons there is less economic research performed per dollar of economic activity in the aircraft industry than in the air transport industry. Two of these reasons have to do with regulation. First, the presence of very comprehensive economic regulation in the air transport industry has generated a vast array of interesting information on economic relationships in the air transport industry. Information of this type is simply not available in unregulated industries, in no small part because firms do not want to make the details of their operations available to their competitors.

Secondly, and perhaps of equal importance, it appears to me that regulated firms may fall into the habit of abdicating the responsibility of performing their own research and analysis, or at least transforming that function into the presentation of justifications to the regulatory agency. This happens because the firm is going to be second-guessed whenever it makes a business decision of any consequence. Thus, there is a tendency for management to shift its attention from the performance of truly high quality research and analysis within the firm toward the supply of ammunition for well entrenched policy positions of the firm, which must be presented and defended to the regulatory body, frequently in an adversary context. Thus, regulated industries
may have by comparison with other industries a high quantity of research and analysis but a low quality.

The last factor that may account for the apparently lower level of research and analysis in the aircraft manufacturing industry is the fact that although the first airplane was made before the first airline could operate, the aircraft industry may in a sense be less developed and less mature than the airline industry. As I mentioned earlier, the airline industry passed from primarily government sales to primarily private sales in the 1930's. Recent reports indicate that commercial aircraft sales in this country are just beginning to equal government military sales. Thus, the private market for commercial transport jets is in a sense a new one. This might account for a low level of research in the past, but it should indicate the need for more work in the future.

It looks as though there is a trend toward more economic research on demand for commercial air transport aircraft, and this is an encouraging development from the standpoint of antitrust law. Many countries which have significant aircraft manufacturing industries are, to say the very least, quite concerned that such an industry cannot survive and compete without Government support. Debate on economic issues in the aircraft industry show a great need for what I referred to a while ago as "factualization." We need more facts on the rate of return necessary to attract assets to the industry; related to that is a need for considerably more facts on the nature of risks in the industry and economies of scale, if any. We also need considerably more information on the nature of foreign competition. What size are foreign firms? Do they enjoy relative freedom from antitrust constraints in their home countries? To what degree does government subsidy and favoritism exist? There is an abundance of generalized contentions on these topics but very few facts.
So, let me conclude with another word of encouragement to the fact producers. I hope there is a growing demand for the kind of factual information produced by those of you in this room, and I hope you will continue to use forums such as this one to continue to focus your considerable intellectual powers on the issues I have been discussing.
DEMAND ESTIMATION AS A FACTOR IN R&D PROGRAM PLANNING

J. P. Mullin
National Aeronautics and Space Administration
Office of Aeronautics and Space Technology
Study, Analysis and Planning Office

In considering proposed research one factor which the planner must evaluate is the benefit to be expected. He must also concern himself with timing of the proposed program, the appropriateness of the level of funding sought and the likelihood that the advance will be implemented. These factors are highly dependent upon one's estimate of the future state. In the area of civil aeronautics important characteristics of this future state are reflected in various demand estimates. Hence our interest in the subject matter of this conference. To be more specific NASA has a need for forecasts which have long term characteristics since the time between a decision to initiate a research project and its effective impact if adopted can be very long indeed—perhaps 15 years or more.

In what follows two examples of how demand estimates might be used in R&D program planning are briefly discussed. The first treats of research aimed at new, more fuel efficient aircraft and the second covers modifications to existing aircraft. It should be emphasized that methodology

Presented at "Air Transportation Demand & Systems Analysis Workshop"—Washington, DC, June 1975
rather than a specific result is being illustrated, and that my purpose in showing this to you is to demonstrate that research planning, as well as business decisions, can be affected by inadequacies in demand forecasting.

Research Aimed at New Aircraft

In this first case let us suppose we are attempting to determine an appropriate level of funding for a government sponsored research and technology program which has as its objective more fuel efficient aircraft technology for use in domestic civil aviation. Suppose further that we are limiting our analysis to direct cash savings and purposely exclude externalities such as pollution reduction or progress toward reduced energy dependence on foreign sources, which may in fact be the most important considerations.

The first step is to estimate the amount of fuel that will be required to operate the future system assuming no changes other than those that will occur through expected fleet mix mutation. This information can be derived from responsible revenue passenger mile and fleet mix forecasts.

As indicated in Figure 1, one can then estimate, assuming a year of introduction for a new aircraft, the segment of future fuel attributable to traffic carried by the new aircraft. It is this fuel which is subject to
savings due to new technology. To first order this estimation depends upon the retirement rate of older aircraft and the total traffic level expected, since the assumption is made that the economic life of existing aircraft are not reduced by the new aircraft. Assuming a fuel price the present value of fuel allocable to new aircraft can then be calculated. The gross present value of a percentage saving in fuel cost attributable to a more efficient new aircraft can then be displayed parametrically with fuel price as indicated in figure 2. As that figure further indicates we can arrive at an appropriate annual R&D investment by estimating the probability the advance will be incorporated, applying a tax rate to estimate net benefits, and an indication of desired return on investment through a management determined benefit-cost ratio. Incidentally, we do not maintain that the cash benefit measure used here is anything other than a practical surrogate.

This type of analysis contains considerable uncertainty and at this stage can hardly be considered deterministic—but it can be useful in grappling with a difficult public question. As Figure 2 implies the results are sensitive to estimates of both demand and fleet mix.
Setting Objectives for Research & Technology on Aircraft Modifications

One factor in deciding whether NASA should invest in research leading to aircraft modifications is an assessment of the likelihood that if the R&D is successful the improvement will actually be incorporated into the civil fleet.

In considering this likelihood (and ruling out for purposes of this analysis regulatory imposition) one needs to adopt the point of view of the airline manager. He will want to know if the proposed modification offers sufficient economic gain to offset the required investment. If it does, he will likely buy. If it doesn't, he will not and the NASA R&D supporting the advance will have gone for naught. In the discussion which follows, the practical decision methodology for an airline manager is briefly outlined and implications for the setting of specific objectives for R&T programs of this type are drawn.

There are a number of methods by which a proposed investment can be evaluated, including, for example, by computing its net present value using an appropriately selected discount rate, calculating its internal rate of return or using the payback method which divides the total investment by the average annual benefit realized to arrive at a payback period. The payback method is least satisfactory since it ignores benefits which accrue subsequent to the
payback period. Nevertheless, it is widely used in practical investment analysis because of its conservatism and simplicity. It may also be used when capital is difficult to raise. As has been indicated in discussions with industry representatives this method may be used by the airlines in evaluating proposed modifications.

In the detailed development of Appendix I it is shown that under payback criteria the maximum permissible investment is proportional to the gross constant annual benefit

\[ I = K_n S \]

where the constant of proportionality is a function of payback period, as well as marginal corporate tax rate, investment tax credit rate and depreciable asset life. This relationship is plotted parametrically with payback period in Figure 3 using the proportionality constants calculated in the appendix.

This information can be used by the R&D manager in setting specific targets for proposed research. If he can arrive at an estimate of expected gross annual savings with the proposed modification, and can get some idea of industry's payback policy, a quite specific objective in terms of total cost of the modification to an airline can be derived.
It is pointed out that this analysis provides insight into likelihood of implementation but does not treat the appropriate cost of the NASA R&D program. Appropriate investment level can be determined using methods analogous to those outlined in the previous section, and depend heavily upon timing and demand estimates.

**Conclusion**

The purpose of this discussion has been to illustrate the potential importance of moderate and long term demand estimates in R&T program planning. Such estimates have been shown to be significant in both the areas of determining appropriate program size and in setting specific project objectives.
TECHNOLOGY PROGRAM SIZING

PV SAVINGS

FUEL SAVING TARGET, %

FUEL COST

60 c/g

40 c

20 c

E(Bg)

DESIRED B/C RATIO

ANNUAL INVESTMENT $M

(5 YR LEVEL FUNDED PROGRAM)

PROBABILITY OF IMPLEMENTATION (PI)

$B

3 %

50%

33%

MARGINAL TAX RATE
GROSS ANNUAL SAVING

Payback = 1 yr

2 yrs

3 yrs

4 yrs

MAXIMUM INVESTMENT
The relationship of maximum permissable investment to gross annual benefit under payback criteria

The cash flow resulting from a gross income $S$ is determined as follows:

Gross Income or Reduced Expense $S$

Depreciation $D$

Taxable Income $(S-D)$

Tax @ $T$ $T(S-D)$

Profit After Tax $(1-T)(S-D)$

Cash Flow $(1-T)(S-D) + D = S-T(S-D)$

(PAT + Depreciation)

or in the $n^{th}$ year

$$(CF)_n = S_n - T_n(S_n - D_n)$$

To get total cash flow the first year investment tax credit must be added & $(CF)_n$ summed

$$CF = \frac{1}{n} \sum_{n=1}^{\infty} (CF)_n + ITC = \frac{1}{n} \left[ \sum_{n=1}^{\infty} [S_n - T_n(S_n - D_n)] + ITC \right]$$

Then the average annual cash flow is:

$$\bar{CF} = \frac{1}{\bar{n}} \left[ \frac{1}{\bar{n}} \left[ \sum_{n=1}^{\infty} [S_n - T_n(S_n - D_n)] + ITC \right] \right]$$

The payback period is defined as total investment/average annual benefit

$$P_B = I \left( \frac{\bar{CF}}{\bar{n}} \right)^{-1} \text{ where } I \text{ is Investment}$$

Therefore:

$$I = \frac{P_B}{\bar{n}} \left[ \frac{1}{\bar{n}} \left[ \sum_{n=1}^{\infty} [S_n - T_n(S_n - D_n)] + ITC \right] \right]$$
For a payback analysis $P_B$ is appropriately set equal to $n$, and double declining balance (DDB) depreciation* should be used to maximize early year cash flow. Under DDB it can be shown that:

$$D_n = I \left( \frac{2}{L} \right) \left( 1 - \frac{2}{L} \right)^{n-1}$$

where $L$ is depreciable asset life making these substitutions for $I$ we have

$$I = \frac{S}{n} \left( S_n - T_n \left( S_n - I \left( \frac{2}{L} \right) \left( 1 - \frac{2}{L} \right)^{n-1} \right) \right) + ITC$$

Recognizing that $ITC = RI$ where $R$ is tax credit rate assuming gross income & tax rate ($T_n$) constant we sum & rearrange to:

$$I = \frac{nS(1-T)}{[1 - \frac{2T}{L} \frac{R}{n} (1 - \frac{2}{L})^{n-1} - R]}$$

Assume: Marginal tax rate $T = .48$

(this could be adjusted to include state and local tax as well)

ITC rate $R = .07$

Then

$$I = \frac{.52nS}{[.93 - .96 \frac{L}{n} (1 - \frac{2}{L})^{n-1}]}$$

For the aircraft modification problem we can assume depreciable asset life $L = 10$ yrs. and hence:

$$I = \frac{.52nS}{[.93 - .096 \frac{L}{n} (.8)^n]}$$

or

$$I = KnS$$

where $Kn$ is determined by choice of payback policy $n$ & is tabulated below for several $n$'s.

<table>
<thead>
<tr>
<th>$n$</th>
<th>$Kn$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.624</td>
</tr>
<tr>
<td>2</td>
<td>1.39</td>
</tr>
<tr>
<td>3</td>
<td>2.24</td>
</tr>
<tr>
<td>4</td>
<td>3.20</td>
</tr>
</tbody>
</table>

*It should be noted that it may be permissable to expense some modifications, which can be handled by setting $D = I$ in the first year, and $D_n = 0$, $n \neq 1$. Also if straight line exceeds DDB it would be used.
THE ROLE OF EPA IN
REGULATING AIRCRAFT/AIRPORT NOISE
By John C. Schettino &
Harvey J. Nozick

ABSTRACT

A principal finding of the Environmental Protection Agency (EPA) in its study of aircraft and airport noise in compliance with the Noise Control Act of 1972, was that a comprehensive national program for aircraft/airport noise abatement was needed to insure that the noise control options available to the aircraft manufacturers and operators, the airport operators, the Federal Government and other public authorities are implemented to protect the public health and welfare. To initiate implementation of this finding and to bring about near-term reductions in community noise levels, the EPA is currently preparing regulations to be proposed to the Federal Aviation Administration (FAA) for noise abatement flight procedures, noise source emissions (aircraft certification), and airport noise. For the longer term, the EPA is conducting a study to determine the noise reductions required to progressively lower community noise levels resulting from aircraft operations and upon which to base a coordinated long-range aviation noise abatement and control program. The status of EPA regulations and the preliminary results of the long-range aviation noise requirements study are presented.
This presentation is concerned with aircraft noise and EPA's role in the development of a long-range program of abatement and control. Public and Federal awareness of the effects of aircraft noise reach back almost fifty years. One of the earliest recorded reports of aircraft noise nuisance occurred in 1928 when the proprietor of a poultry farm in Ohio complained that low-flying planes were disrupting egg production. Federally sponsored research aimed at reducing the levels of aircraft noise began in the Forties when the NACA (National Advisory Committee for Aeronautics) initiated a research project investigating noise propagation from light airplanes.

Over the past twenty-five years there has been a plethora of Federal agency studies, Ad Hoc Commission reports, and industry investigations stimulated by the continuing and growing problem of aircraft noise. Not only has the population residing near airports been increasingly impacted by this problem, it has also inhibited the growth of the aviation industry.

During the past five years, a significant increase in national concern for the improvement of environmental quality standards has led to several specific legislative actions for enhancing the quality of life and protecting the health and welfare of the U.S. citizenry.
Before reviewing the current status and future objectives of the EPA program, a brief review of the legislative history, which precipitated these actions, is appropriate.
LEGISLATIVE HISTORY

I. The "Reorganization Plan #3 of 1970" created the U.S. Environmental Protection Agency by transferring fifteen existing Governmental units, with their functions, responsibilities, and legal authority, to the new agency. The primary purpose of the Plan was to provide for a consolidation of pollution control authority under one Administrator, rather than a disjointed array of proliferating independent programs. The areas of pollution control affected by this Reorganization Plan included chemical, radiation, pesticide and solid waste effluents. Notably absent at this point was the Federal responsibility for noise pollution control. The Council on Environmental Quality, which is the environmental policy office within the Executive Branch, indicated at that time that it was developing recommendations for the President in the field of noise regulation, and that the additional responsibility for noise may be added to the EPA mandate at a later date.

II. Public Law 91-604, "The Noise Pollution and Abatement Act of 1970" is the Title IV Amendment to the Clean Air Act, which provided for the establishment of an Office of Noise Abatement and Control (ONAC) within the Environmental Protection Agency. ONAC was charged with carrying out "... a full and complete investigation and study of noise and its effect on the public health and welfare . . .". The
study report was to be submitted to the President and the Congress within a year, together with recommendations for legislation or other action.

"The Report to the President and Congress on Noise"(2) was completed in December of 1971 and officially submitted on January 24, 1972. Fifteen Technical Information Documents(3-17) were developed during the course of the investigation, and used as the bases for the Report. Also used in the preparation of the Report were eight volumes of documented testimony (18-25), related to various aspects of the study, which were obtained at a series of public hearings under authority of the Act.

Concurrently with the development of the Report, both the Administration and various Congressional Committees had developed legislative proposals which would provide the authority to institute noise control actions. The Title IV Report provided much of the supporting documentation leading to the eventual development of the Noise Control Act of 1972.

III. Public Law 92-574, "The Noise Control Act of 1972", was passed on October 27, 1972. For purposes of this review of aircraft/airport-related noise abatement and control, three sections of the Act are significant:

Section 4 - Federal Programs
Section 5 - Noise Criteria and Control Technology
Section 7 - Aircraft Noise Standards
A. Section 4

The specific authorization for EPA to establish interagency noise research coordination is in Section 4(c)(1) of the Noise Control Act which reads:

"The Administrator [of EPA] shall coordinate the programs of all Federal agencies relating to noise control. Each Federal agency shall, upon request, furnish to the Administrator such information as he may reasonably require to determine the nature, scope, and results of the noise-research and noise-control programs of the Agency.

The EPA envisions that such research coordination can provide a mechanism to aid in fulfilling its responsibilities under Section 4(c)(3) of the Act:

"On the basis of regular consultation with appropriate Federal agencies, the Administrator [of EPA] shall compile and publish, from time to time, a report on the status and progress of Federal activities relating to noise research and noise control. This report shall describe the noise-control programs of each Federal agency and assess the contributions of those programs to the Federal Government's overall efforts to control noise."

EPA has initiated a definitive program for the mandated coordination and reporting authority expressed in the Act. This is discussed in more detail in subsequent sections of this paper.

B. Section 5

Section 5(a)(1) states: "The Administrator [of EPA] shall, after consultation with appropriate Federal agencies, . . . develop and publish criteria with respect to noise."

Section 5(a)(2): "The Administrator [of EPA] shall, after consultation with appropriate Federal agencies, . . . publish information on the levels of environmental noise, the attainment and maintenance of which in defined areas under various conditions are requisite to protect the public health and welfare with an adequate margin of safety."
Reference 26 provides the background criteria information required in Section 5(a)(1) of the Act. It reflects:

"... the scientific knowledge most useful in indicating the kind and extent of all identifiable effects of noise on the public health and welfare, which may be expected from differing quantities and qualities of noise."

The data therein was subsequently utilized in developing the so-called "Levels Document" required under Section 5(a)(2) of the Noise Control Act. That report identified environmental noise levels, and duration of exposure, related to hearing loss and criteria. These levels will be used as guidelines for future regulatory action which EPA is considering.

C. Section 7

Section 7 of the Act is concerned solely with aircraft noise. It required EPA to conduct a study of the:

"(1) adequacy of Federal Aviation Administration flight and operational noise controls;
(2) adequacy of noise emission standards on new and existing aircraft, together with recommendations on the retrofitting and phaseout of existing aircraft;
(3) implications of identifying and achieving levels of cumulative noise exposure around airports; and
(4) additional measures available to airport operators and local government to control aircraft noise."

The completed study was submitted in July 1973 along with six supporting technical documents. The report indicated that EPA would propose aircraft and airport noise regulations to the FAA for promulgation, where EPA determined that these regulations were necessary to protect the public health and welfare. It is significant to note
that under the provisions of the Act, FAA retains its authority for the promulgation of noise regulations. EPA can propose regulations to the FAA, which must be acted upon in accordance with Section 7(c)(1) of the Noise Control Act, which defines the details of the EPA/FAA procedural relationship in carrying out the development of these aviation noise control regulatory actions. The status of the EPA-proposed regulations is discussed in the following section.
I. Proposed Noise Regulations

As a result of the July 1973 Aircraft/Airport Noise Study, EPA determined that an effective program to protect the public health and welfare with respect to aircraft noise would require the development, and proposal to the FAA, of three complementary types of regulations:

A. Noise abatement flight procedures.

B. Noise source emission regulations requiring modification of the existing jet fleet, in addition to more stringent noise control criteria for future aircraft developments.

C. An airport noise regulation, which would limit the cumulative exposure received by noise-sensitive communities surrounding airports.

Nine proposals have been or are being developed by EPA; three covering flight procedures, five source control regulations and one airport regulation. The status of each, as of January 31, 1975, is discussed in the following paragraphs. It should be pointed out that the FAA has indicated that they are currently developing several aircraft source noise regulations or proposed regulations. These regulations may be completed and promulgated prior to the issuance of the EPA proposals.
If, in this case, there is no substantive difference between the two agencies, with respect to health and welfare considerations, then EPA will probably not go forward with their proposal. To do so would only serve to delay any Federal action in the area of noise abatement. Reporting on the specific details of each EPA proposal is not appropriate for this forum. However, this information is available (or will be available) in the Federal Register as indicated below. All of the operational procedure and source control regulations are scheduled for submittal to the FAA before the end of this Fiscal Year.

A. Flight Procedures

(1) Minimum Altitudes

NPRM 74-40, submitted to the FAA on December 31, 1974 (and reported in the Federal Register on January 6, 1975), proposes that the recommended "keep-'em-high" procedures indicated in FAA Advisory Circular 90-59 be made mandatory. This would keep all turbojet (including turbofan) aircraft higher in the terminal area prior to the approach and landing phase. Written comments on the proposed rule are to be submitted by March 7, 1975. A public hearing is scheduled for March 5, where public participation in the rule making process is solicited. FAA action on the proposal will follow in accordance with the provisions of Section 7(c)(1) of the Noise Control Act.
(2) Takeoff

Individual airports, or runways of the airports, can be placed into the following three main categories regarding community noise exposure: sideline noise sensitive; near downrange noise sensitive; and far downrange noise sensitive. A set of standard takeoff procedures, reflecting these airport characteristics and suitable for safe operation of each type of civil turbojet airplane, is being considered to minimize the noise exposure of the noise sensitive communities.

(3) Approach and Landing

Two-segment approaches and reduced flap settings are being considered as typical operational procedures that would effectively reduce noise impact under the aircraft approach path. The two-segment approach results in reduced thrust settings and increases the distance between the noise source and the receiver thereby reducing the noise impact. Reduced flap settings permit lower engine thrust settings thereby reducing the noise energy developed at the source.

B. Source Control (Aircraft Certification)

(1) Propeller-Driven Small Airplanes

On January 3, 1975, the FAA issued Amendment 4 to FAR Part 36 (published in the Federal Register January 6, 1975), which established noise standards for this
category of aircraft effective February 7, 1975. 
EPA believes that this class of aircraft can meet 
more stringent requirements and accordingly has 
submitted a proposed regulation to the FAA (NPRM 
74-39), published in the Federal Register on 
January 6, 1975). Some of the areas of non-concurrence 
include:

(a) the unit of noise measurement, 
(b) the noise levels, 
(c) the compliance dates, 
as well as some technical and procedural differences. 
The FAA has indicated that publishing the FAR 36 
Amendment does not preclude the future adoption of the 
EPA proposals as a supplement to the Amendment. This 
will be subject to the comments on the EPA-proposed 
NPRM and results of public hearings on the subject, 
scheduled for March 3-4, 1975.

(2) Retrofit/Fleet Noise Level

Two separable, but interrelated regulations have 
been developed. The first is essentially a straight 
retrofit rule (similar to that proposed by the FAA in 
NPRM 74-14), which would require all civil subsonic 
turbojet aircraft to meet the requirements of FAR 36.
The EPA proposal would include aircraft of less than 75,000# gross weight, whereas the FAA-proposed rule would exempt these aircraft at this time.

The second proposed regulation, a Fleet Noise Level Rule, would supplement the retrofit rule and provide a means for exploiting future technology. It would permit a "ratcheting down" of the allowable noise levels in accordance with demonstrated technology developments. Both of these proposals were submitted to the FAA on January 28, 1975.

(3) Supersonic Civil Aircraft

A proposed regulation is being developed which relates to both the current production aircraft (Concorde and TU-144) and future production of new-type (yet to be developed) supersonic civil aircraft. Source noise control for the Concorde and TU-144 has been applied, as far as available technology permitted, during the development cycle of these aircraft. Although they still cannot meet the noise levels established for subsonic turbojet aircraft, their contribution to the community noise problem can be mitigated by various operational controls. Several options will be identified in the NPRM and public comments are to be solicited. Future aircraft, on the other hand, utilizing demonstrated advanced technology components, will be required to meet specific noise limits.
(4) Short Haul Aircraft

A proposed noise regulation for short haul aircraft is being developed. For this purpose, "short haul" relates to aircraft with VTOL, STOL or RTOL characteristics as defined by specified runway lengths. Because of the unique noise characteristics and flight patterns associated with helicopter operations, a separate rule may be developed for this class of aircraft.

(5) Modifications to FAR 36

FAR Part 36, which established noise limits for new-type certificated turbojet aircraft, was promulgated in December 1969. Approximately a dozen new-type aircraft have been introduced into the civil fleet since then, each of which meet the noise criteria of FAR 36, and most of them significantly below the prescribed limits. In addition, new production of non-noise certificated turbojet aircraft must now also meet FAR 36 noise limits as a condition for receiving an airworthiness certificate (Amendment 2 to FAR 36).

These actions, together with pending retrofit rules would not only insure non-escalation of current aircraft noise exposure impacts in the vicinity of airports but would result in a substantial reduction. For future
aircraft, subsequent technology developments are expected which would produce still lower noise levels. The EPA proposal to the FAA will require, for future aircraft designs, the employment of the best available noise control state-of-the-art as well as application of technology developments currently in progress. Another feature being considered for inclusion in the EPA proposal is directed to insuring that aircraft certificated at noise levels lower than those presently permitted by FAR 36 will be allowed only a limited growth in noise levels in subsequent derivative airplanes. Figure 1 illustrates how regulatory actions can accomplish these objectives by progressively lowering the allowable noise levels in new production aircraft.

A summary of FAA regulatory actions in the area of aircraft source noise abatement is presented in Table 1. We believe the release of the EPA Report to Congress\(^{(28)}\) in July 1973 may have provided a stimulus for accelerating the FAA's action program.

C. Airport Noise Regulation

It is generally recognized that even with the application of source technology and optimum operational procedures, there will still be a residual noise impact on communities surrounding the nation's airports. The magnitude of this impact is directly related to airport activity; that is:
- Number of operations
- Type of aircraft
- Runway/community co-relation
- Proportion of night operations

The airport noise regulation envisioned will establish a process whereby the airport operator, utilizing all of the tools at his disposal consistent with his legal authority, will be able to develop a plan (within the constraints of safety) for minimizing the effects of aircraft noise on the adjacent communities. Prior to the establishment of such a regulation, the EPA plans to test the concept (or process) at various airports. The U.S. Air Force is participating in this program, utilizing Andrews Air Force Base as a test site. Several civil airports will be participating as well, with AOCI support. Results of these tests will contribute much needed data for establishing the details of the regulation to be developed. It is expected that this proposed regulation will be submitted to the FAA for promulgation later this year.
II. Interagency Coordination

A. Research and Development

Early in 1974 EPA initiated its Federal noise research coordination effort by establishing four interagency noise research panels relating to aircraft, surface vehicles, machinery and health effects. Agencies represented on these panels are shown in Table 2.

In addition to exchange of information, the general functions of the panels in their respective areas are:

* Review and assessment of the current state of technology.
* Review and assessment of the status of research and technology development.
* Preparation of recommendations concerning ongoing research activities.
* Recommendation of noise research programs and projects, and methods for their accomplishments.
* Preparation of reports on the status and/or progress of ongoing noise research activities.
* Receipt and review of pertinent scientific and programmatic advice from communicating with other standing bodies.
During calendar year 1974 the research panels' efforts were directed primarily to preparation of reports on the status and progress of ongoing noise research activities. This represented a first step in the EPA program for meeting the requirements of Section 4(c)(1) of the Noise Control Act. A summary report(35), based largely on the panel reports, has been prepared. The report describes the status of current Federal activities relating to noise research and control. This is the first in a series of periodic reports to be developed in conformance with Section 4(c)(3) of the Noise Control Act. Although the report provides descriptions of Federal agency noise research and control programs, it contains only limited information with respect to the "assessment" referred to in the Act. In-depth analyses of those programs will be initiated in the near future to determine the relevancy of the research underway to support the near- and long-term goals of EPA, which is to reduce environmental noise to acceptable levels. In addition, the assessment will identify the requirements for additional research efforts. With respect to aircraft/airport noise, this assessment is part of a long-range noise abatement program currently under development and discussed in more detail later in this presentation. As part of the process of conceptualizing
a long-range National Aviation Noise Abatement Program (NANAP), a report was prepared for ONAC by Informatics, Inc., which had as its objective a review of previous organizations and studies that have concerned themselves with the coordination of Federal activities and policies in the field of civil aviation(36). It was felt that by illuminating some of the pitfalls experienced in the earlier attempts at coordination, which may have limited their effectiveness, the same constraints could be avoided in the future. One of the principal conclusions resulting from this study was:

"Successful coordination efforts in the past have evidently been facilitated by high-level agency support and participation as well as the existence of an appropriate coordinating institution."

This high-level Agency involvement has become a key requisite in the development of the NANAP. An initial step has been taken in this regard with the preparation of a Memorandum of Understanding between the EPA and the DOT.

B. Memorandum of Understanding

Comments have been made that Section 7 of the Noise Control Act places EPA and FAA in an adversary relationship. We do not see it this way, nor does the Legislative History of the Noise Control Act indicate that this was the
Congressional intent. Any such relationship would be a negative approach to the problem thereby resulting in drawn out procedural delays in implementing a positive noise abatement program. In order to remove the potential of such delays occurring, a Memorandum of Understanding (MOU) has been drafted between the Environmental Protection Agency and the Department of Transportation (including the FAA). The MOU establishes a coordination (or consultative) process between the two Agencies to facilitate the exchange of information and views on noise program activities of mutual interest, including proposed and final regulations and planned research and development programs which relate directly to these regulatory proposals or actions. The agencies are committed to effecting a full and frank exchange to minimize duplication of effort and to assure that, prior to offering a proposed action for public comment, disagreement has, to the maximum extent possible, been resolved or the area of disagreement has been clearly delineated. The day to day coordination is to be effected at the working level through the Office of the Deputy Assistant Administrator of ONAC and the Director of Noise Abatement of DOT. If unresolvable disagreements arise at this organizational level, the problem is
referred upwards for resolution. Through this procedure, it is anticipated that substantive differences can be resolved early enough in the regulatory process so that noise regulatory actions can be expedited.
FUTURE REGULATORY ACTIONS

Previous sections of this paper provided a brief overview of the past and present activities of the EPA in its continuing effort to provide public health and welfare guidelines and specific proposals for abating aircraft noise. The proposed aircraft noise regulations currently being developed are limited by the available technology capability provided by the combined research and development programs of both the Federal Government and private industry. While implementation of the aircraft source noise regulations discussed earlier will bring considerable relief to a large sector of the noise impacted population, they alone will not eliminate the problem. Promulgation of an airport regulation, in conjunction with more responsible land use planning around airports, will prevent the problem from escalating. However, as air traffic demands increase, the airport regulation alternatives could also inhibit future airport and airline growth unless additional technology developments are encouraged.

Recent forecasts (37-39) of air carrier traffic growth and fleet size indicate significant increases in numbers of operations and quantity of jet aircraft in the fleet, both of which reflect increased passenger demand. Historically, the size of new aircraft tends to increase with time as growth derivatives of current aircraft and new replacement aircraft are introduced into the fleet. Figure 2 illustrates the most
recent FAA jet fleet forecast which includes the longer term effects of the currently depressed economy as well as the impact of jet fuel costs and availability. These constraints result in a reduction in the pace of acquisition of new and quieter aircraft with a concomitant extension in the service life of the older JT3D and JT8D powered aircraft. Superimposed on the figure is the forecast data from the DOT 23 Airport Study(39). While the old narrow body fleet assumption is consistent with that of the FAA, the DOT study assumed a more rapid introduction of quieter aircraft into the fleet. It should be remembered that the inputs to this study were frozen before the long-term effects of the economic downturn and the fuel "crisis" became apparent.

Similarly, Figure 3 indicates a forecasted growth in aircraft operations. The FAA growth rate of 4 percent through FY 1980 results from the slower introduction of newer larger aircraft. Beyond 1980, the growth rate decreases as new larger aircraft are progressively introduced into the fleet. The DOT study forecast depicts a steady growth in operations through the forecast period.

The combination of more and larger aircraft, operating more frequently, will inevitably lead to increased noise exposure unless preventive measures are taken early enough. One such measure, in addition to the steps currently underway, is to insure that as new noise reduction technology is developed, a means for applying this technology to future aircraft programs is available.
In the past, noise technology has been developed without specific objectives and with no planned schedule for eventual application to production or development aircraft. With the publication of the "Levels" document\(^{(27)}\) some guidelines are now available. Figure 4 illustrates, conceptually, the relative benefits resulting from the implementation of some aircraft noise abatement regulations currently being proposed by the EPA and the FAA. The data base for the Figure, through 1987, was developed in the DOT sponsored study\(^{(39)}\) which included detailed analyses of present and future operations at 23 U.S. airports (accounting for a majority of the U.S. enplanements and arrival and departure statistics). The input data to this study assumed there would be some new or derivative aircraft added to the fleet by 1987. The noise levels generated by these new aircraft were assumed to be consistent with the levels representative of the current widebodies and those demonstrated for the SAM retrofit of the narrow bodies and estimated for re-fanned engine programs. In a follow-on study sponsored by EPA\(^{(40)}\), the results of the 23 airport study were extrapolated to provide a national estimate. In addition, data were developed for the year 2000 which included the potential development of another generation of quiet aircraft.

A brief discussion of these results is appropriate at this time. As indicated in Figure 4, the assumed change in fleet mix will produce a significant reduction in noise impact area over the next 20 years. By implementing SAM retrofit and operational procedures this benefit
can be realized as early as 1978. Furthermore, if the fleet mix and aircraft operational statistics turn out to be less optimistic than forecasted, (that is, quieter and newer aircraft remain a small percentage of the fleet, resulting in increased operations of the current narrow-bodied aircraft as indicated in Figures 2 and 3), then the upper curve which represents the results due to fleet mix would tend to move up, thereby producing somewhat reduced noise benefits. The retrofit curve would also tend to move up due to the increased operations but not nearly as much, since the noisy aircraft in the fleet will have been modified, thereby maintaining the fleet benefits derived therefrom.

In order to indicate the benefits of future noise reductions, additional studies were conducted to determine relative noise impact areas, assuming all of the aircraft in the U.S. air carrier fleet were at levels of at least FAR 36 minus 5, 10, 15, and 20 dB's. This study did not attempt to establish the feasibility or practicability of achieving these arbitrary reductions in aircraft noise levels. The objective was to develop a better perception of the relative noise reduction value of these alternatives if in fact they were to become available in future years through improved technology. As indicated in Figure 4, FAR 36-20 could, on a national basis, reduce the NEF 30 impact area to zero. Whether this is a realizable, or even a necessary, objective is yet to be determined.

In terms of objectives, a slightly different cut at the problem highlights the need for a coordinated attack, covering all noise
regulatory actions, in order to provide a balanced program of noise reduction which can yield the most benefit, for the least cost, at the earliest time.

Figures 5(A-D) provide a conceptualized approach for identifying required aircraft and airport noise regulatory actions against a theoretical set of noise objectives.

For purposes of this discussion, the two horizontal lines in Figure 5A depict hypothetical health and welfare objectives. The upper line relates to the potential for hearing loss with long-term exposure to a given level of noise. The lower line relates to an annoyance level which characterizes interruption of normal human activity such as, for example, speech interference. If the long-term objective is to reduce the intrusive noise to a more acceptable level, then specific actions need to be programmed in order to provide the technology which can then be integrated into the system in an economically reasonable time frame. The two curves of Figure 5A represent the noise environment at the airport boundary (or at the community interface) at hypothetical large and medium hub airports. It must be recognized that the airport noise problem is extremely site-specific so that remedial action at one airport may not prove as beneficial at another airport where there may be differences in terms of aircraft types, flight tracks, location of residential communities, etc.

Point A on the figure identifies today's environment. At the large airport, the noise level is such that there is a potential for hearing
damage with long-term exposure. At the medium hub, the aircraft noise environment is below this level but still well above the annoyance criterion. Point B illustrates the conceptualized airport environment, due to aircraft noise, after a fleet retrofit program has been implemented and optimized operational procedures have been introduced. Finally, Point C illustrates what might result as the aircraft noise levels are reduced still further as new quieter aircraft replace the older aircraft in the fleet. These aircraft, in this time frame, would utilize the technology which had been developed and demonstrated in the early 70's. Even with this, the airport community may still be exposed to high annoyance levels. If the objective is to be achieved, additional research and development is required. The rate at which the development effort is scheduled, however, is dependent upon other factors, in addition to technological and budgetary constraints.

Figure 5B superimposes a theoretical ambient noise environment around the airport which is growing due to assumed increases in highway, recreation, and/or construction activity. By 1987, it is apparent that additional reductions in aircraft source noise will not result in any noticeable benefits in the community unless the ambient level is also reduced. This then requires a balanced noise reduction program rather than a concentrated effort on any one noise source. If the ambient noise is controlled so that it remains below the threshold of the aircraft source noise (Figure 5C), then the aircraft noise impact could be further reduced by technology refinements, imposing airport operational
restrictions and/or the use of appropriate land use options. The degree of effort required is a function of the specific airport and environ characteristics and the anticipated results of continued source noise reduction potential, both for aircraft and non-aircraft sources.

The most extreme case is where the ambient noise is steadily reduced through regulatory actions affecting non-aircraft source noise so that aircraft generated noise continues to be the dominant cause of annoyance as indicated in Figure 5D.

The EPA proposed National Aviation Noise Abatement Program (NANAP) will consider all of the elements discussed previously in the development of a planned program for future aircraft noise regulatory actions. In summary, these will include:

- Establishment of noise reduction objectives in terms of levels to be attained and compliance dates. These may be modified with time as new information becomes available.
- Quantification of the airport noise environment resulting from present regulatory actions.
- Evaluation of the current technology efforts in noise research and development in terms of their application benefits.
- Coordination of aircraft and non-aircraft noise reduction technology and their interactive implications.
- Identification of the future research and development needs to meet the established noise objectives.
The NANAP will be developed and coordinated utilizing a formal interagency mechanism which will minimize unnecessary duplication of research and development and be directed to the attainment of pre-defined noise objectives.

An effective program for aircraft noise abatement requires a national commitment to improve the quality of life in the human environment. The dedication of industry and the Federal Government to achieve this end is unquestioned. All that remains is to "get on with it."
REFERENCES

(1) FAA Historical Fact Book - A Chronology, 1926 - 1971, Department of Transportation, Federal Aviation Administration, 1974

(2) Report to the President and Congress on Noise, Senate Report 92-63, Feb. 1972


(4) Noise from Industrial Plants, EPA Report NTID300.2, Dec. 31, 1971


(7) Effects of Noise on Wildlife and Other Animals, EPA Report NTID300.5, Dec. 31, 1971

(8) An Assessment of Noise Concern in Other Nations, EPA Report NTID300.6, Dec. 31, 1971

(9) Effects of Noise on People, EPA Report NTID300.7, Dec. 31, 1971

(10) State and Municipal Non-Occupational Noise Programs, EPA Report NTID300.8, Dec. 31, 1971

(11) Noise Programs of Professional/Industrial Organizations, Universities and Colleges, EPA Report NTID300.9, Dec. 31, 1971


(14) The Effects of Sonic Boom and Similar Impulsive Noise on Structures, EPA Report NTID300.12, Dec. 31, 1971


(18) Public Hearings on Noise Abatement and Control, Construction Noise - Atlanta, Georgia, VOL I, July 8-9, 1971


(21) Public Hearings on Noise Abatement and Control, Standards and Measurements Methods, Legislation and Enforcement Problems - San Francisco, California, VOL. IV, Sept. 27-29, 1971

(22) Public Hearings on Noise Abatement and Control, Agricultural and Recreational Use Noise - Denver, Colorado, VOL. V, Sept. 30 - Oct. 1, 1971

(23) Public Hearings on Noise Abatement and Control, Transportation Noise (Rail and Other); Urban Noise Problems and Social Behavior - New York, New York, VOL. VI, Oct. 21-22, 1971

(24) Public Hearings on Noise Abatement and Control, Psychological and Psychological Effects - Boston, Massachusetts, VOL. VII, Oct. 28-29, 1971

(25) Public Hearings on Noise Abatement and Control, Technology and Economics of Noise Control; National Problems and Their Relation with State and Local Programs - Washington, D.C., VOL. VIII, Nov. 9-12, 1971


(33) Review and Analysis of Present and Planned FAA Noise Regulatory Actions and Their Consequences Regarding Aircraft and Airport Operations, EPA Report NTID 73.6, July 27, 1973

(34) Military Aircraft and Airport Noise and Opportunities for Reduction Without Inhibition of Military Missions, EPA Report NTID 73.7, July 27, 1973

(35) Status and Progress of Noise Research and Control Programs in the Federal Government, EPA Report (To Be Published 3/75)

(36) Civil Aviation Studies and Interagency Coordinating Organizations - Background History, EPA Report 550/9-74-019, December 1974
(37) Aviation Forecasts - Fiscal Years 1975-1986, FAA, Sept., 1974

(38) Unpublished FAA Data


(40) National Measure of Aircraft Noise Impact Through the Year 2000 - To be Published
FIGURE 1
AIRCRAFT NOISE CERTIFICATION REGULATION

<table>
<thead>
<tr>
<th>AIRCRAFT CATEGORY</th>
<th>APPLICABILITY DATE</th>
<th>NEW TYPE CERTIFICATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) All subsonic transport aircraft and all subsonic turbojet aircraft of any category</td>
<td>AFTER 12/1/69</td>
<td>FAR 36</td>
</tr>
<tr>
<td></td>
<td>After 12/1/73 except JT3D powered aircraft and aircraft less than 75000# G.W. for which compliance date is after 12/31/74</td>
<td></td>
</tr>
<tr>
<td>(2) Propeller driven small airplanes</td>
<td>AFTER 10/10/73</td>
<td>Amendment 4</td>
</tr>
<tr>
<td></td>
<td>AFTER 1/1/80</td>
<td>Amendment 4</td>
</tr>
<tr>
<td>(1) All subsonic transport aircraft and all subsonic turbojet aircraft of any category</td>
<td>AFTER 197(X)</td>
<td>Reduced Levels</td>
</tr>
<tr>
<td></td>
<td>AFTER 197(X) + Y</td>
<td>Revised Amendment 2</td>
</tr>
</tbody>
</table>
### TABLE 1

**AIRCRAFT SOURCE NOISE - REGULATORY ACTIONS**

<table>
<thead>
<tr>
<th>FAR 36</th>
<th>Prior to 7/73</th>
<th>7/73 - 1/75</th>
</tr>
</thead>
<tbody>
<tr>
<td>RULE</td>
<td>(12/69)</td>
<td></td>
</tr>
<tr>
<td>AMENDMENT 2 *</td>
<td>NPRM 72-19</td>
<td>RULE (10/73)</td>
</tr>
<tr>
<td>AMENDMENT 3 **</td>
<td>NPRM 71-26</td>
<td>RULE (12/74)</td>
</tr>
<tr>
<td>PROP-DRIVEN SMALL AIRCRAFT</td>
<td>NPRM 73-26</td>
<td>RULE *** (12/74)</td>
</tr>
<tr>
<td>RETROFIT/FNL</td>
<td>ANPRM 70-44 (10/70)</td>
<td>NPRM 74-14 (3/74)</td>
</tr>
<tr>
<td>SHORT HAUL AIRCRAFT</td>
<td>ANPRM 73-3 (1/73)</td>
<td>ANPRM 73-32 (12/73)</td>
</tr>
<tr>
<td>APPROACH</td>
<td></td>
<td>ANPRM 74-12 (3/74)</td>
</tr>
<tr>
<td>TAKEOFF</td>
<td></td>
<td>A.C. 91-39 (1/74)</td>
</tr>
<tr>
<td>MINIMUM ALTITUDE</td>
<td>A.C. 90-59 (2/72)</td>
<td>A.C. 91-36 (8/72)</td>
</tr>
<tr>
<td>SUPERSONIC CIVIL AIRCRAFT</td>
<td>A.C. 91-36 (8/72)</td>
<td>A.C. 91-36A (7/74)</td>
</tr>
<tr>
<td>FAR 36 REDUCTION</td>
<td>ANPRM 70-33 (8/70)</td>
<td></td>
</tr>
</tbody>
</table>

* NEW PRODUCTION OF OLD AIRCRAFT
** ACOUSTICAL CHANGE
*** AMENDMENT 4 TO FAR 36

A.C. - ADVISORY CIRCULAR
(A)NPRM - (ADVANCE) NOTICE OF PROPOSED RULEMAKING
Table 2

STRUCTURE OF RESEARCH PANELS

<table>
<thead>
<tr>
<th>Noise Research Panel</th>
<th>Current Agency Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft</td>
<td>NASA, DOT, DOD, HUD, DOC, EPA</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Vehicles*</td>
<td>DOT, HUD, DOD, DOC/NBS, EPA</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>HEW/NIOSH, DOL/Bureau of Mines, DOT, DOD, DOC/NBS, EPA</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise Effects</td>
<td>HEW, (NINDS, NIOSH, NIEHS), DOT, NSF, HUD, NASA, DOD, DOL/OSHA, DOC/NBS, EPA</td>
</tr>
</tbody>
</table>

* This panel is also charged with the responsibility for the Federal research supporting land use policies.
FIGURE 2
AIR CARRIER JET FLEET
FORECASTS

TOTAL JET FLEET

3 & 4 ENGINE WIDE BODIES
PLUS
ADVANCED 2 & 3 ENG. NARROW BODIES
(REF. 38)

JT3D/JT8D FLEET

REF. 37

REF. 39

REF. 39
FIGURE 3
AIR CARRIER OPERATIONS FORECASTS

GROWTH RATE = 3 1/2%

ACTUAL

TOTAL OPERATIONS (MILLIONS)

YEAR END (19__)
FIGURE 4
AIRCRAFT NOISE REDUCTION ALTERNATIVES

NOTE: CALCULATED DATA POINTS AS SHOWN. TREND LINES ASSUMED.

CHANGE IN FLEET MIX
SAM + 2 SEGMENT APPROACH + POWER CUTBACK

ALL AIRCRAFT AT LEAST FAR 36-5

FAR 36-20

NEF 30 NATIONAL IMPACT AREA (% 1972 AREA)

100
80
60
40
20
0

YEAR END
FIGURE 5A
AIRCRAFT/AIRPORT NOISE OBJECTIVES
(CONCEPTUAL)

- HEARING LOSS POTENTIAL
- LEQ OR LDN AT AIRPORT BOUNDARY
- ANNOYANCE

YEAR END


LARGE HUB AIRPORT
MEDIUM HUB AIRPORT
AIRCRAFT SOURCE NOISE

REGULATORY ACTIONS
A-B RETROFIT PLUS OPERATIONAL PROC.
B-C FAR36-X
FIGURE 5B
AIRCRAFT/AIRPORT NOISE OBJECTIVES (CONCEPTUAL)

HEARING LOSS POTENTIAL

L<sub>EQ</sub> OR L<sub>DN</sub> AT AIRPORT BOUNDARY

ANNOYANCE

YEAR END


REGULATORY ACTIONS
A-B RETROFIT PLUS OPERATIONAL PROC.
B-C FAR36-X

LARGE HUB AIRPORT
MEDIUM HUB AIRPORT

AIRCRAFT SOURCE NOISE

AMBIENT NOISE
FIGURE 5C
AIRCRAFT/AIRPORT NOISE OBJECTIVES
(CONCEPTUAL)

HEARING LOSS POTENTIAL

LARGE HUB AIRPORT

AIRCRAFT SOURCE NOISE

MEDIUM HUB AIRPORT

REGULATORY ACTIONS
A-B RETROFIT PLUS OPERATIONAL PROC.
B-C FAR36-X

AMBIENT NOISE

AIRPORT OPERATIONS LAND USE OPTIONS

LEQ OR LDN AT AIRPORT BOUNDARY

ANNOYANCE


YEAR END
FIGURE 5D
AIRCRAFT/AIRPORT NOISE OBJECTIVES
(CONCEPTUAL)

- HEARING LOSS POTENTIAL
- LEQ OR LDN AT AIRPORT BOUNDARY
- ANNOYANCE

YEAR END

REGULATORY ACTIONS
A-B RETROFIT PLUS OPERATIONAL PROC.
B-C FAR36-X

LARGE HUB AIRPORT
MEDIUM HUB AIRPORT
AIRCRAFT SOURCE NOISE
AMBIENT NOISE
THE CRITICAL NEED FOR AN INTEGRATED APPROACH TO DATA COLLECTION

By George P. Howard

In order to undertake rational transportation analysis and planning, credible forecasts are essential. However, forecasting has become a complex discipline as national and international economic conditions fluctuate. Moreover, it is no longer sufficient to predict the unconstrained demand for travel. The impact of environmental, economic, and social issues must also be considered.

Because of the complexity of the forecasting problem, many sophisticated techniques of forecasting and analysis have been developed. These methods have the capability of incorporating variables, previously regarded as extraneous, into the analysis techniques. For example, in some cases it may be useful to incorporate total trip expenditures rather than ticket cost in determining the cost of travel. However, the development of relevant, accurate data has not kept pace with the advance of these analysis techniques. Therefore, it is important that further research must be directed not only to improving methodology but also to improving the quantity and quality of input data that planners and forecasters have available to them.

If airports are to fully utilize the advance techniques of forecasting and analysis, a program of integrating available data sources, along with the development of additional data sources would be highly desirable. At the present time, the lack of relevant, timely data is a major constraint. This is especially true when one tries to investigate the air transport system from a viewpoint of the consumers of air transport as opposed to the producers.

Paper submitted to the Workshop on Air Transportation Demand and Systems Analysis--June 2, 1975, Washington, D.C.
It is evident, given the rapidly changing economic climate, that there is insufficient knowledge of consumer behavior. A periodic and continuous U.S. Travel Market Survey would provide valuable information, about consumers, for the analysis process. This survey, similar to the University of Michigan studies of 1955 to 1965, could take the form of a national probability sample of households. It should provide a variety of information on travelers, their trips, and their future travel expectations. Information that should be obtained would include:

1) mode of transportation
2) frequency of travel
3) trip purpose
4) trip expenditures
5) origin and destination
6) demographic characteristics: age, income, education, and occupation

Additionally, a periodic National Inflight Survey, similar to the ones undertaken by the Port Authority for New York/New Jersey's air passengers, should be designed to provide relevant information on passenger and trip characteristics and other factors significant to aviation. Since 1956 the Port Authority has obtained information from over 200,000 air travelers in the Port District. In addition to the type of information collected in the University of Michigan studies, data were collected on:

1) group size
2) type of ticket used
3) reasons for choosing air travel
4) destination of trip
5) ground access modes: including the use of parking lots, rental cars and bus transportation
These surveys have provided the Port Authority with a better understanding of traveler characteristics in the New York/New Jersey region, and, therefore, better information for planning future air transportation facilities. The Port Authority staff, in cooperation with other sponsors, would be capable of expanding our regional inflight survey to one with nationwide coverage. We would be pleased to enter into discussions on the feasibility of such a project.

Similarly, a periodic survey of air cargo data, measuring intercity shipments, should be undertaken. This would be an important complement to the CAB's passenger O&D surveys. Information that should be collected would include:

1) commodity description
2) origin and destination
3) commodity value per pound
4) shipment size

We would suggest that this research could be accomplished by an air cargo waybill survey, similar to one now being undertaken by the Port Authority, but on an expanded national level. As with the passenger inflight survey, we would consider participating in the development and execution of such a survey subject to a determination of its economic feasibility.

The basic premise that should govern the development of standards for a statistical system is that aviation constitutes a service industry. Presently, many of the statistical programs in the aviation field have been developed to fulfill an operating or regulatory function. Viewed as a service industry, the primary task is to develop standards of measurement which reflect the real function that aviation plays in moving goods and people in the overall transportation system. A data collection program with emphasis on the qualitative, rather than the quantitative, aspects of travel would enable aviation to meet the changing requirements of the users of transportation and provide valuable inputs for the planning process.
In addition to the development of data and standards for data collection there are certain special projects that would be worthwhile pursuing. One of these projects should be a study to evaluate the trade-off that transportation users make between price and service. For example, what is the value of speed and frequency of service to transportation users. This would be especially appropriate, in those areas, where high speed rail service may present an alternative mode of travel.

To foster the development of professional skills in the air transportation field, a subsidy program that would provide new and additional Air Transportation courses in universities having major transportation curriculums would be worthwhile. Additionally, the establishment of "on-the-job" training programs for Air Transportation students, with all or part of their salaries subsidized by U.S. D.O.T./N.A.S.A. or other interested government agencies, would enable students to obtain practical knowledge of the unique aspects of air transportation. This form of cooperative education is not unique; however, such a subsidy program would promote its expansion in the Air Transportation field.

This has not been an attempt to provide an exhaustive list of possible areas for future university research but rather an attempt to identify certain specific areas where universities, working with federal and local agencies, could provide important knowledge and information that would enhance the planning process.

Given the experience and benefits the Port Authority has received in developing and analyzing survey information on air transportation in the New York/New Jersey region, our staff would welcome the development of additional information, as well as integration of existing regional and national data, which would significantly improve our understanding of air transport and result in improved inputs for future planning. We believe that many other airport hubs would equally benefit from the development of a comprehensive data program.
GROUND ACCESS - THE KEY TO AIRPORT DEVELOPMENT

By

John L. Graham
Airport Facilities Planner
Los Angeles Department of Airports
June 2, 1975

INTRODUCTION

The determination of a proper subject for aviation research is, of course, a very interesting and difficult task. Currently, there are many serious problems affecting the major airports, not only in the United States but throughout the world. Not only should we be trying to attack a major airport problem in this research, but we must also attempt study in an area where we could reasonably hope to develop a workable approach - something that could be readily applied and implemented at the major airports.

As specifically related to the Los Angeles Department of Airports, I can think of three major areas of concern:


1. Environment

In terms of its current effect on airport development in the Los Angeles area, the environmental factor has to be the primary determinantal delaying the implementation of airport master plans necessary to meet the aviation demands of the Southern California area. Under this environmental category, the noise factor has to be the number one element. A solution to this problem or at least a method for alleviation must be found in the near future so that
the airport can again become a good neighbor. Failing this, it will be very difficult for any kind of airport expansion as necessary to meet demands. However, we must also realize that much research has been done in this area and the primary decisions to be made as to methods of approach are now, for better or worse, in the hands of various interest groups and politicians.

2. Land Use
No one can argue that, had better land use planning around airports been instituted as the airports developed, the noise issue would not be as critical. However, human nature is such that this was not done and we are suffering from the effects of this poor land use planning. One need only witness the over $100 million that the Los Angeles Department of Airports has spent over the past several years purchasing residential properties in high noise areas where residential units should obviously have never been constructed. However, as in the case with the environment, no one questions the need for better land use planning. Further research would continue to bear this out. The problem now in this area lies with convincing the many political agencies having jurisdiction over lands in the vicinity of airports that the planning is meaningless without the implementation.

3. Ground Access
The third issue lies in the area of providing better ground access to airports. Before orderly growth can occur to satisfy regional and national aviation demands, the ground access problem must be resolved. This issue, essential though it is, is no more critical than those mentioned above. However, I feel that there are
applications for improvements to ground access that should be studied and that much better approaches can be developed through research to effectuate solutions to the ground access problem. For this reason, I have selected this topic for consideration for further research and studies.

Of the 746 airports in the United States served by commercial air carriers, 20 serve 64% of all commercial passenger movements. Of these 20, three-quarters are plagued by ground transportation congestion and delays due to the concentration of the vehicular activity caused by the airport and its surrounding land uses. In 1974, Los Angeles International Airport served over 23 and one-half million annual passengers (MAP), of which over 70% arrived and departed by some form of ground transportation.

Within the past several years, several major improvements to ground access have been completed or are currently underway at LAX including:

1. The construction of Center Way - A street running east and west through the main parking lot in the central terminal area. All parking areas and structures now empty into Center Way, thus keeping most traffic leaving the airport away from the terminal buildings on the north and south.

2. The airport radio traffic service - 530 on AM car radio. Our radio station broadcasts from 7 a.m. to 11 p.m., seven days a week, providing up-to-the-minute traffic and parking information to automobile drivers approaching the airport on Century Boulevard and within the terminal area.
3. An additional traffic lane to World Way north, the main traffic artery within the central terminal area.

4. The establishment of our current reduced-rate park-and-ride facility, the VSP parking lot on 111th Street. This remote lot has been in service for over five years and now has approximately 3,700 public parking spaces. Free tram service to the terminal area is available from this lot at ten minute intervals throughout most of the day.

Our passenger forecast for LAX indicates that by 1980 we will be serving approximately 35 million annual passengers (MAP) and that we will reach our capacity of 40 MAP some time in the late 1980's. The major constraint to growth at LAX is not air space which is adequate. Area is available for construction of new terminal facilities to go well beyond 40 MAP. Area is also available for construction of parking lots to serve automobiles for a traffic level well beyond 40 MAP. The problem at LAX is one of ground access capacity. How can we get over 70% of 40 MAP through the external community into the airport area and then, once within the airport boundary, how do we get them to the terminals? Solutions to this problem will determine whether we can ultimately reach our goal or whether we will fail.

This overall problem can be attacked in at least four ways, each of which deserves much further study.

First, of the short-haul traffic passing through Los Angeles International Airport, what percent could travel to their destinations by alternate modes? Nearly one-half of the traffic passing through
LAX is destined for areas within 500 miles. The coastal corridors from Los Angeles to San Diego and from Los Angeles to San Francisco are heavily traveled in the air. Can systems be developed for this type of travel which could more efficiently transport travelers? Specifically, what are the implications of high speed ground transportation for siphoning off a high percentage of this traffic and thus helping clear access roadways to both origination and destination airports? Considering the time spent traveling to and from congested airports, cannot a better way be found to provide comparable service to short distance travelers that will keep them on the ground?

Second, can we not make better use of other existing airports in large hub areas so that all traffic - short-haul, medium-haul, and long-haul - is not funneled through one airport? In the current environment, it will be very difficult to build new airports. However, in most of the large hub areas in the United States, there exist airports which are far under-utilized, in which airline schedules could be developed to provide travelers with a choice of airports. Splitting up the traffic thusly would not only ease the access burden at the heavily congested airports, it would also provide travelers in many cases with airports at more convenient locations. A study on this issue would involve a number of elements including not only an analysis of ground traffic congestion and conditions in the metropolitan areas including the airports, but also consideration of air space problems and the critical element of noise pollution at airports in residential areas.

Third, what further improvements can be made to ground access at
existing major airports? Siting LAX as an example, it was determined several years ago that the central terminal area had a very limited capacity for vehicular traffic. One answer for increasing ground access capacity was double-decking of the roadway. However, this idea was attacked as soon as it was formulated. What was the wisdom in expending huge capital sums for another major roadway system and attendant multi-level parking structures which would only serve to increase the congestion and confusion in the central terminal area? Why not rather remove the passengers from their automobiles at some remote point and bus them directly to their desired terminals, particularly since open land for the construction of these park-and-ride facilities was available so close to the central terminal area? Although this conclusion was reached long before the advent of the energy crunch, the dispersed parking approach now seems particularly appropriate in light of these new concerns.

The concept of remote parking lots involves several vital aspects:

1. The directing of passengers to these areas without the need for traveling on the primary highway arteries into the central terminal. This must be accomplished by some means of notifying travelers before they hit the traffic tie-ups. The radio station at LAX could be an answer although its range would have to be expanded well beyond its existing limits. Another approach might be the construction of changeable message boards at key locations on all airport access arteries. These boards could direct passengers into remote parking areas as well as provide up-to-date information on traffic and parking conditions in the central terminal.

2. Ticketing and check-in in the remote parking areas. In the
central terminal complex at LAX, the vehicular traffic produced by curb pickup and dropoff alone will ultimately saturate the central roadway. Therefore, it is essential to study a system of encouraging passengers to pick up their tickets and check their baggage remotely from the central terminal area. This encouragement can be provided by the radio station or by the variable message board as mentioned above.

Utilizing the remote parking approach, an improved transportation system must be found to move the passengers from the parking lots into the central terminal area. In the near future, buses traveling on the existing roadway level can be used. However, ultimately some kind of a fixed guideway system separated from the ground traffic must be developed. Much research will be required in determining what kind of a system this should be. Too many times the trend has been for the construction of ultra sophisticated, ethereal systems, heretofore untried, which sound great in philosophy but rarely work. The approach might rather be to take a closer look at system that are currently operating and select one with a high degree of reliability that can meet airport needs.

Fourth, the previous element of remote parking lots still keeps the projects within the airport boundary or very close thereto. When considering remote facilities, why not consider terminal spread throughout the entire metropolitan area using fast, convenient ground access into the major airports such as LAX? This type of service would be very convenient to travelers while simultaneously reducing the amount of vehicals traveling to the airport.
Starting this July, the Los Angeles Department of Airports plans to open such a remote terminal facility located in the San Fernando Valley, a distance of about 25 miles from LAX. This facility is forecast to serve over 200,000 passengers by 1980. Should it prove successful, a number of other similar terminals will be developed throughout the metropolitan area.

The history of remote terminals such as the one planned in Los Angeles has not been encouraging. Airlines are reluctant to staff facilities some distance from the major airports. Passengers are not always offered service as convenient as it should be or at least convenient enough to entice them from their automobiles. Of the remote terminal projects that have failed or at least not lived up to expectations, what are the reasons for these failures? Cannot sufficient encouragement be given by various kinds of incentives to induce the traveling public to utilize these facilities? The benefit of these terminals to major airports would be such that much study should be accomplished to attempt to make these remote terminals work.

CONCLUSION
Singling out one topic for aviation research would be next to impossible. Although I have touched on a number of issues, there are other, equally important factors which I have not covered—elements such as demand forecasting, air space restrictions, data collection, etc. Certainly, these elements must also be studied. By intention has been to point out some of the specific problems which we are experiencing in Los Angeles and for which there seem to be implementable solutions.
All of the elements of ground access which I have discussed are critical. However, the successful resolution of any one of them would contribute greatly toward the alleviation of the ground access problem at major airports and thereby remove a primary constraint to the satisfying of air traffic demand.
Air Transportation Workshop
June 2, 1975
Mayflower Hotel

Airport Authorities Panel
2:30 P.M. to 5:30 P.M.

Prepared Remarks
by Jake O'Reagan - William B. Hartsfield Atlanta International Airport

Introductory

- My pleasure to be asked to participate in this workshop on air transportation demands and systems analysis.

- Representing Mr. Max Walker, Director of Airport Development, City of Atlanta, who asked me to express his apologies for being unable to participate.

- Should establish my credibility to sit with such a group of distinguished airport authorities:

  -- 33rd year in aviation.

  -- past eight working with airports on technical side of operations, management, planning and physical development.

Text

- My understanding of the objective of the workshop is to determine what directions will have the greatest future benefit for the industry.

- A very broad objective and I'm confident we can only scratch the surface in three days.

- Suspect that many in Washington and other segments of the industry would appreciate an answer.

- Note that the workshop is sponsored by CAB, DOT & NASA, but the workshop director is with the Department of Aeronautics and Astronautics at M.I.T.

- Difficult to distinguish if the objective of "future directions" is slanted toward the government or academic sides of the industry.

- Suspect that the unstated objective is to identify the most promising areas and directions of future study and research in our universities.

- My reasoning for this is that the DOT/FAA has recently concluded the Annual Planning Review Conference which included representatives from all segments of our industry but very few from the academic side of the industry.
In discussing the airports panel of the workshop with Max Walker he stated that there were no specific subjects assigned, but said he had intended to provide remarks on three items of importance to the future of airports and specifically air carrier airports:

1. Financing availability for land banking for long-range airports or airport improvements.
2. The importance of aircraft and airport compatibility.
3. Additional definition on environmental requirements.

On the land banking item, I consider it one of the most important elements in the planning and development of our airports of the future.

--- Not necessary to earmark vast land areas for big new airports of the future.

--- Importance of properly zoning and banking of land around existing and planned airports to assure the future compatibility of the airport and its neighbors.

--- An area of future study might be the study of the uses of these lands near the airport through proper zoning and how the airport can be an accepted neighbor.

On the importance of airport and aircraft compatibility it has been historic that the manufacturers develop a new aircraft and the airport authorities modify the airport to fit the needs of the new aircraft.

--- Today's real world of high costs to modify airports and the limited land available to expand the airport to both accommodate the aircraft and the volume of passengers using the accesses to the airport are placing unacceptable demands on the airport operators.

--- An existing working group — Industry Working Group — was organized in 1967 to insure airport and aircraft compatibility. This group is composed of representatives from the airport operators, airlines, aircraft and engine manufacturers. Meet periodically to discuss future aircraft trends and their effects on the airport. Group has been moderately successful in some areas but have not been as effective as could be in limiting the increasing size and weights of aircraft. For example, what follows the 747? There are some on the drawing boards in excess of 1.5 million pounds.

On the item of addition of definition of environmental requirements, I suppose we could use the entire period allotted for the panel in discussing the environmental issues. For the sake of brevity, I believe there are two simple recommendations that would make life more bearable for airport operators. First, eliminate as many gray areas as possible and spell out in black and white, what is or is not required in the environmental impact issues as they relate to airports and second, find some way to reduce the time, money and effort spent in the resolution of environmental issues.
Earlier in my remarks, I mentioned the Annual Planning Review Conference. Having participated in each annual conference, I've seen the attendance drop from nearly 1200 in the earlier conferences to approximately 250 at the recently concluded conference. At each conference, the National Aviation System Plan developed by the FAA for the next 10 year period is introduced. This year's plan was presented as "an integrated plan of action for meeting anticipated needs in the Aviation System through 1985" and the conference supposedly "provides a focal point for industry/government cooperation in agency planning".

-- It has been my experience that industry/government cooperation has not been readily apparent.

- The conference is divided into day-long sessions - one for the government agencies, the other for industry.
- Industry spokesmen are from ALPA, AOPA, ATA, AIA, AOCI, NBAA, NASAO and many more.
- Most of the spokesmen present the views of the association and most of the remarks are directed at FAA or government shortcomings. Examples:
  
  ALPA - 2 segment approaches unsafe
  
  AOPA - can't afford black boxes to comply with FAA requirements
  
  ATA - retrofit too expensive
  
  AOCI - must have retrofit/refan engines to reduce unacceptable noise and resultant legal actions
  
  NASAO - Federal airport development funds for general aviation airports can best be administered by the States (Buzz word - New Federalism).

- Personal observation that Planning Review Conference has become a sounding board for many but offers little in the Planning Review areas for the shape of our industry for the next 10 to 20 years.

-- Example - this year:

- no mention of what is planned in the area of alternate fuel sources

- land banking, land-use or zoning as it relates to airport development or expansion not introduced.

- increasing airport capacity problems directly related to the accesses to the airport was another topic that was avoided.

- My opinion, Planning Review Conference in need of revitalization and should include the academic/research segment of industry.

- Another area of participation for this group would be the periodic "Mini-conferences" or Consultative Review conferences conducted by the DOT/FAA.
Summary

- Only some thoughts on how increased participation by all segments of the industry can determine "what directions will have the greatest future benefit for the industry".

- Hope that they will stimulate questions or discussions within our panel.

- My pleasure to be with you, even as a pinch-hitter for Max Walker.

- Thanks.
Good afternoon, gentlemen. It is a pleasure for me to attend this "WORKSHOP" and I wish it every success. I bring you greetings from the City of Chicago and Mr. William E. Downes, Jr., our Commissioner of Aviation.

The title of the Workshop, "Air Transportation Demand and System Analysis" is a bit formidable and all inclusive, and illusive, and indicates an area of interest that is much larger than that of the average Airport Authority. I would like to leave the topic of national and local traffic forecasting to others and limit my remarks to a system problem on the airport. We know our City-pair relationships and basic characteristics of our 38,000,000 odd passenger market.

When we discuss and work with a system, one generally thinks of extremely complex data gathering processes, program generation, validation and testing, and simulation exercises, dealing with numerous possible variables, in an attempt to arrive at specific output that might become the basis for determination by individuals.

The role of the Airport Authority and his specific area of immediate concern and interest generally lies within the airport boundaries and adjacent neighborhoods, or in our case, a multi-airport system, the interaction and the role of the sponsor, users, and the community.

The Federal Government has the authority to control in a broad sense who uses our facilities, both the national and international carriers, the rate at which our facilities can be used (quota hours and number of operations) and the type of equipment used in the airspace.
The Airport Authority then provides and maintains an environment within which these scheduled/non-scheduled carriers, and GA activity takes place under local Laws or Ordinances, that give exclusivity to the operation and imposes certain responsibilities to the travelling public and commerce.

Within these parameters, we in Chicago are interested in maximizing the use of our airport resources, insuring the travelling public that adequate and appropriate facilities are made available and suitably maintained for their use, and that related airport needs are kept current with use and anticipated need. All of these goals should be achieved within a balanced airport system.

Keeping an airport in balance is not an easy matter, due to a number of factors at work within not only the airport, but also the community. At each of our airports we have: (1) The overall airport; (2) the airfield; (3) terminal complex, and (4) support area requirements. External to the airport are our relations with the neighborhoods, surface access, community economic and governmental needs, and the airport's relationship with other local, regional and national modes of transportation.

Returning to the airport, certain measurable activities take place every 24 hours that have a pronounced effect on the Owner/Operator's ability to plan, manage, and operate his facilities. These measurable items are recorded by different interested parties: The FAA, among others, record runway utilization, arriving aircraft type and time of activity, some delay data, and other pertinent information. Air carriers record passenger activity, aircraft movements, cargo, mail and express weights, fuel usage, delay data, etc.; the Weather Bureau
keeps daily and hourly records of all aspects of the weather, including precipitation by types, wind velocity and direction, ceiling data, visibility, etc.; the Fixed Base Operator retains records dealing with general aviation and other transient aircraft activity, records fuel delivery by type of fuel, and maintains other data useful to the airport operation. The Airport Authority also maintains specific records which deal with the unique aspects of their activities, plus rent-a-car, parking, bus, limo, vehicle, etc., volumes.

The Airport Operator has access to some non-proprietary information at the airport, but many times does not have a staff, expertise, or system to correlate the pertinent pieces of data to give him meaningful output to assist him in planning and operating the airport.

In reviewing the record data available from the different sources, and the material needed to complete the data file for the Airport Authority, specific omissions are apparent that can be filled by the Authority or obtained by comparison or manipulation of the material available.

Returning to the title of this Workshop, the balanced capacity of each airport is a factor within the overall air transportation system. Knowing the balanced capacity of a particular airport or system of airports is not, in our opinion, a simple rule-of-thumb or historical matter. We believe that this is a dynamic range of values that is extremely sensitive to weather conditions, runway alignments and characteristics, the presence or absence of navigational aids and the fleet mix that is using the airport, which in itself may be imposing more seat capacity than the terminal building complex and ground access system can support.
Because of the dynamic character of the operation of the airport, we are developing a data bank that will be updated periodically which will provide ready access to the airport history of activity as well as testing for future events or levels of use.

We in Chicago have two simulation models that assist in both planning and operation of O'Hare International Airport. These deal with: (1) Aircraft movement from the outer fixes to the taxiway turnoff upon arrival, and departing aircraft routing from the taxiway through runway employed, and (2) aircraft movement within our taxiway system to and from the gate positions. A third model is in preparation which will deal with people, both passenger, greeter, and well-wisher, within the terminal building complex up to the interface with ground access, including parking. The data bank necessary to support these models as planning tools is considerable and must be maintained to insure accuracy and reliability of the results. Not all airports require the use of such models; however, the inventory of items in the data base could be adapted to any airport.

We feel that if the airport is considered as a system, there should be developed a convenient, easily maintained planning and operation tool that can be used by the Airport Authority. This form of system analysis can assist with the day-to-day operations of the airport, help the Authority maintain a balanced facility, anticipate changes in use of the airport, and have a logical historical base available for future planning and fiscal requirements.

The direct benefit to be gained from the use of such a data base and analysis technique, in addition to those mentioned earlier, would be improved
passenger accommodation and amenities, increased reliability of the overall airport system, reduced operating costs by improved facilities, and delay reduction, greater balance in use of a single or multi-airport system, including, in our case, Midway Airport and Meigs Field, and logical growth potential and limitations for the overall airport.

What I propose is the development of a system or technique, available to all Airport Operators, that will enable them to readily maintain a unique airport data file and easily access the data for planning and operational purposes. This will enable the Airport Operator to know, perhaps for the first time, the numerous specifics of his operation and the character and levels of activity of the different airport users.

Paul D. Shaver
Chief of Planning
Department of Aviation
City of Chicago

June 2, 1975
The job of planning in our industry, as in all others, is to determine those actions which will optimize our financial results. The basic dilemma facing the professional planner is that he must practice his science by first delving into one of the oldest of the mystical rites—foretelling the future.

We know from hard experience the difficulty airlines have had with this task and considerable talent has been applied to this problem. Yet, I would characterize the development of our forecasting ability as having reached a level that can only be referred to as Organized Soothsaying. The current economic conditions of the industry and the perishability of our product (a seat unsold today cannot be inventoried) dictate a need for a forecasting methodology that is substantially closer to the level of development of our other planning tools.

The planning job that we do is based on a number of forecasts. These forecasts are both macro and micro in nature and deal with the environment in which we will be operating. They are then ground through a process which includes timetables, formats, computer runs, etc. In the course of that process, many decisions are made which impact the quality of the plan which is finally produced. The plan is approved and implemented after senior management review and results are monitored and measured. These
results then are fed back to create new and, in many cases, different forecasts.

Chart 2 shows the planning process flow at United for the year 1975. Those places where demand forecasts are made and used are indicated in blue. An important thing to note is that in the course of the twelve-month cycle involving all of the planning done at United, demand forecasts play a significant role. Every planning activity in United is founded on a demand forecast that has its origins in an activity we call the Business Environmental Forecast (BEF).

As you know, a forecast of this type takes into account the major external elements which influence the demand for airline transportation. Using classic techniques of econometrics, each of the items listed on the chart is described in forecast terms. You will note that the last item is a macro forecast of the airline industry market. This forecast is developed in detail for the first five years with additional peg points in the tenth and fifteenth year. Because of the macro economic factors which have a rather constant influence on total demand, and to some extent the law of large numbers, the demand forecast in the BEF is the one in which we have the greatest confidence of any of those which we use.

Chart 3 shows the trends that we examine which might stimulate or depress the Industry Market Forecast. While the list itself is reasonably inclusive, we are unable to quantify the
impact that these trends might have on the basic forecast. We are reduced to subjective judgements that can only indicate a positive or negative contribution. Ultimately, these subjective judgements do little more than to provide justification for accepting the macro forecast.

Using the airline traffic forecasts basic to the BEF, we then focus on trunk carrier load volume forecasts. We project United's market share and revenue passenger miles and, using a yield assumption, determine United's forecasted revenues for the period in question. Because of the sensitivity and leverage of the elements shown for both trunk and United forecasts, the accuracy of the revenues, yields and revenue passenger mile numbers are suspect and are viewed as very subject to change throughout the construction of the plan. One of the greatest problems of the establishment of RPM and revenue levels, even at this macro level, is the relationship of elasticity and yield. We give a great deal of attention to this relationship because its character is so difficult to portray and its impact on revenue is so significant. A reasonably accurate relationship must be established in order that the production levels and associated expenses are appropriate.

The forecasts described thus far are macro in their nature, and are produced by corporate staff. In explaining United's micro forecasting, it's important to note that forecasting at levels lower
than total company is done by the marketing staff of our three geographic operating divisions, assisted by the headquarters scheduling staff. As the prime input source of our micro forecast is different from that of the macro, so are the uses to which the forecasts are put. I have said that the macro forecasts are developed as the basis for our planning process and a focus for the earnings level which the plan should produce. The micro forecasts focus on specific activities and time periods.

These forecasts cover the same three time periods covered in the macro forecasts. A fifteen-year period is forecast to examine fleet needs and long term construction requirements. The five-year forecast is produced in the form of a plan in which market strategies and shorter-term capital expenditures are based. The Annual Plan becomes our operating plan, updated in the near term by financial outlooks. Here we begin to focus on outputs of demand forecasting which involve the execution of action decisions and the expenditure of funds. Some of the typical uses, with which you are no doubt familiar, are financial and schedule planning, manpower planning requirements, final facility construction decisions, route studies and filings and marketing studies.

As a point of interest, let me show you how our micro forecasting process relates within our schedule and load forecasting model—the Online Schedule System. We need not go
through the individual items but for purposes of our discussion the chart does point up the complexity of the process. We know a great deal about the nature of planning, the process itself and how it fits together, and about the data that we use. However, let me point out the area shaded in red. This is the relative size of the load forecast input to the planning process. Surely not very large, yet it is the most important input that we can make.

Given the fact that the forecasting of micro demand is done by the Division marketing people and that the resulting forecasts are the basis for day-to-day operating decisions, let's examine the tools which are available for the job. As you can see, the elements used are simply labelled historical data and forecast data. The historical data examples listed are those available to any airline or industry analyst. The forecast data are basically those on which our macro forecasts have been built. While these forecasts provide a great deal of historical and consistent material, they have a minimal prediction value.

The area which is not addressed and for which we find the greatest need, is specifically what, beyond extrapolation of historical data, can we inject into city and segment level demand forecasting which will make the output more meaningful and more useful.

What makes people fly? You are all familiar with this sort of a listing, giving the motivational factors which account for
airline traffic. However, you will note that the influences of these factors are not quantified on this chart. The weighting of these factors can be accomplished on an historical basis, and as with other forecast material, extrapolated into the future. However, beyond the extrapolative technique, quantification in this area is, at best, judgemental and at worst pure guesswork. Further, the localization of motivational factors is of fundamental importance in micro demand forecasting techniques but currently has little application in the forecasting of individual segment demand. Quantifying changing weights in the near term is speculative and the application of any quantification to local traffic conditions is currently intuitive. As markets emerge and decline we are able on an after-the-fact basis, apply a relative weighting factor to each category and, in those cases, predict local market direction. However, this sort of forecast application only occurs after significant swings in traffic patterns have become visible. The characteristics which influence geographic quantification of the factors which make people fly need further definition in terms of the criteria and the application to specific demand forecasting. Evidence of this need is the fact that facilities construction is continually reacting to fluctuations in local traffic conditions and that overcrowding and/or overbuilding are major problems with which the industry has had to cope since the early 1960's. Along the
same lines, schedule frequency in major markets is almost always reactive rather than dynamic.

As should be evident from the presentation, micro forecasting is currently dependent upon historical extrapolation of segment on-board loads combined with a shaky hierarchy of macro demand forecasts. The primary advantage of this approach is that it has credibility when compared to the current operation. The major disadvantage which must be addressed, however, is the inability to forecast substantial changes in passenger flow.

There is a second major formula for micro forecasting currently used in the industry. It is based on historical CAB O&D data and forecasts a target year (using either constant or variable growth rates for individual origins and destinations). These passenger demand values are then flowed over routings which best meet the passengers' requirement for nonstop service and take into account individual airline preference for segmenting aircraft trips over city pairs. The advantage of this method is the ability to describe service patterns a number of years in the future and take into account optimum aircraft and route results. Disadvantages, however, are two-fold: there is little correlation to present and/or historic traffic levels and the fact that schedules which the airlines offer can significantly alter the ways in which passenger travel is not reflected. Neither method establishes criteria for localized, variable passenger flow, nor identifies the
emerging or declining market.

To summarize then, there are six major areas of current concern in the development of micro forecasts. One is the failure to quantify motivational aspects of demand. As I have said earlier, we don't take into account the localized impact of the motivational variables described in the previous chart.

Two, we have very heavy reliance on historical extrapolation, which fails to take into account the changing nature of localized demand. Third, is a lack of emphasis on the geography of demand in general. We have failed to identify the criteria associated with emerging and declining markets on an overall basis. Our success has only been in those instances where clear, major events have occurred in particular markets, and have been recognized well in advance. This sort of an approach needs to be more pervasive in order to make us better prepared in terms of manpower, facilities and fleet to handle the markets in which the passenger wants to fly and enable us to avoid the expensive capital and fleet errors to which we are easily subject.

Fourth, the long turnaround time required for major micro forecast revision is of great concern since the length of the planning cycle dictates that a micro buildup can only occur once during the cycle without disrupting its flow. We should have the
ability to more quickly focus upon changes in major market networks and their impact on the system.

Fifth, and related closely to the item above, the input on a micro level to the forecast scheduling models is ultimately a manual process. Thus, the current system does not allow for uniform judgement by those making the forecasts. Under these conditions, an imbalance of emphasis in certain markets can easily occur.

Sixth, is something touched on earlier--the question of elasticity, particularly micro elasticity. We need definitive work which will relate the elasticity of demand to fares, service levels and competitive actions.

Finally, let me emphasize that we are not looking for a crystal ball. We do not want to be handed the answer. We need inputs from which to build strategies and from which to evaluate alternate considerations. Specifically, a system to guide resource allocation. As I see it, the ideal sort of research into a micro demand forecasting model will focus on a tool which takes into account the areas of concern that I have described and which can be used by airline marketing people to develop micro forecasts. This should not be a tool which directly feeds a schedule and produces a specific answer, but a tool which provides the kind of guidance required to feed the micro forecasting which is
currently being done. We don't need a model which will produce an inflexible answer. We need a model for which the inputs are known and understood and which can be varied according to localized situations perceived by our management. This sort of a model, then, will enhance the micro forecasting methodology rather than replace what is currently being done.
BASIC PLANNING PROCESS

- PLANS
- FORECASTS
- RESULTS
- APPROVAL
- IMPLEMENTATION
PLANNING PROCESS FLOW

GENERAL
BEF
FIVE YEAR PLAN
CORPORATE OBJECTIVES
SCHEDULE
MARKETING
OPERATING

ANNUAL
CORPORATE OBJECTIVES
SCHEDULE
MARKETING
OPERATING
BUSINESS ENVIRONMENT FORECAST (BEF)

• COMPREHENSIVE VIEW OF MAJOR EXTERNAL FORCES WHICH WILL INFLUENCE UNITED AIRLINES OVER APPROX. THE NEXT FIFTEEN YEARS

• WORLD OVERVIEW
• THE U.S. ECONOMY
• U.S. DEMOGRAPHIC TRENDS
• SOCIAL AND POLITICAL VALUES
• FINANCIAL ENVIRONMENT
• INFLATION AND AIRLINE COSTS/PRICES
• ENERGY
• TECHNOLOGY
• REGULATION OF BUSINESS AND AVIATION
• TRENDS IN RELATED INDUSTRIES
• AIRLINE INDUSTRY MARKET FORECAST
BUSINESS ENVIRONMENT FORECAST (BEF)

AIRLINE INDUSTRY MARKET FORECAST

GROWTH DEPRESSANTS/STIMULANTS CONSIDERED:

- CONTINUED POPULATION GROWTH
- SMALLER FAMILIES
- INCREASED PRODUCTIVITY
- RISING INCOMES
- INCREASED LEISURE
- CHANGING LIFE STYLES
- ENERGY SHORTAGE
- INFLATION
- TOURISM TRENDS
- BUSINESS TRAVEL TRENDS
- AIR FARES
MACRO PASSENGER FORECASTING

<table>
<thead>
<tr>
<th>TRUNK</th>
<th>UNITED</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROSS NATIONAL PRODUCT (BIL $)</td>
<td></td>
</tr>
<tr>
<td>RATIO: DOMESTIC TRUNK PASSENGER REVENUE IN CENTS/$100 GNP</td>
<td></td>
</tr>
<tr>
<td>DOMESTIC TRUNK PASSENGER REVENUE</td>
<td></td>
</tr>
<tr>
<td>TRUNK YIELD ($ PER RPM)</td>
<td></td>
</tr>
<tr>
<td>TRUNK RPM'S</td>
<td></td>
</tr>
<tr>
<td>UA SHARE OF MARKET</td>
<td></td>
</tr>
<tr>
<td>UA RPM'S</td>
<td></td>
</tr>
<tr>
<td>UA YIELD</td>
<td></td>
</tr>
<tr>
<td>UA REVENUE</td>
<td></td>
</tr>
</tbody>
</table>
MICRO PASSENGER FORECASTING

● WHO FORECASTS?
  ● 3 GEOGRAPHIC DIVISIONS/HEADQUARTERS

● WHAT PERIOD?
  ● 15 YEAR
  ● 5 YEAR PLAN
  ● ANNUAL PLAN

● FOR WHAT USE?
  ● FINANCIAL PLANNING
  ● MANPOWER PLANNING
  ● FACILITY CONSTRUCTION
  ● SCHEDULING
  ● ROUTE/MARKET STUDIES
  ● FLEET PLANNING
MICRO PASSENGER FORECASTING

*ELEMENTS USED*

**HISTORICAL DATA**
- ON-BOARD SEGMENT LOAD
- ORIGIN/DESTINATION – UA ON-LINE/CAB
- OMNIBUS SURVEYS
- GROWTH RATES
- MARKET SHARE

**FORECAST DATA**
- ECONOMY
- INDUSTRY TRAFFIC GROWTH
- UA SCHEDULE OFFERING
- UA CORPORATE/DIVISIONAL GOALS
- OA FLEET CHANGES
- OA SCHEDULE ASSUMPTIONS
WHAT MAKES PEOPLE FLY?

- **COMPANY BUSINESS**
- **VISIT FRIENDS/RELATIVES**
- **SIGHTSEEING/VISIT RESORTS**
- **PERSONAL AFFAIRS**
- **CONVENTIONS, TRADE FAIRS**
- **GOVERNMENT BUSINESS**
- **ACCOMPANYING FAMILY MEMBER ON BUSINESS**
- **MILITARY**
CURRENT AREAS OF CONCERN

- MOTIVATIONAL ASPECTS OF DEMAND UNKNOWN
- HISTORICAL EXTRAPOLATION DOMINATES
- INABILITY TO IDENTIFY GEOGRAPHY OF DEMAND
- MANUAL FORECAST INPUT
  - TIME CONSUMING
  - INCONSISTENT
- DEMAND ELASTICITY NEEDED FOR
  - FARES
  - SERVICE LEVELS
  - COMPETITIVE ACTIONS
Flying Tigers' participation on this panel is unique. We are the only organization at this workshop that is going to look at the research needs of the airfreight side of the industry. Most of the discussion thus far has been involved either directly or indirectly with the passenger side of the business. Perhaps this is as it should be since the air transportation industry today has as its primary focus the movement of people from one place to another.

The passenger side of this business is directly in front of the public eye. The exposure and image is tremendous and for those people working in that area there is much ego satisfaction.

However, I predict that, if a similar conference were to be held ten years from now, there would be many more panelists up here with me solely discussing airfreight research requirements. The airfreight industry is growing rapidly in this country and throughout the world. Last year the U.S. airlines had more than $1 billion in freight revenues. Some forecasters say that air cargo revenues will surpass passenger revenues by the year 2000. Other projections are more conservative.

My point is that the air transportation industry must not overlook the airfreight side of the industry. Today, it is at minimum a segment of almost every air carrier's business. Tomorrow, it could be their bread and butter.
Airfreight is already a fundamental part of this country's distribution system. The airfreight user pays a premium price for the two principal advantages of airfreight -- speed and reliability. However, these two advantages add value to the product offered by surface modes. The existence of an efficient, viable airfreight transportation system in this country allows shippers to maximize the use of slower, less reliable surface transportation. The shipper can utilize the airfreight system as a marketing tool for handling urgent problems and special situations. Airfreight is an integral part of the total transportation network of the country. Thus, the better the airfreight system, the better the entire system of the movement of goods.

Hypothetically, if I could create a corporate holding company called Air Transportation, this company would have certain characteristics. It has jet aircraft which carries passengers, passengers and freight, or just exclusively freight. It operates on airports which have terminals for both passengers and freight.

I would find, however, that this holding company has two subsidiaries. One entitled Air Passenger Transport and the other called Air Freight Transport. These subsidiaries have very different characteristics and, consequently, very different problems and solutions.

Let me highlight a few of the things that make the airfreight business different from the air passenger business. First of all, the basic economics of the two are different. The air carriage of passengers is often the lowest cost mode of transportation and passengers seek low cost fares. On the other hand, airfreight is
usually the highest cost mode. This is because shippers are willing to pay for a premium, reliable service for the movement of their goods.

The logistics of the two are different. Passengers are a rather basic, homogenous commodity whose needs can be handled relatively easily. Passengers can take care of themselves -- getting to the terminal, on and off the aircraft, etc. On the other hand, freight comes in all sizes and shapes and needs many different types of handling. Freight cannot think for itself and thus has to have all of its needs taken care of by others.

The preferences of passengers and shippers are also at opposite ends of the spectrum. Most passengers prefer non-stop, daylight flights on wide-bodied aircraft. Shippers usually want the goods to depart at night at the end of the work day. They are not concerned about the number of stops or connections for the shipment but only with the door-to-door time. And freight really doesn't care which type of aircraft it is flying.

To further illustrate the differences, consider that the passenger business has a relatively simple pricing structure. It is a consumer market much more sensitive to promotion and personal discretion. Passengers make round trips. Passenger travel is irregular and to a limited number of destinations while passengers themselves are diffuse. Ticketing and documentation is relatively simple for passengers and usually involves only single-party transactions.

In contrast, freight tariffs are far more extensive and complex. The freight market is subject to more economic decision making. Freight usually moves in only one direction. Freight
is more repetitive and requires broader geographic coverage.
Freight documentation is complex -- especially for international
shipments -- and usually involves two or more parties, a shipper
(or consignor) and a receiver (or consignee), in every trans-
action.

These distinctions between the two industry segments are
rather elementary. Yet there are many in the air transportation
industry and the regulatory agencies who forget these basic
differences when they plan and operate the freight portions of
their businesses. Their freight philosophies are often carbon
copies of their passenger philosophies. However, they are
entirely different businesses with entirely different character-
istics and needs. My point is simple. The research needs of the
airfreight business are different from those of the air passenger
business.

At Flying Tigers we know this because airfreight is our only
business. Tigers has been in the airfreight business for thirty
years. I can tell you that this business of thirty years ago is
not the same as the business we are in today. We can't tell you
much about the passenger business, but we can sure tell you
about the freight business.

And yet, with all of our years of experience, we have just
scratched the surface in acquiring reliable research knowledge
about this industry, about our needs and about our customers' 
needs.

One area that we have just begun to investigate focuses on
the concept of "dynamic needs" which arise due to change. There
are many external influences on organizations. They exist in a
political, social, economic, competitive, technological and human environment. In that environment, change is the only predictable force and with change come new needs. Change has a direct effect on us in the airfreight business and throughout the air transportation industry. It also has an effect on our customers.

We all have to recognize this dynamic changing environment in which we exist. Regulators have to be particularly cognizant of the dynamics of the environment because there is a strong temptation to assume that the industry is and will continue to be in a static state. We have seen this occur in other transportation modes. The entire transportation industry is now suffering as a result of this failure to understand the dynamics of the environment. We must not allow this to happen to the air transportation industry.

Here are some of the types of change that we have begun to identify and monitor. We have not systematically evaluated each of the change processes and further investigation is needed to understand their potential effects on the industry and on our customers.

Economic Change. The state of the economy, the level of real growth (or decline) in GNP, the rate of inflation, the strength of the dollar, the prime lending rate, the fluctuation in rates of exchange, and other such economic factors all affect the customer's need for distribution services. The airfreight industry must not only understand the ramifications of such changes on its U.S. customers but also on its Japanese customers and those in other markets as well.
Technological Change. New technology and new products often lead to new distribution needs. Products early in their product life cycle may require different distribution systems than products at more advanced states of the product life cycle. In particular, expedited distribution may be important in the introduction stage for a new product and in the high sales growth stage.

Competitive Change. Change in the nature of competition within an industry or in the market structure may cause the emergence of new distribution needs. Distribution may also be used as a competitive tool, as in the guarantee of one-day parts delivery to dealers.

Management/Organizational Change. Change in a company's management structure or in its management style may lead to new distribution needs. A centralized company may, for example, have different distribution needs than a decentralized company. A company's emphasis on either tactical or strategic decision-making will have a direct input on how a company manages its distribution process.

Operations Research, Systems, and Control Changes. A company's move to new control systems and the use of operations' research may lead to new distribution needs. Herein may lie the opportunity for "planned emergency" airfreight programs.

Consumer Change. Change among the customer's consumers (the ultimate consumer) may create new needs. As birth rates decline, leisure activity increases, more women work, and education increases, needs of the ultimate consumer change, industry must respond, and distribution systems will be affected accordingly.
Knowledge of the external environment's impact on our industry and our customer's industries has profound implications on air transportation decisions being made now which affect the future.

There are some other research areas that I would like to recommend for your consideration. The specific areas are:

1) Capital Resource Management
2) Environmental Improvement Costs
3) Technology and the Marketplace
4) Time Sensitivity
5) Price Elasticity

**Capital Resource Management**

We have already been talking about change and the dynamic economy in which our industry operates today. We function in an international economy in which conditions change much faster than they have in the past. A primary area for additional study involves the capital management needs of the air transportation industry.

First of all, the industry needs to recognize the magnitude of its capital intensity. The capital turnover ratios for air-freight are about .8 for an efficient operator. This means that, if you invest $100 million in your operation, you could only generate about $80 million a year in total revenue. Compare that with the steel industry, which is considered to be one of the most capital intensive industries in the world. This industry has a capital turnover ratio of 1.0 or 25 percent better than the air transportation industry.
At Flying Tigers we are currently operating two 747s and will place a third one in operation later this summer. One of these aircraft plus ground equipment, spares and other facilities adds up to a $33 million investment. And that price is a bargain one since these aircraft were converted to freighters from passenger liners. To recover the $33 million capital costs plus operating expenses for just one 747 freighter over its lifetime we have calculated that it will take almost one-half billion dollars of revenue. Multiply this by the number of 747s in operation and calculate similar numbers for the other commercial transports in operation and the revenue requirements are staggering. Airline managements are going to have to think in terms of capital management.

Financial experts are now warning us that we are entering an era of scarce capital resources. This phenomenon will be occurring while the demands for long-term capital by both the private and public sectors of our economy will be greater than ever before. Competition for long-term capital will begin to become highly competitive. Right now, if you compare our industry to the attractiveness of alternative investments, our position is not very good.

Some basic research is needed to educate this industry on changes it must implement so that it can attract the capital necessary for not only its growth but for its continued operations. The industry must place itself in the position of a viable investment alternative.

Basically, I'm suggesting that an investigation be made on how the industry might best present itself to the financial
community. Perhaps there needs to be some basic changes in thinking by air transportation industry leaders both within the airlines themselves and in the regulatory agencies. The question of appropriate return on investment should be investigated, especially in light of the intense competition for capital and the current levels of investment now required to fulfill the public service role of the air carriers. Research should be conducted on the alternative means of financing -- debt, equity and leasing -- and how these should be treated by the financial community, regulators and carriers. A capital resource study should include an existing evaluation and alternative recommendations on the appropriate form of capital cost recovery schedules for the air carriers.

In developing capital cost recovery requirements, the insurance industry uses the "annuity method," the real estate industry uses the "mortgage payment" concept while the airline industry is currently required to use a "net book value" approach. Wall Street investors evaluate investments based on a constant cash flow which covers such items as depreciation, interest, lease payments, pre-tax profits, etc., on an annual basis, which are necessary to make a target return over the life of the investment. Simply stated, the net book value approach is an antiquated financial evaluation technique.

Alternative recommendations should consider:

1) Recognizing the time value of investment and cash.
2) Recognizing the replacement value of the assets employed.
3) Assisting in developing pricing strategies which will employ assets in the future to improve the long-run earnings and growth potential of the industry.

4) Assisting in fostering long-run price stability for the industry.

5) Acting as a healthy discipline to control periodic overcapacity and investment phases.

Environmental Improvement Costs

One of the major social changes which society is undergoing today is the concern for the environment. The air transportation industry must meet new requirements in order to comply with new environmental standards. However, these new requirements cost money. They may involve retrofit programs, new equipment, new procedures. Some of the requirements may not even be able to be met with today's technology. At the same time we want to maintain a healthy industry.

We need help from the researchers on this matter. One basic study might involve a cost/benefit analysis of the economic value of the air transportation industry to society. As part of this study, the researchers could investigate the real costs of proposed environmental improvements.

The whole question of costs is one which needs the attention of the researcher. The air transportation industry, like all others, has been hard hit during this period of hyper-inflation. Last year's fuel crisis, which still remains with us in the form of dramatically higher prices, has had a devastating effect on the
industry. We have attempted to recover some of the increase costs through rate increases. However, there has been severe public criticism in opposition to these efforts. This was exemplified during the recent congressional hearings on this subject.

We as an industry need help in communicating some of the basic economic facts of life to the general public. The air transportation industry is charged with certain public service obligations. In order to meet those obligations, we must have understanding and cooperation from the public which we are trying to serve.

Technology and the Marketplace

Much of the research that has already been conducted on the air transportation industry has been conducted by the airframe manufacturers. We probably wouldn't be where we are today without their contributions. However, most of the data generated by them has been limited to the airplanes and the boxes (containers) flying inside them. We need some very basic research performed to determine what is inside of those boxes. We need better information on what is moving by air, to what points from what points, and, most importantly, why it is moving by air.

With that information we can then make better projections of future demand for airfreight service. Another type of information that would be of tremendous value in projecting future demand would be some basic research data on future industrial alignments. Are they moving closer to or farther from supply areas? Are industries continuing to locate in the traditional market areas or are they moving to secondary market areas? What are those secondary markets
and what are their needs for airfreight service?

Data from such investigations would help us make more meaningful decisions on the types of equipment that will be needed in the future. The airframe manufacturers have plans on the drawing boards for a new generation of aircraft that will be designed solely as freighters and not as combination aircraft or converted passenger aircraft. However, most of these aircraft will be large ones, some with payloads even greater than the existing wide-bodied aircraft. In the past, the industry has always benefited from the additional leverage given by the production of larger vehicles. Now, however, we may have reached the point where we need to be looking at smaller, more efficient aircraft instead of larger ones from the public interest point of view.

There are many market pairs today that demand airfreight service and yet do not have enough traffic to make wide-bodied service economic. A smaller-sized freighter might be the answer, and this is an area that should be studied.

**Time Sensitivity**

One of the primary qualities of airfreight is its speed. The user pays a premium price for this speed. Yet we really don't know much about the time sensitivity of airfreight and what the time parameters are for the shipper. Some basic research needs to be conducted to determine what those time sensitivities may be; how they differ by industry; and what the air transportation industry can do to improve its ability to meet these critical shipper needs.
**Price Elasticity**

We have said that the airfreight user is willing to pay a premium price for the speed and reliability he needs. The whole question of price elasticity is one which needs further investigation. There has been research on this matter as it concerns the passenger. However, as we noted before, the passenger is different from freight. An investigation into this matter would help the industry determine whether it can increase its market base solely through pricing activities or whether it must use other means.

One final point that I would like to touch on is the matter of deregulation. There is discussion in many quarters about deregulating the airline industry. Every potential research area that I have discussed, and I suspect every one that will be covered in this workshop, would be affected by such a move. I hope that before the various branches of the government take steps to effect such a drastic change in the air transportation system there will be sufficient in depth research made to determine what the real effects will be of such a move. What will be the outcome for the industry? How will it really affect the consumer? Answers to these questions must be given to the ultimate decision makers before they cast their votes on the issue.

As I conclude this review of some potential areas for basic research, I hope that you will conclude with me that any research conducted for the air transportation industry must include the airfreight segment of the industry. Airfreight is a different entity from the passenger business. Yet it is
growing in its impact upon the entire air transportation industry and plays a key role in the country's distribution system. Despite this growing importance, there has been minimal research conducted on the airfreight business. Researchers have traditionally focused on the passenger side of the business in terms of technology, regulation, marketing and pricing. There must now be greater emphasis on airfreight. Some basic research in at least some of the areas I have outlined is certainly called for. I am confident that the investment in time and money will pay many dividends for the air transportation industry and for the country.
THE IDENTIFICATION OF SERVICE AND THE CONTRIBUTIONS OF AIR TRANSPORTATION TO THE ECONOMY

By A.C. Ford, Long Range Planning, Delta Air Lines, Inc.

The purpose of this Workshop is to identify the most promising areas of future research in air transportation demand and system analysis. These areas, hopefully, would provide direction of future research at universities pursuant to an improved understanding of the U.S. air transportation system and, in turn, an improvement in the planning process.

The planning process is made up of many planning exercises—some complement one another and should in all cases relate to one another through some basic planning frame that identifies the basic needs and benefits of air transportation as air transportation relates to the total economy.

Through this relationship, value assessments could be made as impact studies and changes to the system relate to the total system and its contributions to the economy. There is no way to make a value assessment of a particular exercise involved in an isolated element of the system without an understanding of its relative position and contribution to the whole.

It is the purpose of this presentation to suggest a basic planning frame that would provide the fundamental platform for relative assessment of those planning exercises in the areas of:

- Geographics
- Growth Forces
- Science Search
- Area Delineation
- Composition
- Connectivity
- Organizational Structure
- Market Demand
- Technology
- Operating Functions
- Fiscal Effectiveness
- Socio-Economic Benefits
This planning platform would define the current interrelationship of air transportation to the total economy—admittedly a complex and difficult task; however, it is a necessary one if we are to understand the total system and its effectiveness. The vast scope and complexity becomes visible when we study the development of the air transportation system and how it evolved into its present state.

The Civil Aeronautics Act of 1938 provided a stable environment in which the airlines could progress. During this same time period, the DC-3 provided the airlines with a safe and economical airplane. From that period on, the network expanded into the most comprehensive and reliable transportation network on the face of the earth.

Three important events resulting from technology should be recognized during this past history. First, the DC-3 provided the vehicle for early growth with enough passengers on board to begin the development of connecting complexes for distribution of passengers throughout various market demands. Next, the DC-4 and L-049 aircraft made possible transoceanic flight and transcontinental flight. Finally came the jet aircraft with significant improvement in comfort, reliability, economics, and speed. Speed provided a great increase in service by allowing a business passenger to go from his home to do a day's work and return home the same day. For the vacationing passenger or the visitation passenger, this speed allowed time for the purpose of travel rather than using a significant amount of that time in travel.

During this period of 40 or so years, major social and economic changes have occurred: Technological progress has been great; the educational level has increased tremendously; and there have been significant changes in the structure of demographics. During this dynamic history, the airlines had to develop
a correspondence with all the elements of the economy which would insure a service level necessary to the demands of individuals, businesses, institutions, and government.

During this period, from 1938 until the present, the airlines have continued to develop as service demand increases. Management, operating procedures, skills, and resulting efficiencies have been established by thousands upon thousands of airline personnel in response to millions upon millions of passengers and shippers in order to provide a satisfactory level of service: at the same time, these thousands of airline personnel have developed correspondence with the support areas necessary to supply the airlines with the services and resources required for operation.

This presents a picture of a composite and coordinated group of skills within the structure of the airline made up of operational, marketing, regulatory, personnel, and technical specialists: the assembly of these airline skills and processes is concentrated in providing the service required by the personal traveler, both for pleasure and visitation, and simultaneously fulfilling the needs of the industry and government business traveler. Similar skills and processes are applied to the satisfaction of the demand for shipment of freight, mail, and express.

Established on the one hand is the correspondence between the support organizations and the airlines, and on the other hand is the correspondence between the airlines and the demand for service. Because of their complexity, these two sets of correspondence establish a magnitude of requirements that would defy total identification and assessment.

To digress for a moment from our pursuit of a fundamental planning frame—we find ourselves many times in argumentative
situations that have been hypothesized through cause and effect reasoning. Needs are either found or invented to which an effect is given hypothetical measurement. There is something very, very wrong with this process if it is to be used for anything other than academic discussion. To give real world meaning to cause and effect, the operative word "response" must be interjected between the two, for it is the feasibility to respond to the cause which will determine the effect in any meaningful measurement.

As cause, response, and effect apply to air transportation, the response must be a feasible reaction to need (cause). Feasibility is the capability of providing the service level of comfort, safety, reliability, and speed to operate in a free enterprise system with the stability of regulated competition having as a result sufficient funds to invest in future growth and improvement.

We have established the correspondence between the airlines, the support organizations, and the service to the public and government. In these two sets of correspondence, cause can be identified. The response to this cause can only be found in a thorough understanding of the skills and structure of the airlines; therefore, prior to proceeding into the planning platform, it is recognized that a view of the economy must encompass the interrelationship between the airlines, their support organizations, and their service responses to the rest of the economy.

With the vast amount of correspondence between air transportation and other sectors of the economy, how can we visualize the response to demand of air transportation so that the effects can be measured? The input-output
graphical display of the economy provides the technique in which air transportation can be identified relative to all other sectors of the economy. Input-output analysis is one member of a large family of analytical tools that have been developed in recent years. Its value for planning purposes lies in the ability to trace the flow of goods and services among the various sectors that make up the economy and to measure the effects of anticipated changes in the individual sectors.

An appropriate acronym in the use of the input-output technique for visualizing relative position in this specific case is given the term APRASE, the Airline Position Relative to All Sectors of the Economy.

By adapting present input-output analysis, the industry, consumer, government, imports, and exports can be defined and analyzed in terms of inter-industry dollar transactions and expenditures by consumer and government as well as the value of imports and exports. Such analysis can go a long way toward presenting in a readily visualized manner the integration and participation of the airline industry in the present national economy. This proposed system of analysis has been specifically designed to fulfill this need based upon existing input-output analysis and impact analysis techniques.

Figure I illustrates an input-output table structured to identify air transportation. This table has been condensed in order to make the display manageable. Table I provides a cross reference of the APRASE sector table to the Wharton Obers, and Almon input-output models as well as to cross reference the sectors to the Standard Industrial Codes.

Figure II illustrates the APRASE model in planning jargon followed by Figure III which explains the same model in plain English.
The APRASE input-output model becomes a head's up display of the national economy from which impacts and assessment scenarios can be made, both of which are tied to this single planning frame. Specific assessment of value can be related to planning exercises.

APRASE is not intended as a problem solving device, but rather is designed to assess the interrelationship of problems and threats so as to permit better long range planning.

It is not the primary purpose of APRASE to determine the Gross National Product contribution of scheduled air transportation to the total economy. Such a single comparison would be very misleading as to the true value of scheduled air transportation to the economy. Scheduled air transportation, like some other elements, provides a velocity to the economy that is not shown in a Gross National Product contribution. You might say that the velocity of air transportation increases the lift-over-drag ratio of the economy. Any examination of the APRASE system must include the value of time.

Once APRASE has been developed, impact studies and assessments can be made to answer questions such as the following:

1. What part does air transportation play in an overview of the national economy?
2. How is air transportation demand distributed within the components of the economy?
3. What has been the relationship of growth between air transportation and all other sectors?
4. With the varying growth rates in different industries and within the components of final consumption demand, what market impact will these changes bring about in the future of air transportation traffic demand?
5. What industries will benefit from the facilities and equipment expansions required by the airlines?

6. What is the relationship of the price of one industry's products to those of another industry with respect to inflation?

7. What is the relationship between domestic air transportation and the international air transportation to and from the United States by passengers who are U.S. citizens on foreign carriers (imports equivalent) and foreign passengers transported by U.S. flag carriers (exports equivalent)?

8. How does the relationship of the quality of service (speed, comfort, and reliability) relate to the dynamics of the velocity of the economy?

9. What is the relative position of air transportation in the total communications system?

10. What is the land use and environmental impact of air transportation in comparison to all other sectors of the economy?

11. What is the economic multiplier of air transportation?

The APRASE technique presents a current definition of air transportation in the economy from which the transportation system can be examined for improvement. Many important planning exercises are being made today and will be made in the future. If an APRASE technique is developed, the various planning exercises can be given an economic assessment through this program.
### AIRLINE POSITION RELATIVE TO ALL SECTORS OF THE ECONOMY

**AFRASE - GRAPHIC DISPLAY**

#### INTERMEDIATE INDUSTRY DEMAND

<table>
<thead>
<tr>
<th>Sectors 1 - 31</th>
<th>Purchases</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manufacturing-Non Durables</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manufacturing-Durables</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transportation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Utilities, Trade and Finance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Government</td>
<td></td>
</tr>
</tbody>
</table>

#### FINAL DEMAND

<table>
<thead>
<tr>
<th>Sectors F1 - F4</th>
<th>Capital Investment</th>
<th>Personal Consumption</th>
<th>Exports</th>
<th>Government</th>
</tr>
</thead>
</table>

#### GROSS NATIONAL PRODUCT

<table>
<thead>
<tr>
<th>Sectors G1 - G6</th>
<th>Net Export/Import</th>
<th>Inventory</th>
<th>Current</th>
<th>Deflator Real - 1963</th>
</tr>
</thead>
</table>

#### VALUE ADDED

<table>
<thead>
<tr>
<th>Sectors V1 - V9</th>
<th>Value Added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries</td>
<td></td>
</tr>
<tr>
<td>Taxes</td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td></td>
</tr>
<tr>
<td>Retained Earnings</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{Value Added} = \text{GNP} \]
In Plain English

What Do We and They Do for the Economy
We and Our Helpers
Everybody
Regulators/Protectors

Where $ go In and Where $ go Out
and Back Again
What Do We Do for Each Other

What Will Keep Us From Doing a Good Job

What Will Help Us Do a Good Job and Grow
Selling Tickets
Operating
Giving Good Service
Making A Profit

APRASE VISUAL MODEL
A Display of What's Going On
Pictures - Words

APRASE SYMBOLIC MODEL
Our Number
Manipulating Device
That Uses Numbers
Instead of Words to
Show What, Where,
and How Much

Where the
Smart Devices
Come From

APRASE VERBAL MODEL
Our Display
The Airlines Display
Our Word and Picture Device
of Cause, Response, and
Effect

What and Why
of Problems
and
Opportunities
and
Threats

DIRECTION AND RATE
of What We Expect
and How We Figure it Out
Figure III

APRA I & II, CONSTRUCTION
Scope - Use - Basis

Plain English Version

In Planning Jargon

Contributions to the Economy
Industry
Public
Government

The Input and Output of Purchase & Sales

Constraints on Airline Development

Opportunities for Growth

APRA VISUAL MODEL

Graphic - Exposition
APRA I - Industry
APRA II - Company

APRA SYMBOLIC (MATHEMATICAL) I-O MODEL

Wharton Model
OBE Model
Almon Model
Special Selected Models

APRA VERBAL MODEL

SCENARIOS

PROJECTIONS
Premises
Forecasts
Assumptions
Methodology

Studies
Conditions
Positions
Trend Performance
Resources
### APRASE SECTOR IDENTIFICATION

#### Intermediate Industry Demand

**Primary:**
1. Agriculture, Forestry, & Fisheries
2. Mining
3. Contract Construction

**Manufacturing, Non Durables:**
4. Food and Kindred Products
5. Textiles and Apparel
6. Printing & Publishing
7. Petroleum & Related Industries
8. Other Non Durable Goods

**Manufacturing, Durables:**
9. Furniture & Fixtures
10. Fabricated Metal Products
11. Motor Vehicles & Parts
12. Aircraft & Parts
13. Instruments & Related Products
14. Other Durable Goods*

**Transportation:**
15. Scheduled Airlines
   - 1 Passenger
   - 2 Cargo
      **Subtable**
      - 1 Freight
      - 2 Express
      - 3 Mail
16. Other Air Transportation
   Excluding Airports
17. Other Transportation, Transportation Services, Including
   Warehousing

**Utilities, Trade, Finance:**
18. Communications
19. Electric, Gas, Water, & Sanitary
20. Wholesale & Retail Trade
21. Finance & Insurance
22. Real Estate

### Services:
23. Hotels
24. Business Services Excluding Advertising
25. Advertising
26. Medical, Professional, & Educational Services
27. Amusements
28. Other Services

**Government:**
29. Post Offices
30. Airports
31. Other Government Enterprises

#### Intermediate Industry Value Added

1. Compensation of Employees
   - 1 Wages & Salaries
   - 2 Supplements

2. Net Interest
3. Dividends Paid
4. Federal Taxes
5. State & Local Taxes
6. Retained Earnings
7. Depreciation
8. Other
9. Imports
   **Subtable**
   - 1 Passenger
   - 2 Cargo
      **Subtable**
      - 1 Business
      - 2 Personal
      - 2 Express
      - 3 Mail

**Note:**

Diversified/Conglomerate Industry.
For the purpose of the Intermediate Demand Matrix Diversified/Conglomerate Industry products/services are distributed in appropriate sectors. For Diversified/Conglomerate Industry identification of companies, refer to SIC 398 in Section V.
### APRASE SECTOR IDENTIFICATION

<table>
<thead>
<tr>
<th>Final Demand</th>
<th>Gross National Product</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F1. Capital Investment</strong></td>
<td></td>
</tr>
<tr>
<td>- 1 Equipment</td>
<td><strong>G1. Final Demand</strong></td>
</tr>
<tr>
<td>- 2 Construction</td>
<td><strong>G2. Net Export/Import</strong></td>
</tr>
<tr>
<td><strong>F2. Personal Consumption</strong></td>
<td><strong>G3. Inventory Factor</strong></td>
</tr>
<tr>
<td><strong>Subtable</strong></td>
<td></td>
</tr>
<tr>
<td>- 1 Personal Passenger Travel</td>
<td><strong>G4. Current GNP</strong></td>
</tr>
<tr>
<td>- 1 Vistiation</td>
<td><strong>G5. Deflator</strong></td>
</tr>
<tr>
<td>- 2 Vacation</td>
<td><strong>G6. Real GNP</strong></td>
</tr>
<tr>
<td>- 3 Change of Residence</td>
<td></td>
</tr>
<tr>
<td>- 4 Students</td>
<td></td>
</tr>
<tr>
<td>- 5 Military</td>
<td></td>
</tr>
<tr>
<td>- 2 Personal Cargo</td>
<td></td>
</tr>
<tr>
<td>- 1 Freight</td>
<td></td>
</tr>
<tr>
<td>- 2 Express</td>
<td></td>
</tr>
<tr>
<td>- 3 Mail</td>
<td></td>
</tr>
<tr>
<td><strong>F3. Government</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Subtable</strong></td>
<td></td>
</tr>
<tr>
<td>- 1 Business Passenger Travel</td>
<td></td>
</tr>
<tr>
<td>- 1 Civil Travel</td>
<td></td>
</tr>
<tr>
<td>- 2 Military Travel</td>
<td></td>
</tr>
<tr>
<td>- 2 Business Cargo</td>
<td></td>
</tr>
<tr>
<td>- 1 Freight</td>
<td></td>
</tr>
<tr>
<td>- 2 Express</td>
<td></td>
</tr>
<tr>
<td>- 3 Mail</td>
<td></td>
</tr>
<tr>
<td><strong>F4. Exports</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Subtable</strong></td>
<td></td>
</tr>
<tr>
<td>- 1 Passenger Travel</td>
<td></td>
</tr>
<tr>
<td>- 1 Business</td>
<td></td>
</tr>
<tr>
<td>- 2 Personal</td>
<td></td>
</tr>
<tr>
<td>- 2 Cargo</td>
<td></td>
</tr>
<tr>
<td>- 1 Freight</td>
<td></td>
</tr>
<tr>
<td>- 2 Express</td>
<td></td>
</tr>
<tr>
<td>- 3 Mail</td>
<td></td>
</tr>
<tr>
<td>ATPRASE</td>
<td>Wharton</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>59</td>
<td>59</td>
</tr>
<tr>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td>ATPRASE</td>
<td>Wharton</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>26P</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>26P</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>ATPHASE</td>
<td>Wharton</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>14 (cont.)</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>ATPASE</td>
<td>Wharton</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>18</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>32</td>
</tr>
<tr>
<td>19</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>37P</td>
</tr>
<tr>
<td>24</td>
<td>38P</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>38P</td>
</tr>
<tr>
<td>26</td>
<td>38P</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>37P</td>
</tr>
<tr>
<td></td>
<td>38P</td>
</tr>
<tr>
<td></td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>41</td>
</tr>
<tr>
<td>29</td>
<td>42P</td>
</tr>
<tr>
<td>30</td>
<td>30P</td>
</tr>
<tr>
<td>31</td>
<td>42P</td>
</tr>
<tr>
<td></td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>45</td>
</tr>
</tbody>
</table>
As I understand the purpose of this symposium, you have invited us here to suggest certain areas which would represent fruitful areas for intellectual investigation.

Therefore, in this paper I propose to highlight a situation we have observed in the routes served by Allegheny. The situation is not unique to our system and has been the subject of other papers which I plan to discuss.

Simply stated, we have noted that frequently an improvement in stage length does not necessarily mean an improvement in break-even load factor. Obviously this appears to be contrary to the general principle that short haul transportation is inherently less efficient than long haul transportation. Naturally, the conclusions are based on the inputs used, and the following variables all play an important part in the analysis:

- 65% of our costs are related to flying time; therefore, as time increases so naturally do costs.
- Fares on the other hand are related to mileage; therefore, when flying time is not related to the mileage (speed distortion) economic imbalances occur.
HAVING OBSERVED THE PROBLEM, THE NEXT OBVIOUS QUESTION IS WHAT IS CAUSING IT AND WHAT CAN BE DONE ABOUT IT. IN THIS PAPER I WILL NOT ATTEMPT TO ANALYZE THE LONG RANGE IMPLICATION OF THESE FINDINGS BUT MERELY OUTLINE THE DEGREE OF THE PROBLEM AND SUGGEST THAT IT IS A VALID FIELD FOR INDEPTH INTELLECTUAL ANALYSIS.

MAJOR QUESTIONS IMMEDIATELY COME TO MIND:
- Is the problem regional?
- Is it simply the ATC system?
- Is it solvable?
- Is it important?

On the last point I must answer affirmatively. Short haul transportation, and by short haul air transportation I mean up to 400 miles stage length, is still the preferred mode of travel. To set the background I have adopted a statement from the MITRE Symposium on short haul transportation which was held in April, 1973 (Slide 1 and 1A).

Short haul demand is expected to grow strongly over the next two decades provided that a system to adequately serve that demand is available.

This summary statement from the report of the panel on Demand Growth and Prospects concluded that the demand is there. Almost everything I read indicates that given a choice most people still overwhelmingly prefer to travel by air. Therefore, if the demand exists, how can air transportation companies continue to provide this service within the existing systems. At the same
MITRE Symposium in the spring of 1973 Art Lewis in a CASSANDRIAN statement noted the fuel problem. (Slide 2)

A further complication is the energy crisis which may cause major changes in quality of life and may result in a short haul aviation curtailment in the future. For aviation, it’s later than we think.

At the present time there appears to be no major technological breakthroughs coming within the next three to five years in airframe or power plant. We are also assuming that the FAA and DOT will not develop major system changes in the Air Traffic Control areas.

**Effective Block Speeds**

Now to illustrate the impact of the present system on actual schedule (Slide 3). As you can see, we have plotted the effective block speeds (Effective block speed = airport to airport statute miles / scheduled block to block time). Each dot on the graph is the block speed of an existing schedule for a DC9-30. The range of speeds circled at the 200 mile stage length shows a high speed of 295 miles and a low speed of 207 miles per hour. In this case, obviously there are many flights incurring non-productive costs.

This analysis is very similar to the paper presented by Scott Crossfield at the MITRE Symposium in 1973 (Slide 4). Mr. Crossfield observed that non-productive flying time averaged approximately 18% of the total time in his typical airline example.
BREAKEVEN LOAD FACTORS

To illustrate the impact these speeds have on cost and fares, we have measured the effective speed on breakeven load factors at a stage length of 400 miles (Slide 5). As a result of Phase 9, fares are related to direct mileage. Thus, the fare is the same regardless of the flying time and costs incurred. As this slide illustrates, the breakeven load factor at 400 miles is 36% on the average but ranges from 42% at -1 standard deviation to 32% at +1 standard deviation. If the fares were related to the costs incurred, the regular fare of $45.00 would have to range as high as $52.00 in some cases; to a low of $40 to maintain the average breakeven load factor at 36%.

SUMMARY

I believe short haul transportation will not be provided in the quantity demanded by air travelers. The demand will not be met without a major change in the transportation system as we know it today. Higher fares will be necessary and they in turn will retard the demand. Massive subsidies offer one possible solution but they are obviously politically unpopular.

We suggest short haul air transportation needs to be evaluated from a national priority standpoint. The relationship of operating costs and fares suggests short haul air transportation is in serious trouble.
SHORT HAUL DEMAND IS EXPECTED TO GROW STRONGLY OVER THE NEXT TWO DECADES PROVIDED THAT A SYSTEM TO ADEQUATELY SERVE THAT DEMAND IS AVAILABLE.
A FURTHER COMPLICATION IS THE ENERGY CRISIS WHICH MAY CAUSE MAJOR CHANGES IN QUALITY OF LIFE AND MAY RESULT IN A SHORT HAUL AVIATION CURTAILMENT IN THE FUTURE. FOR AVIATION, IT'S LATER THAN WE THINK.

Art Lewis
MITRE Symposium
April, 1973
NON PRODUCTIVE BLK TIME
AVERAGE ~ 18%

FIGURE 9.
TYPICAL AIRLINE EXAMPLE

BEST OF EXPERIENCE BOUNDARY.

MEAN TAXI DELAY
PRACTICAL BEST TAXI TIME
AVERAGE FLIGHT

STAGE LENGTH - SM

BLOCK TIME - MINUTES
EFFECT OF SPEED ON
BREAK-EVEN LOAD FACTOR AT 400 MILES
(DC9-30)

Break-Even Load Factors
Mileage Based Fare of $45

<table>
<thead>
<tr>
<th></th>
<th>- 1 S.D.</th>
<th>Average</th>
<th>+ 1 S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>42%</td>
<td>36%</td>
<td>32%</td>
</tr>
</tbody>
</table>

Fares Needed to Maintain
36% Break-Even Load Factor

<table>
<thead>
<tr>
<th></th>
<th>- 1 S.D.</th>
<th>Average</th>
<th>+ 1 S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10</td>
<td>$52</td>
<td>$45</td>
<td>$40</td>
</tr>
</tbody>
</table>

RP - 5/30/75
As an airline operating daily to destinations throughout the world, World Airways is concerned with the practical aspects of research and marketing. The Company wants to have facts that bear upon its operations, facts that can be used to make management decisions to enhance the airline's efficiency and operating results.

We are not particularly interested in the super-sophisticated procedures and techniques used by professionals, for example, in their long-range forecasts. Such terms as linear programming, trend extrapolation, envelope curves, figure of merit and exponential smoothing have no relationship to the data needed by our management for judgment decisions. We are baffled when confronted with terms like delphi technique, lead-lag relationship analysis, morphological research, relevance trees, cross impact analysis and probabilistic system dynamics. These are terms taken from a recent survey sent to World with regard to the long-range planning practices and policies in service industry.

In short, we need understandable data and interpretation of that data in clear, precise language.
Outline

Workshop on Air Transportation Demand and Systems Analysis

Mayflower Hotel, Washington, D.C., June 2, 3, and 4

I. Economic Forecasts

a) What type of airplanes should the manufacturers be planning for future passenger/cargo operations

b) Basic consumer research to provide information other than a quantity of numbers

c) Political considerations; the impact of governments upon travel, what attitudes might be expected of governments that would affect tourism and charter travel in and out of the countries concerned

d) Trends in airport development affecting traffic

e) Need for long-range forecasting worldwide

II. Research Needed on Motivation

a) If it's worth while to get people out of the habit of driving on long trips

b) If it's worth while to have more people-to-people contacts between countries

c) If it's worth while to utilize the capacity of our air travel system more fully

Then, it's important to know why people fly so we can find ways to encourage more air travel. Everyone involved should be interested in this subject. World should be particularly interested, because any expansion in air travel will probably be in the types of travel World provides.

d) How Important Are the Following?
II. (Con’t)

**Price** How many do or don't travel because of economic reasons? How important are economic reasons, compared to all other reasons people have for traveling by air? How much price elasticity is there in air travel? On what occasions? Among what groups? What's the best way to define and measure price elasticity?

**Escapism** How many travel because they've decided it's time to get away from it all? To do something different? What causes this? When does it happen? Who does it happen to? What are these people looking for in the trips they take? Are the benefits and experiences they're looking for different from those of other travelers? If so, in what way?

**Interest** How many travel because they have a greater interest in the world around them than non-travelers do? Who are these people? How can they be identified? Are they likely to be better educated, or is this type of innate interest and curiosity something that's independent of education?

**Stage in life** Are there times in life when people have a greater yearning to travel and a greater freedom or ability to do it? If so, what's the relative importance of this in comparison to other factors in determining the probability that a person will or will not travel by air? What is most important about the stage in life? Age? What the person is doing - student, employed, retired? Marital status - single, married, widowed? Presence and age of children in the household?

**Special occasions** How many are traveling because of weddings, funerals, sickness in the family and the like? What determines whether an individual will take a trip on such an occasion? Who does, who doesn't and why?

**Business travel** There's probably been more research on this than most of the above subjects, but there's still a lot we don't know. What determines whether a business trip will be taken? How important is the company, the boss, the individual themselves in deciding whether a trip is necessary? How often is it a business necessity or a business luxury?
II. (Con't)

We know so little about the motives for travel that any attempt to list the possibilities is probably incomplete. One aim of any research in this area should be to uncover all of the things that cause people to travel by air. One approach would be to find out:

Who wants to travel and does? Why?
Who wants to travel and doesn't? Why?
Who doesn't want to travel? Why?

Subjective versus objective reasons. How many of these reasons can be objectively measured in the sense that when certain things happen, certain people will travel? How many of these reasons are subjective, in the sense that peoples' decision to travel by air can be influenced by advertising and promotion?

Forecasting. Can a better understanding of the factors that cause people to travel by air be used to get more accurate forecasts of the amount of air travel? This, or the ability to predict the probability that certain types of people will travel in certain situations, might well be used as the criteria for judging the adequacy of research on motivation.

III. Social Benefits of Travel

a) What are these benefits; who benefits most

IV. What is the most economical size that an airline should be?

a) In terms of routes and fleet size and composition of fleet

b) What is the smallest number of aircraft of a given type that an airline should have in relationship to its market

V. What has been, and what will be the impact of one-stop ITC's on scheduled service and other modes of travel.

VI. Air Cargo Research

a) What does the GNP of a nation have to do with its import/export activities
VI. (Con't)

b) How does the GNP relate to individual companies

c) What will be the impact of the imbalance of trade caused by the funds going into the OPEC nations.

VII. What effect has the restriction of charters to certain destinations had on the growth of air travel?

VIII. Governmental regulation forecasting

a) Charter rules

b) Scheduling bans

c) Aircraft type restrictions

IX. Impact of projected energy situation with regard to aircraft type and leisure travel, for charter or scheduled airlines

X. Computer Related Research

a) Need a reliable method for gathering flight and maintenance related on a timely basis as the aircraft moves from point to point.

b) Aircraft in flight performance should be monitored by ground located computers for the purpose of providing information relating to pending or probable system failures.

c) Computer oriented pre-flight checkout could be performed prior to each flight.

d) On a worldwide basis all aircraft could be monitored to ensure -

- on course

- safe distance from all other aircraft

- safe distance above topography

XI. Financial Reporting

Can reporting to regulatory agencies, i.e., CAB, be improved whereby management can use the reports to run their business,
XI. (Con't)

as opposed to having to keep two or more sets of records. Further, should not there be adherence or standardization in reporting in accordance with generally accepted accounting principles and Financial Accounting Standards Board Opinions.

a) Much time and effort is placed into reporting to the Civil Aeronautics Board monthly, quarterly and annually, the value of which is minimal to the air carrier in providing useful data by which it can measure operations. The time and efforts of many persons are sapped creating schedules, numbers, statistics, etc., in a form that is not utilitarian to the carrier and thereby must be of doubtful value to anyone else.

b) Most carriers today are publicly held and are thereby required to perform additional informational reporting to various other regulatory agencies, services and commissions, all of which saps the talents of individuals, leaving little time for devising creative methods for management reporting. Further, there are conceptual differences in the nature of reporting required by the SEC versus the CAB, and any resemblance between the two is purely coincidental. First of all, the SEC has a broader base of company coverage than does the CAB and its method of standardized reporting is controlled by Form, Generally Accepted Accounting Principles, Financial Accounting Standards Board Opinions and Accounting Series Releases. The Board, on the other hand, uses its Uniform System of Accounts and Reports (USAR) Accounting and Reporting Directives, and Observations of the Director as a means toward standardization in the measurement of companies in the same industry.

c) The USAR in its present form, is an excellent candidate for a major revision, since major changes have taken place in airline industry operations since its development. Little has been done to this document to improve its usefulness as a standardized reporting guide. Definitions, descriptions of accounts and general account instructions included therein lend themselves to different interpretations by carriers in the same business, i.e., we probably all have a different basis of computing an available ton mile even though the ACL's may be the same.
XI. (Cont')

d) Reporting to the CAB on Form 41 is geared primarily to overall company airline operations. The Form 243 is an attempt at segregating MAC operations from the overall to determine its profitability to the carrier. The carrier, on the other hand, segregated its operations by aircraft type, type of operation (commercial, passenger, cargo, military), geography, etc. providing related statistics to measure each. Also, each carrier uses standard indices to measure the functional costs of operation, such as RPM's, cost per mile/block hour, etc. for direct and indirect operating costs. Subjective, and sometimes arbitrary allocations are used to spread indirect costs to types of operation and aircraft. Consistency by each carrier provides credibility to these indices when used for internal management decision-making.

It would not be prudent here to suggest that each carrier report to the Board in its own form, as this would be totally impractical. But the Board should move toward more standardization in reporting of direct operating costs for the entire industry, and more specialized and separate reporting between the scheduled carriers and supplemental carriers.
Panel 3 - Air Carriers

*ARE THEY OR ARE THEY NOT? ARE COMMUTER AIRLINES PART OF THE NATION'S AIR TRANSPORT SYSTEM, OR ARE THEY NOT?*

By Thomas S. Miles, President & Chief Executive Officer
National Air Transportation Associations, Inc.

Notes to TSM for ad lib presentation:

(1) Review participation as panelist at DOT Conference on Regulatory Reform, April 26, 1975.

(2) Mention how some people in government and the academic world are pointing to commuter airlines as the living example of the successes that can be achieved by air carriers operating under minimum regulations.

(3) Explain the commuter air carrier industry. See following:

Commuter air carriers operate under exemption granted by the Civil Aeronautics Board from Section 401(a) of the Federal Aviation Act of 1958. They are registered with the Board under Part 298 of its Economic Regulations; hold operating certificates issued by the Federal Aviation Administration; and operate aircraft under all applicable Federal Air Regulations.

Although air taxi operators first commenced scheduled air services in the 50's, it was not until 1969 that the CAB created the commuter air carrier industry as it is known today. In that year, the CAB issued an order defining a "COMMUTER AIR CARRIER as an air taxi operator which (1) performs at least five round trips per week between two or more points and publishes flight schedules which specify the times, days of the week and places between which such flights are performed, or (2) transports mail by air pursuant to a current contract with the [U.S. Postal Service]."

On July 18, 1972, the Board issued an order restricting commuter air carriers to the operation of aircraft seating no more than 30 passengers with a payload capacity of no more than 7,500 pounds unless it authorizes the operation of larger aircraft under an exemption to satisfy the needs of specific markets. Previously, the carriers were restricted to aircraft with a certificated gross take-off weight not exceeding 12,500 pounds.

Commuter air carriers are regulated by the CAB under a *laissez faire policy*. Their primary responsibilities are to register with the Board; carry the passenger liability and personal property insurance prescribed by the Board; provide the Board with copies of their schedules, fares, rates and charges; and file periodic reports covering their operations in the carriage of passengers, cargo and mail.

Commuters do not hold certificates of public convenience and necessity. Nor are their fares, rates and charges regulated or subject to approval by the Board. Operating without subsidy and route protection, they can enter or leave any market at any time. The go or no go decision for establishing scheduled services between any given pair of points is usually based on each carrier's own evaluation of the market, i.e., is the traffic potential adequate to cover the operating costs, etc. and return a reasonable profit on investment — both short-term and long-term.
Commuter air carriers are normally found in communities where the population or business activity is not sufficient to support adequate and timely service by the CAB-certificated carriers with their large aircraft. They are known as the pioneers in providing safe, reliable, economical and timely frequent service (passenger, cargo and mail) in response to public and community needs.

In many markets, the CAB has approved suspension/replacement arrangements between certificated carriers and commuter airlines. Some states have adopted intra-state regulations governing the operations of commuter air carriers which include route protection provisions and subjects their fares, rates and charges to state approval. Such regulations are imposed on commuters even though their operations, involving interstate commerce, fall under the jurisdiction of the CAB.

NOW THAT YOU KNOW HOW AND WHERE THE COMMUTERS OPERATE, YOU MAY ASK: "WHAT ARE THE RESULTS?"

Notes to TSM for ad lib presentation: Select pertinent data from statement before the House Aviation Subcommittee, April 9, 1975.

Q. How many airports are served by commuter airlines in the carriage of passengers?

In making preparation for the publication of the 1975 Report of the Commuter Airline Industry, we analyzed the October 1, 1974 edition of the Official Airlines Guide featuring the schedules of all U.S. domestic airlines including 131 commuter airlines. This is what we found:

- There are 665 airports in the 50 states, the Commonwealth of Puerto Rico and the territories and possession of the United States served by the scheduled domestic airlines including trunk, local service, helicopter, commuter and intra-state carriers:
  - 210 (31.6%) are served exclusively by the commuter airlines.
  - 256 (38.5%) are served exclusively by the certificated carriers.
  - 199 (29.9%) are served jointly by the certificated and commuter carriers.
  - 665
In serving a total of 409 airports, the commuter airlines serve 1,530 city-pairs on a single-plane basis and thousands of additional city-pairs by connecting with the major airlines. (If the commuter airlines operated an average of 3.5 flights per business day in these 1,530 markets, it would mean that they operated 5,350 daily flights. An NATA study is now underway to determine the exact number of flights scheduled per day between small communities and hub airports for the convenience of connecting passengers and shipments. A comparative analysis will also be made of the frequency of service of the local service carriers who receive “Public Service Revenues” as well as the services of the unsubsidized commuter airlines. The commuters have the reputation of providing timely frequent service in response to community needs.)

Out of the 665 airports served on a scheduled basis:

- 365 (54.9%) are served by a single carrier. 193 (52.9%) of these rely on commuter airlines, while 172 (47.1%) are served by the certificated carriers.
- 131 (19.7%) are served by two carriers.
- 61 (9.2%) are served by three carriers.
- 27 (4.1%) are served by four carriers.
- 11 (1.6%) are served by five carriers.
- 21 (3.2%) are served by six carriers.
- 4 (0.6%) are served by seven carriers.
- 11 (1.6%) are served by eight carriers.
- 4 (0.6%) are served by nine carriers.
- 30 (4.5%) are served by ten or more carriers.

665

4/ See Exhibit C for listing of 665 airports by state.

5/ A “commuter air carrier” as defined by the CAB is “an air taxi operator which performs at least five round trips per week between two or more points and publishes flight schedules which specify the times, day of the week and places between which such flights are performed, or (2) transports mail by air pursuant to a current contract with the U.S. Postal Service”.

† This study did not include small community airports in Alaska served by Kodiak-Western Alaska; Reeve Aleutian and Wien Air Alaska.
Only three states are without the convenience of timely, frequent commuter airline service: Alabama, Montana, and North Dakota. Out of the 47 states enjoying commuter airline service, 21 are dominated by commuter airlines from the point of view of the number of airports served in each state.

The airlines maintain a total of 1,671 stations at the 665 airports served on a scheduled basis. 1,048 (62.7%) are operated by the certificated airlines while 623 (37.3%) are operated by the commuter airlines.

Q. Your survey of the OAG covered airports served on a scheduled basis by air carriers engaged in the carriage of passengers, or combination of passengers and cargo. Are there any airports served exclusively by all-cargo commuter air carriers and air taxi mail contractors?

YES. A recent report from the CAB shows that there are over 134 airports served exclusively by such carriers. By adding this figure to the 665 airports enjoying scheduled passenger service, we come up with a total of 799 airports, 543 (68%) of which are served by commuter airlines. Out of these 543 airports, 344 (63.3%) are served exclusively by commuter airlines engaged in the carriage of passengers, cargo and/or mail.

Q. How many commuter airlines operate as “all-cargo” carriers or hold air taxi mail contracts?

Approximately 20-25 commuters operate as all-cargo carriers while 62-64 air taxi operators hold air taxi mail contracts and thus fall under the definition of a commuter air carrier.

Q. How much traffic did the commuter airlines carry in 1974?

As commuter airline traffic statistics are maintained by the Civil Aeronautics Board on a confidential basis for 12 months, the latest figures we have are for the year ended December 31, 1973. Using their figures as a foundation, one could estimate traffic as follows:

<table>
<thead>
<tr>
<th></th>
<th>1973</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passengers</td>
<td>5,687,614</td>
<td>6,200,000</td>
</tr>
<tr>
<td>Passenger Miles</td>
<td>575,809,567</td>
<td>633,400,000</td>
</tr>
<tr>
<td>Cargo (Pounds)</td>
<td>92,963,189</td>
<td>110,500,000</td>
</tr>
<tr>
<td>Mail (Pounds)</td>
<td>147,795,590</td>
<td>168,800,000</td>
</tr>
</tbody>
</table>

For the actual figures, perhaps the CAB would release same to the Subcommittee on a confidential basis.
SO IS THERE ANY WONDER WHY SO MANY ARE SAYING THAT THE CAB'S LAISSEZ FAIRE POLICY IS WORKING SO WELL IN THE PUBLIC INTEREST?

WE'RE HERE TODAY TO IDENTIFY THE MOST PROMISING AREAS OF FUTURE RESEARCH IN AIR TRANSPORTATION DEMAND AND SYSTEMS ANALYSIS.

GENTLEMEN . . . LET ME RECOMMEND THE COMMUTER AIRLINE INDUSTRY FOR SUCH RESEARCH AND TO EXCITE YOUR INTEREST, LET ME NOW OFFER A FEW PROPOSALS — PROPOSALS THAT ARE BOTH SENSITIVE AND RESPONSIVE TO THE NEEDS OF PASSENGERS, SHIPPERS AND COMMUNITIES THAT ARE SO DEPENDENT ON THE SCHEDULED SERVICES OF COMMUTER AIRLINES.

THERE ARE THOSE AT THE CAB WHO SAY THAT THE COMMUTERS ARE AN IMPORTANT PART OF THE NATION'S AIR TRANSPORT SYSTEM. BUT WHEN IT COMES TIME TO MAKE THE COMMUTERS FULL PARTNERS IN SERVICE TO THE PUBLIC, THE CAB IS SOMewhat LACKING IN ITS RESPONSE. FOR EXAMPLE: WE CANNOT PARTICIPATE IN . . . .

Notes to TSM for ad lib presentation:

(1) Discuss Air Freight Directory published by Air Cargo, Inc. for marketing air freight.

(2) Discuss Standard Ticket and Area Settlement Plan for travel agents.

(3) Discuss joint fares.

(4) Discuss problem with OAG in publication of connecting schedules . . . unjust, unduly discriminatory and unlawful.

IF THE SOLUTION TO SUCH BASIC PROBLEMS IS GOING TO BE DEPENDENT ON REGULATORY REFORM, THEN WE SAY: "LET'S GET ON WITH IT!"

Notes to TSM for ad lib presentation:

(1) Discuss problem some commuters are experiencing in financing aircraft.

(2) Discuss Aircraft Guarantee Loan Legislation that was enacted for local service carriers when they were "feeders".

(3) Explain that such legislation is not available to commuters.
IF IT IS GOING TO TAKE REGULATORY REFORM TO MAKE COMMUTER AIRLINES ELIGIBLE FOR AIRCRAFT LOANS, THEN WE SAY: “LET’S GET ON WITH IT!”

Notes to TSM for ad lib presentation:

Expand on following key sentences . . . .

THERE ARE OVER 150 CERTIFICATED POINTS BOARDING LESS THAN 50 PASSENGERS PER DAY. IT COULD BE THAT THEY DO NOT HAVE TIMELY SERVICE. (Expand)

IT IS FELT THAT MANY COULD BE SERVED MORE EFFICIENTLY AND AT FAR LESS COST TO THE GOVERNMENT IF THEY WERE SERVED BY COMMUTERS. (Expand)

BUT THERE ARE TWO PRINCIPAL REASONS WHY SERVICE TO SUCH COMMUNITIES IS NOT BEING TRANSFERRED TO THE COMMUTERS . . . .

SCOPE CLAUSE (Explain)

COMMUNITIES FEAR LOSS OF CERTIFICATED CARRIER AND ITS OBLIGATION TO SERVE . . . . COMMUTER WOULD HAVE NO SUCH OBLIGATION (Explain)

IF IT IS GOING TO TAKE REGULATORY REFORM TO IMPROVE SCHEDULED SERVICE AT SUCH POINTS AT FAR LESS COST TO THE FEDERAL TREASURY . . . . AND WITH THE CONSUMPTION OF FAR LESS FUEL, THEN WE SAY: “LET’S GET ON WITH IT!”

Example: 100 MILE TRIP
Beech 99 burns about 49 gallons of jet fuel.

Convair 580 burns about 155 gallons.

With 10 passengers on a given flight (good load factor for the commuter whose equipment is geared to the needs of the market . . . poor load factor for the local service carrier whose equipment is too big for the market), the commuter burns 4.9 gallons per passenger while the Convair consumes 15.5 gallons per passenger.
Note to TSM for ad lib presentation:

Discuss problem of state versus federal regulations of commuter airlines.

THE FEDERAL AVIATION ACT PREEMPTS THE STATES FROM GETTING INVOLVED IN THE REGULATION OF SAFETY. COULD NOT BE THE TIME FOR THE ACT TO BE AMENDED TO PREEMPT THE STATES FROM GETTING INVOLVED IN THE ECONOMIC REGULATION OF ALL AIR CARRIERS?

(Give examples of state regulations and the costs involved. "public pays"

IF IT IS GOING TO TAKE REGULATORY REFORM TO GET THE STATES OUT OF THE REGULATION OF AIR CARRIERS – REGULATIONS WHICH ARE HAVING AN ADVERSE IMPACT ON FEDERAL REGULATED CERTIFICATED AND COMMUTER AIR CARRIERS AND THUS COULD BE HELD TO CONSTITUTE AN UNCONSTITUTIONAL BURDEN UPON INTERSTATE COMMERCE, THEN WE SAY: “LET'S GET ON WITH IT!”

Note to TSM for ad lib presentation:

Summarize problems facing commuters.

IN ANSWERING MY OPENING QUESTION, IT MUST BE ADMITTED THAT THE COMMUTER AIR CARRIERS ARE NOT AS YET AN IMPORTANT PART OF THE NATION'S AIR TRANSPORT SYSTEM IN VIEW OF THE PROBLEMS WE'VE JUST DISCUSSED. IS RESEARCH THE ANSWER TO SUCH PROBLEMS? IF SO, LET'S GET ON WITH IT!

THANK YOU . . .
THE "MONEY CHANGERS'" OUTLOOK

Remarks By Harry E. Colwell III, Vice President, The Chase Manhattan Bank, N.A. at the M.I.T. Workshop Washington, D. C. on June 3, 1975

I. WHAT IS THE BANKERS' ROLE IN AIRLINE FINANCE?

The banks are a major source of airline funds for equipment and other needs, and have been so historically for many years going back to the infancy of the industry. Types of financing are:

a. Intermediate Term Loans for equipment and down payments, usually having maturities of four to eight years. Such loans frequently made in conjunction with long term loans for institutional lenders.

b. Occasional working capital loans, usually with maturities of 30 to 180 days.

c. Leasing of equipment, both straight and leveraged, with leases running for up to 14 to 16 years.

d. Tax exempt financing, direct or through bonds, for airline terminals, ground equipment, et al.

e. Loans to aircraft manufacturers, usually under lines of Revolving Credits.

II. WHAT DATA DO BANKS RECEIVE NOW?

Bankers get a wide flow of data from various sources and I am sure are not aware of much more information which could be readily available. Some of the data are:

a. Financial Data, Balance Sheets, P & L Statements, on monthly or quarterly basis received from borrowing customers, plus Annual Reports, Audits, S.E.C. Reports, and Forecasts. These are sent to banks for their information by either request or under terms of credit agreements.

b. Banks get some C.A.B. Reports, Releases, and other studies and orders, though probably do not use these as efficiently as they could. Such data usually has a fair delay factor.

c. ATA data, analyst studies and reports, plus many publications such as Aviation Daily, Aviation Week, and AVMARK.

d. Manufacturers' studies and brochures.

Continued .........
THE "MONEY CHANGERS'" OUTLOOK

e. Most important of all, visits to airline facilities to meet management, kick tires, and review the facilities. Also, constant talk with people in the aerospace field.

All this data is used to help us make sound judgments on new credit requests, to find new, deserving customers that are growing, and to keep posted on the progress (or lack thereof!) of current borrowers. A point to mention is the hope the airlines will become more consistent and uniform in their financial reporting.

III. WHAT DATA COULD BANKERS USE TO MORE EFFECTIVELY SERVE AIRLINES AND THE COUNTRY'S TRANSPORTATION SYSTEM?

These are only rough suggestions and ideas of mine.

a. Origin & Destination Studies to show route densities and service, with attempts to show time of day, day of week, and seasonal factors. I now know from Art Ford this can be had for $1,500!

b. Sensitivity Studies on Price Elasticity. Impact of various special fares. Influence of type of equipment. Can similar routes be compared to make experiments more scientific by having "controls".

c. Greater use of Demographics. Stratified demand reports by economic level of passengers to demonstrate impact of business cycles on traffic over various routes.

I have a gut feel that we can learn much about traffic if we recognize the impact of various groups on traffic levels.

d. Capacity studies to determine actual practical ability of airlines to raise load factors on a consistent basis, while still maintaining reasonable levels of service. Study of departure times and aircraft sizes to determine optimum performance.

e. Data re the impact of fuel and labor cost increases on total costs.

f. Analysis of airports and airport facilities seeking evidence of "bottlenecks" in the system. Review of airport type costs - terminals, hangers, ground equipment.

g. Demand profiles on low cost charters or charter-type flights between key markets. Also, data on scheduled traffic so there can be a basis for rationalization of two legitimate but conflicting areas.

Continued ........
h. Independent data on the productivity and costs of various types of aircraft. This is applicable to both passenger and cargo aircraft.

i. Attempts to find "leading indicators" for the airline industry so that early warnings can be given on future hazards.

j. Work on the problem of ultimately heading towards structures more logical and greater service to the public than current routes which often grew historically by hit or miss.

k. Finally, projections of the future growth & needs. All the above contribute to the greater accuracy of the forecasts.

I have tried to suggest kinds of studies that I feel could help the airlines, the regulators, the financial institutions, and the public to have sounder bases for changes which will improve the airline system and maintain it on a healthy, dynamic, and free enterprise system.
I - INTRODUCTION

IN PREPARING FOR TODAY'S PRESENTATION I WAS CONCERNED AS TO WHAT A BANKER MIGHT SAY THAT WOULD BE OF INTEREST TO A GROUP COMPOSED OF AIRLINE EXECUTIVES, EXECUTIVES OF FIRMS ENGAGED IN THE MANUFACTURE OF AIRCRAFT, AND REPRESENTATIVES OF GOVERNMENT INVOLVED IN AVIATION. AS A BANKER INVOLVED IN THE AVIATION INDUSTRY I FELT YOU MIGHT BE INTERESTED IN OUR VIEW OF THE AIRLINE INDUSTRY THROUGH 1980 WITH PARTICULAR EMPHASIS ON THE ABILITY OF THE AIRLINES TO FINANCE THEIR REQUIREMENTS DURING THIS PERIOD. HOPEFULLY THIS WILL NOT ONLY BE OF INTEREST TO THOSE OF YOU ENGAGED IN THE AIRLINE BUSINESS BUT ALSO TO THOSE WHO ARE INVOLVED IN SELLING YOUR PRODUCTS TO THE AIRLINES EITHER DIRECTLY OR THROUGH PRIME CONTRACTORS. WITH THE DECLINE IN MILITARY EXPENDITURES THE AEROSPACE INDUSTRY HAS BECOME MORE AND MORE DEPENDENT UPON THE VICISSITUDES OF THE COMMERCIAL AIRLINE INDUSTRY. THIS HAS BEEN SEEN IN THE RECENT PAST WITH CANCELLATION OF SOME FIRM ORDERS FOR AIRCRAFT BY THE CARRIERS AS WELL AS THEIR FAILURE TO EXERCISE A SUBSTANTIAL NUMBER OF OPTIONS. AS WILL BE DISCUSSED SUBSEQUENTLY A CONSTRUCTIVE ROLE ON THE PART OF GOVERNMENT WILL BE ESSENTIAL IF THE CARRIERS ARE TO BE ABLE TO SECURE ADEQUATE FINANCING TO MEET THEIR REQUIREMENTS.

IN ASSESSING THE ABILITY OF THE AIRLINES TO FINANCE THEIR REQUIREMENTS THROUGH THE 1980's I WILL DEAL WITH THE FOLLOWING AREAS.

FIRST, OUR ESTIMATE OF THE FINANCING REQUIREMENTS DURING THIS PERIOD.
SECONDLY, POSSIBLE SOURCES OF FUNDS TO MEET THESE REQUIREMENTS.

THIRD, THE INFLUENCE OF FINANCIAL RATIOS ON THE SOURCES OF FUNDS UTILIZED.

FOURTH, THE ROLE OF GOVERNMENT IN ASSURING THE AVAILABILITY OF THESE FUNDS.

AS YOU WILL SEE WE ARE OPTIMISTIC OVER THE LONG RUN AS TO THE ABILITY OF THE AIRLINES TO SECURE THE NECESSARY FINANCING BUT ONLY IF THE AIRLINE MANAGEMENTS, THE FINANCIAL COMMUNITY, AND THE GOVERNMENT DO THEIR PART.

II- ESTIMATE OF AIRLINE FINANCING REQUIREMENTS THROUGH 1980


ON THE BASIS OF THESE ASSUMPTIONS THE PROSPECT OF THE DELIVERY OF APPROXIMATELY 500 AIRCRAFT FOR THE PERIOD 1975 THROUGH 1980 DOES NOT SEEM UNREALISTIC. IT SHOULD BE NOTED THAT 141 OF THIS NUMBER ARE ALREADY ON ORDER AND IN THE PIPELINE. UNLIKE THE SITUATION OF SEVERAL YEARS AGO ONLY 32% OF THESE PROJECTED DELIVERIES ARE WIDE BODIES AIRCRAFT. MOST OF THE DEMAND SEEMS TO BE FOR EXPANDED VERSIONS OF NARROW BODIED AIRCRAFT. SHOULD

SINCE MOST BANKERS ARE CONSERVATIVE, WE ARE WILLING TO CONCEDE THAT THESE ASSUMPTIONS OF TRAFFIC GROWTH MAY BE SOMEWHAT OPTIMISTIC AND THE PROJECTED GROWTH IN AVAILABLE SEAT MILES MIGHT NOT BE REQUIRED. HOWEVER, WE FEEL THAT THE AIM OF MANY CARRIERS TO STANDARDIZE THEIR FLEET AS A MEANS OF MODERATING ESCALATING COSTS WILL CONTRIBUTE TO SOME FLEET REPLACEMENTS IRRESPECTIVE OF AIRLINE CAPACITY NEEDS. ANOTHER IMPORTANT FACTOR THAT COULD ACCELERATE FLEET REPLACEMENT IS THE FACT THAT MANY CARRIERS WILL STILL HAVE AIRCRAFT FLEETS WITH A SIGNIFICANT NUMBER OF AIRCRAFT THAT FAIL TO MEET ENVIRONMENTAL STANDARDS.

IN THE LAST SEVERAL YEARS IN REACTION TO THEIR RECENT POOR SHOWING, MOST AIRLINES HAVE DONE A REMARKABLE JOB IN GETTING THEIR COSTS UNDER STRICT CONTROL. I DO NOT MEAN TO IMPLY THAT THERE IS NOT MORE TO BE DONE IN THIS AREA BECAUSE THERE CERTAINLY IS AND SEVERAL CARRIERS HAVE A WAYS TO GO IN MAXIMIZING COST REDUCTION. HOWEVER, THE FACT REMAINS THAT AREAS WHERE MANAGEMENT CAN EXERCISE CONTROL AND BRING ABOUT FURTHER COST REDUCTIONS ARE GETTING FEWER AND FEWER. THERE IS NOT MUCH JUICE LEFT IN THE LEMON. THE PROBLEM BECOMES PARTICULARLY ACUTE
WHEN YOU LOOK AT THE RAPID ACCELERATION OF WAGES, LANDING FEES, AND FUEL COSTS WHERE MANAGEMENT CONTROL IS MINIMAL. IN CONSEQUENCE WE EXPECT TO SEE THE MOVE TOWARD FLEET STANDARDIZATION CONTINUE DURING THE NEXT FEW YEARS WITH OLDER LESS EFFICIENT AIRCRAFT REPLACED B"7 BOEING 727-200's, AND EVENTUALLY - 300's, DOUGLAS DC-10's, AND LOCKHEED L-1011's WITH PERHAPS A FEW MORE BOEING 747's LATER ON.

A FURTHER MOTIVATING FACTOR TOWARD THE WIDE BODY AIRCRAFT WILL BE THE IMPACT OF CAPACITY CONSTRAINTS AT EXISTING AIRPORTS. IT IS INTERESTING TO NOTE THAT BY 1980 IT IS ESTIMATED THAT IN EXCESS OF 48 % OF AVAILABLE SEAT MILES WILL BE FLOWN ON WIDE BODY AIRCRAFT.

IT MAY BE THAT ONE ESTIMATE OF 500 AIRCRAFT IS TOO HIGH. IT IS CERTAINLY POSSIBLE THAT FURTHER PROBLEMS IN THE ECONOMY WOULD MITIGATE AGAINST THE TRAFFIC GROWTH AND WOULD LOWER BOTH TOTAL REQUIREMENTS AS WELL AS FINANCING REQUIREMENTS. HOWEVER IN ANY CASE IT APPEARS CERTAIN THAT SUBSTANTIAL NUMBERS OF AIRCRAFT WILL BE DELIVERED BETWEEN NOW AND 1980 AND AS A RESULT A SUBSTANTIAL AMOUNT OF FINANCING IN THE AREA OF 5 BILLION DOLLARS WILL BE REQUIRED.

III- POSSIBLE SOURCES OF FUNDS TO MEET THESE REQUIREMENTS.

HISTORICALLY THE AIRLINES HAVE TAPPED THE FOLLOWING SOURCES OF FUNDS TO FINANCE THEIR EQUIPMENT PURCHASES IN ADDITION TO INTERNAL CASH GENERATION WHICH IS OF COURSE THE SINGLE LARGEST AND MOST IMPORTANT SOURCE OF FUNDS.

1) COMMERCIAL BANKS LOANS- SINCE THE EARLY DAYS OF AVIATION AS WE KNOW IT FOLLOWING WORLD WAR II AND INTO THE EARLY 50's
PISTON AIRCRAFT PURCHASES, FROM DC-4's THROUGH DC 7's, WERE FINANCED THROUGH BANK BORROWINGS. THE TERM OF BANK BORROWINGS VARIED FROM THREE TO SEVEN YEARS WITH SEVEN YEARS CONSIDERED A REALISTIC USEFUL LIFE FOR SUCH AIRCRAFT. WITH THE ADVENT OF THE JET BORROWINGS FROM COMMERCIAL BANKS INCREASED THROUGH SUBSTANTIAL BANK REVOLVING CREDITS MANY OF WHICH ARE CONVERTED INTO TERM LOANS AFTER THREE OR FOUR YEARS WITH FINAL MATURITIES AS FAR AS NINE OR TEN YEARS FROM INITIAL COMMITMENT. BECAUSE THESE CREDITS ARE UP TO $300MM LARGE SYNDICATES OF 35 TO 40 BANKS ARE OFTEN INVOLVED.

2) LONG TERM LOANS FROM INSTITUTIONAL LENDERS: IN THE LATE 1950's AND EARLY 1960's WITH THE INTRODUCTION OF THE COSTLIER JETS WITH LONGER USEFUL LIVES IT BECAME APPARENT THAT THE AIRLINES WOULD BE UNABLE TO REPAY LOANS OVER THE NORMAL BANK TERM OF FROM 7 TO 9 YEARS. LENDERS CAPABLE OF PROVIDING FUNDS FOR 15, 20 AND EVEN 25 YEARS WERE NEEDED AS THE CARRIERS TURNED TO THE INSTITUTIONAL LENDERS. SUBSTANTIAL LOANS, USUALLY WITH MORATORIUMS ON REPAYMENT FOR THE FIRST 5 OR 10 YEARS WERE MADE TO THE AIRLINES DURING THIS PERIOD BY THE MAJOR INSURANCE COMPANIES WITH THE BANKS TAKING CARE OF THE EARLIER MATURITIES. IN RECENT YEARS WITH THE DECLINE IN AIRLINE EARNINGS AND THE INABILITY OF MANY CARRIERS TO MEET THE NEW YORK STATE INSURANCE LAW FIXED CHARGE COVERAGE TEST VERY LITTLE IN THE WAY OF SENIOR LONG TERM INSURANCE FINANCING HAS BEEN DONE.

3) SALE OF EQUITY AND CONVERTIBLE SUBORDINATED DEBENTURES IN THE PUBLIC MARKET: TO SUPPORT SUCH EXTENSIVE LEVERAGE AND
KEEP WITHIN NORMAL DEBT/EQUITY RATIOS OF 1.25 TO 1.50 TO 1 IT WAS NECESSARY TO INCREASE AIRLINE EQUITY BASES. IN THE EARLY DAYS PUBLIC ISSUES WERE LIMITED TO STRAIGHT EQUITY BUT WITH THE INCREASED REQUIREMENTS OF THE 1960's THE CONVERTIBLE SUBORDINATED DEBENTURE BECAME A MAJOR FACTOR IN AIRLINE CAPITAL STRUCTURES.

THIS PATTERN OF FINANCING INVOLVING THE ABOVE THREE MAJOR SOURCES OF FINANCING OCCASIONALLY SUPPLEMENTED BY SENIOR CONDITIONAL SALE FINANCING AND SOME SUBORDINATED FINANCING BY THE MANUFACTURERS PERSISTED THROUGH THE PROFITABLE MID-1960's TO FINANCE THE MORE ADVANCED BOEING 707's AND DC-8's AS WELL AS THE B-727's AND DC-9's. TRAFFIC GROWTH AND JET AIRCRAFT EFFICIENCIES LED TO IMPROVED AIRLINE PROFITS. INSTITUTIONAL LENDERS AND BANKS WERE ACCORDINGLY ENCOURAGED TO INCREASE THEIR COMMITMENTS WHILE IMPRESSIVE MARKET APPRECIATION OF AIRLINE SECURITIES LED TO CONTINUED EQUITY AND CONVERTIBLE DEBENTURE ISSUES.

DURING THIS PERIOD OF GENERAL PROSPERITY, THE AIRCRAFT LEASE WAS BORN. EVEN IN 1965 AND 1966 SOME OF THE CARRIERS BEGAN TO REALIZE THAT, DUE TO THEIR HUGE EQUIPMENT PURCHASES AND THE TAX ADVANTAGES OF ACCELERATED DEPRECIATION, THEY WOULD BE UNABLE TO USE ALL OF THEIR 7% INVESTMENT TAX CREDIT DURING THE ALLOTED PERIODS AND SOUGHT TO PRESERVE THE CREDIT THROUGH A LEASE WHERE THE TAX ADVANTAGES WOULD BE USED BY ANOTHER PARTY AND PASSED ON TO THEM IN THE FORM OF A LOWER EQUIVALENT INTEREST COST.

PICTURE. CONCURRENTLY, DECLINING VALUES OF AIRLINES STOCKS REDUCED THE ATTRACTIVENESS OF EQUITY AND SUBORDINATED OFFERINGS. SINCE THE DEBT PORTION OF LEVERAGE LEASES HAD THE CHARACTERISTICS OF AN EQUIPMENT TRUST CERTIFICATE, i.e., THE LENDER HAD THE CREDIT OF THE AIRLINE AND, IN EFFECT, A FIRST MORTGAGE ON THE PLANE, SMALLER INSURANCE COMPANIES AND INSTITUTIONAL LENDERS WITH NO PREVIOUS AIRLINE EXPOSURE, PARTICIPATED IN THE SENIOR DEBT PORTION RATHER THAN THE LARGE INSURANCE COMPANIES WITH SIGNIFICANT AIRLINE PORTFOLIOS. ALSO IN VIEW OF THE SECURED NATURE OF THE TRANSACTION THE NEW YORK STATE COVERAGE TEST DID NOT APPLY.

THEREFORE, DURING THE RECENT DIFFICULT PERIOD FOR THE INDUSTRY MOST FINANCING HAS BEEN LIMITED TO BANK BORROWINGS AND LEASING.

HOWEVER, IN ORDER TO RAISE THE APPROXIMATELY 5 BILLION DOLLARS OF REQUIREMENTS THAT WE ANTICIPATE, ALL OF THE TRADITIONAL SOURCES OF FUNDS WILL HAVE TO BE UTILIZED.

IV - THE INFLUENCE OF FINANCIAL RATIOS ON THE AFOREMENTIONED SOURCES OF FUNDS-- ASSUMING OUR ESTIMATES OF TRAFFIC GROWTH ARE REALIZED AND OUR ASSUMPTIONS ON INCREASES IN YIELD AND COSTS HOLD UP IT IS ESTIMATED THAT MOST OF THE CARRIERS WILL BE ABLE TO SECURE ADDITIONAL UNSECURED LONG TERM BORROWING FROM INSURANCE COMPANIES BY THE LATTER PART OF THE 1970's BY MEETING THE NEW YORK STATE INSURANCE LAW REQUIREMENT THAT EARNINGS PLUS LEASE RENTALS MUST COVER FIXED CHARGES, i.e., RENTALS PLUS GROSS INTEREST AN AVERAGE OF 1.5 TIMES OVER THE MOST RECENT 5 YEAR PERIOD AS WELL AS IN AT LEAST ONE OF THE TWO YEARS IMMEDIATELY PRIOR. THEREFORE, IT IS ASSUMED THAT AT
LEAST PART OF THE FINANCING REQUIRED WILL BE IN THE FORM OF 20 TO 25 YEAR TERM MONEY FROM INSTITUTIONAL.

IT IS ANTICIPATED THAT LEASING WILL CONTINUE TO PLAY A KEY ROLE IN THE CAPITAL STRUCTURES OF THE AIRLINES IN MEETING THE FINANCING REQUIREMENTS THROUGH 1980 FOR THE SAME REASONS AS IN THE PAST. HOWEVER, MOST BANK AND INSURANCE LENDERS NOW REQUIRE IN THEIR CREDIT AGREEMENTS THAT LEASING BE LIMITED TO APPROXIMATELY ONE THIRD OF THE TOTAL FLEET. THIS IS BEGINNING TO BIND IN THE CASE OF SOME CARRIERS AND COULD BE SOMEWHAT OF A LIMITING FACTOR.

AS IN THE PAST BANKS WILL PLAY A KEY ROLE IN MEETING THE AIRLINE FINANCING REQUIREMENTS OF THE LATE 1970's. HOWEVER, ALL THE SENIOR SOURCES OF FUNDS, i.e., BANKS, LONG TERM INSTITUTIONAL LOANS, AND LEASES MUST NOT EXCEED 150% OF EQUITY AND SUBORDINATED DEBT WHICH MEANS THAT ACCESS TO THE EQUITY MARKET IS ESSENTIAL IF THE PROJECTED FINANCING REQUIREMENTS ARE TO BE MET.

V- THE ROLE OF GOVERNMENT IN ASSURING THE AVAILABILITY OF FUNDS-

IT IS OBVIOUS THAT A KEY PARAMETER TO THE ABILITY OF THE AIRLINES TO ACCESS THE EQUITY MARKET AND ENTICE THE LONG TERM LENDERS BACK INTO THE FOLD, IS EARNINGS. AS DISCUSSED EARLIER WE ARE ASSUMING THAT THE CARRIERS WILL MAXIMIZE THEIR COST CONTROL EFFORTS IN AREAS THAT ARE SUBJECT TO MANAGEMENT DISCRETION. HOWEVER, WITH SUCH A LARGE PERCENTAGE NOT REALLY SUBJECT TO MANAGEMENT CONTROL, SUCH AS WAGES, FUEL COSTS, AND LANDING FEES, IT IS APPARENT THAT COST INCREASES OF THIS TYPE WILL HAVE TO BE MATCHED BY INCREASES IN YIELD THROUGH FARE ADJUSTMENTS. TIMELY RESPONSE BY THE CIVIL AERONAUTICS BOARD TO THIS PROBLEM IS CRITICAL TO THE ABILITY OF THE CARRIERS TO
FINANCE THE BILLION WE ESTIMATE THEY REQUIRE FOR AIRCRAFT PURCHASES DURING THIS PERIOD.

OF COURSE, TIMELY FARE INCREASES WHEN NECESSARY ARE NOT THE ONLY SOLUTION AS THERE IS SOME EVIDENCE THAT CURRENT FARE LEVELS ARE DANGEROUSLY HIGH. EFForts TO KEEP LOAD FACTORS UP THROUGH CAPACITY AGREEMENTS SHOULD BE ENCOURAGED. ALSO THE REGULATORY AUTHORITY MUST USE GOOD JUDGEMENT IN MAKING ROUTE AWARDS TO AVOID TOO MUCH COMPETITION ON CERTAIN ROUTE SEGMENTS WHICH HAS BEEN A PROBLEM IN THE PAST. LASTLY, ANY MOVEMENTS TOWARDS DeregULATION MUST BE CAREFULLY THOUGHT OUT, AND NOT MADE IN RESPONSE TO THE POLITICAL WINDS BLOWING AT THE TIME.

IN SUMMARY ENLIGHTENED REGULATION ON THE PART OF GOVERNMENT IS NECESSARY IF THE CARRIERS ARE TO EARN A RATE OF RETURN ADEQUATE TO ACCESS THE EQUITY AND LONG TERM FINANCIAL MARKETS WHICH AS INDICATED PREVIOUSLY IS THE KEY TO FINANCING THE AIRCRAFT WHICH WE FEEL THE DOMESTIC TRUNKS WILL REQUIRE THROUGH 1980. IT SHOULD BE NOTED THAT OUR ESTIMATES OF EARNINGS FOR THE PERIOD ARE WELL BELOW THE 12% RETURN SUGGESTED BY THE CAB.

VI. CONCLUSION - IN CONCLUSION WE ARE REASONABLY OPTIMISTIC ON THE FUTURE OF THE AIRLINES ALTHOUGH THERE WILL BE TROUBLED WATERS AHEAD AS THERE HAVE BEEN IN THE PAST. HOPEFULLY, WITH ENLIGHTENED REGULATION, THE TROUGHS WILL BE LESS DEEP IN THE FUTURE THAN THEY ARE AT PRESENT. A HEALTHY AIRLINE INDUSTRY WILL BE IN A POSITION TO BUY A SUBSTANTIAL NUMBER OF NEW AIRCRAFT DURING THE BALANCE OF THE DECADE AND WILL BE ABLE TO PAY FOR THEM.

AS EVIDENCE OF OUR CONFIDENCE WE HAVE ONE BILLION DOLLARS COMMITTED TO THE INDUSTRY EQUALLY DIVIDED BETWEEN THE AIRLINES AND
THE MANUFACTURERS WITH ANOTHER HALF A BILLION DOLLARS COMMITTED TO FINANCE EXPORT AIRCRAFT. YOU MIGHT SAY WE PUT OUR MONEY WHERE OUR MOUTH IS.

THANK YOU VERY MUCH.
Our hosts for today have directed our efforts to the identification of research areas which hold greatest promise for the future development of the air transport system. Such research, if successful, should lead to a better understanding of the U.S. air transport system and to better planning for its growth.

As one who has spent the better part of his life flying airplanes, working for a manufacturer, or for an airline and now as a member of the financial community specializing in aviation matters, there is nothing I would rather do than stand up here and talk to you about aviation and its great future. I think our problem is a bit more complex than that, however, and with the indulgence of our sponsors I would suggest the time is rapidly coming upon us when we must find aviation's 'detente' in the broader spectrum of all inter-city transportation. In many ways, with our innate optimism, I find aviation today is analogous to the fellow who fell off the Pan Am Building and was heard to say as he passed the 75th floor "well -- everything is okay so far".
I hope our ideas today -- and the research that flows from it -- will enable we optimists to negotiate a soft landing by the time we get to some of those lower floors along about the year 1990 and after.

The main idea I would like to leave with you today is one which might help to move us down the long developmental path to a comprehensive National Transportation Policy. Very simply, it is that our universities -- funded by the responsible Federal Agencies and Departments -- should undertake extensive research into the future strengths, weaknesses and all other relevant aspects of all modes of transportation in this country with the objective of providing high quality inputs to our policy makers -- regardless of their political alignment. From such inputs we can hope that these policy makers will be able to develop a modally coordinated National Transportation Policy.

If we had such a policy, my job as a financial analyst would be greatly simplified. As it is I don't quite know whether to expect multiple air carrier mergers leading to an oligopoly of four or five "Bigs", or a mass assault by many four or five airplane carriers a la pure competition with freedom of entry or exit from the business.
When I suggest we continue in our pursuit of a Transportation Policy, I do not mean to raise a sore subject with our D.O.T. sponsors. It is my observation that D.O.T. would have to be super-human to produce something resembling a long-term "consensus" Transportation Policy under prevailing conditions of changing political parties and Departmental leadership not to mention economic and energy chaos which has complicated life since their birth.

For these very reasons, the continuity of thinking and quality of effort that is available through the university research route appeals to me as a better way of thinking through our problems in a very thorough and systematic manner.

Now let me turn to a discussion of several of the emerging long-term problems that trouble me as a financial analyst. These are just a few of the areas of uncertainty that I believe good research may prove helpful in clarifying. A better understanding of these areas should then improve our chances of developing a transportation policy that is meaningful in the context of our future world. And I stress again, one that represents not just aviation but all transportation.
As a start, we must develop a long-range world and domestic environmental forecast. This would include serious attention to emerging population and sociological patterns, demands of third world nations to participate more equitably in the use of resources and redistribution of wealth. Such forecasts should not be so discrete as to provoke endless debate over decimal points, but rather one that is sufficiently illuminating of long-term trends that incumbent politicians cannot knock us off course every time the business cycle turns down.

The "resources" projections within this environmental forecast might tell us that aviation fuels may become so critically short in supply -- and expensive, that our foreseeable economics cannot justify continuation of present and planned service levels and load factors in all current air markets. It might also tell us that energy alternatives in this country such as coal and gasification of coal will lead to massive capital diversions to support the emerging needs of those industries and their transportation networks.
We might find from our research into this area that aviation has now lived out its "glamour" days and in the future will gradually take its logical place in the world and domestic economic order. There is no reason, in my judgment, why that place cannot be important, respected -- and profitable if we do our planning well and far enough ahead to avoid senseless investment and wasteful use of the resources we will need forever.

The next element which I feel must be researched in the context of our environmental projections is the technological outlook. I suspect that many of the needs implied by the socio-logical projections will demand a disproportionate amount of technological effort and capital which will divert from the effort that can be expended on technology for its own sake. In other words, the needs and demands of society will influence technological development rather than technological development influencing society as in the past.

If this assessment is correct, we must accept the possibility that future aviation frontiers -- whether they be physical or economic -- may not be passed simply for lack
of effort and in the broad context -- need. It then goes without saying -- but I'll say it anyway -- that technology will not bail aviation out if we get ourselves too mired down in red ink and debt over the next ten years.

This brings me to the next area which deserves research illumination and one which is particularly troublesome to the financial community. And that is long-term capital requirements of the carriers.

In the beginning, insurance companies provided such capital at attractive interest rates, but with the experience they have had with airlines over the years, capped off with their current write-downs on Pan Am's debt, there is little chance that this will ever again be a major source of capital for the airlines.

As airline equities entered their hay-days of the sixties, convertible debt was popular but once again experience has diluted investor interest in these securities, and most airlines became more dependent on leases and leveraged leases as a way of continuing their fleet expansions despite less than adequate earnings. Currently, leasing and even short-term bank credit are still a necessary form of financing new aircraft deliveries -- equity is, of course, out of the question.
The research I recommend here is to look beyond the currently good cash flows being generated by many of the carriers and see what happens when all the owned aircraft are fully depreciated and the leased equipment is simply an on-going cash expense. Will earnings plowback be enough to continue industry growth -- even at the rate of real economic growth? If not, will banks -- who by then will be feeling pretty lonely as airline lenders -- still be willing to fund even more unprofitable growth. I submit that a reasonable assessment of the magnitude of these problems can be developed years in advance of a crisis, but we must get on with it. And, we must bring our findings back into a system approach to transportation, for many of the same problems afflict the other modes, and it is the system solution we should be seeking if transportation policy is to be sound.

I hope you have discerned that the discussion thus far has been directed to identifying where aviation seems to be going as it increasingly is impacted by the essentially uncontrollable elements of social change, labor, inflation, politics, energy and the environment.
I am convinced good research can improve the predictability of all of these elements -- but we must be willing to accept those of our findings that we cannot change and set course immediately to adapt the present system to meet the requirements of the future system.

More specifically, we should move with particular urgency in those areas which will restore a respectable level of consistent earnings to air carriers. I am not today proposing mergers, discounts, free competition or any other panacea as a way of doing that so much as I am stressing the urgency of setting a policy which recognizes the importance of consistent profits to the capital investment process.

Let me quickly add I am not seeking guaranteed profits or returns on investment for our carriers; but I am urging a better appreciation and understanding of the nature of airline costs by our critics and regulators who seem to think we should be able to withstand the combined pressures of record breaking inflation levels, labor intensity, capital intensity, skyrocketing fuel costs and still reduce fares below long-term marginal costs. Good research should demonstrate the facts of life and lead to sensible solutions to these problems rather
than the blood bath and bankruptcy route some are unwittingly supporting.

If ever we in the financial community can feel there is broad acceptance of carrier profitability in government, then we can be of significant help in the resource rationing process -- in this case capital -- and the result will be more attention by carrier management to the bottom line.

This brings me to the next element which must be put in order if aviation is to develop as I believe it can. And that is the regulatory ease with which management can adapt their companies to the demands of the future. All too often imbedded decisions of years ago hang as a dead weight around managements' corporate neck. We need to develop and permit less onerous procedures for effecting mergers, acquisitions, divestitures, route sales, swaps, suspensions, etc. Only through reshaping of our system can dramatic improvements be made as quickly as necessary. Otherwise, a company that is top heavy with assets and debt can only muddle through hoping that traffic will eventually grow to the point that their imbedded investment will be profitably utilized.
As a suggestion, a commercial solution to rectify regulatory and managerial errors of the past might be in order. This suggestion implies a third party might be utilized extensively to work out corporate and route restructuring without endless regulatory and legal harassment. The principal regulatory concern should be protection of the public interest and avoidance of monopoly.

As opposed to any specific plan, however, the main point is we should identify ways in which management can be helped not hindered in its efforts to improve and maintain profits.

In summary, I have mentioned just a few of the many areas where good research -- used effectively by our government -- can improve the outlook for the aviation industry. I suggest that normal pressures of day-to-day governmental responsibilities and short term shifts of emphasis and leadership -- whether elected, appointed or career -- result in a rather constant and agonizing process of reappraisal of air transportation policies. The result is that our policy is to have no policy -- or, if one seems to be emerging but is not politically acceptable, it can easily be aborted by exploiting minor indiscretions of the policy maker.
The financial community does not find much comfort in this approach and it is my judgment that future capital will flow to the airlines like glue, but with the price of gold if our house is not put in order.

I believe that good research can lead to a better understanding of the aviation industry and its ultimate economic role; and with the help of responsible government and financial leaders the final chapter in our book can be a happy one.
"WHAT IS THE FUTURE OF AIRCRAFT LEASING IN THE UNITED STATES?"

by Mr. Ted Schlègel

GOOD AFTERNOON, "WHAT IS THE FUTURE OF AIRCRAFT LEASING IN THE UNITED STATES"?

BEFORE WE GET INTO THIS, LET US GO BACK IN TIME AND TAKE A LOOK AT LEASING IN GENERAL AND THEN CLOSE IN ON AIRCRAFT LEASING AS WE KNOW IT TODAY.

LEASING IS NOT A NEW DEVICE FOR FINANCING EQUIPMENT.

DURING THE DAYS OF THE PHOENICIANS, SHIP CHARTERS AND LEASES WERE FREELY USED.

HOWEVER, EXCEPT FOR THIS, LEASING DID NOT EXPAND UNTIL THE EARLY 1900'S WHEN THE RAILROADS BEGAN MOVING LARGE AMOUNTS OF CARGO FOR THE MANUFACTURING COMPANIES. THIS CARGO WAS MOVED IN THE MANUFACTURERS' TANK OR BOX CARS. SINCE THESE MANUFACTURERS DID NOT WANT THE EXPENSE OF OWNING AND MAINTAINING THESE CARS, THEY TURNED TO THE PRODUCERS OF THESE TANK AND BOX CARS. THUS THE START OF FULL SERVICE OPERATING LEASES.
THESE RAILROAD EQUIPMENT-ORIENTED LEASING COMPANIES, SUCH AS NORTH AMERICAN CAR, GENERAL AMERICAN TRANSPORTATION CORPORATION, ARE STILL STRONG VIABLE FORCES TODAY.

OF ALL THE RAILROAD EQUIPMENT PRODUCED, 75% OF IT IS ON LEASE.

THESE FULL SERVICE OPERATING LEASES ARE KNOWN AS GROSS LEASES, IN WHICH THE LESSOR PROVIDES SUCH FUNCTIONS AS MAINTENANCE, INSURANCE AND ADMINISTRATION OVER THE INITIAL LEASE TERM. IN THESE LEASES THERE IS NO INTENTION TO SELL THE EQUIPMENT.

HOWEVER, EXCEPT FOR THE SHIPS AND RAILROADS, LEASING WAS NOT COMMONLY USED UNTIL THE LATE 1930'S. DURING WORLD WAR II, ALL SORTS OF GENERAL EQUIPMENT AND REAL PROPERTY WERE AVAILABLE FOR LEASE. THIS TRENDS CONTINUED UNTIL AFTER THE WAR WHEN ITS POPULARITY DECLINED EXCEPT AS A HIGH COST SECONDARY METHOD OF SECURED FINANCING, OFTEN USED BY COMPANIES THAT DID NOT HAVE BANK FINANCING AVAILABLE TO THEM.
WITH THE INTRODUCTION OF COMPUTERS IN THE LATE 1940'S AND EARLY 1950'S THERE WAS AGAIN A GREAT POPULARITY FOR FULL SERVICE OPERATING LEASES, RANGING IN LEASE TERMS FROM ONE TO FIVE YEARS. THIS METHOD ALLOWED THE USER OF THE COMPUTERS TO HAVE THE EQUIPMENT WITHOUT HAVING TO INVEST OR MAINTAIN IT. IT ALSO GAVE THE USER GREAT FLEXIBILITY FOR UPGRADING AND ALSO ALLOWING HIM TO SWITCH TO LATER GENERATION EQUIPMENT. DURING THESE YEARS NOT ONLY WAS THE COMPUTER MANUFACTURER GETTING INTO THIS FIELD, BUT THE LEASING COMPANIES AS WELL. THE PROBLEM THAT EXISTED IN THESE EARLY YEARS WAS THAT THESE LEASING COMPANIES DID NOT FORESEE THE TECHNOLOGICAL ADVANCES THAT COMPUTER MANUFACTURERS WOULD BE MAKING. AS A RESULT, MANY OF THESE COMPANIES WERE USING UNREALISTIC DEPRECIATION METHODS THAT TEMPORARILY GAVE THEM A PRICING ADVANTAGE, BUT LEFT THEM VULNERABLE TO SUDDEN WRITEOFFS. SOME COMPANIES WERE DEPRECIATING IBM 360'S
OVER A 10-TO-12-YEAR LIFE, ALTHOUGH EARLIER COMPUTERS HAD LIFE CYCLES OF ABOUT FIVE YEARS. COMPUTER LESSORS, SUCH AS LEASCO CORPORATION, ITEL CORPORATION, AND BOOTHE COMPUTER, FLEW HIGH FOR AWHILE BUT WERE HARD HIT WITH THE INTRODUCTION OF IBM'S NEW 370 SERIES THAT UNDERCUT THE 360'S. MANY OF THESE LESSORS HAD TO TAKE BACK CANCELLED COMPUTERS, AND HAD TO ADJUST THEIR BOOKS WITH HEAVY WRITEOFFS.

ONE THING THAT HELPED LEASING'S CREDIBILITY HAS BEEN THE BIG PUSH BY THE BANKS INTO THE BUSINESS. BANKS HAD BEEN OFFERING LEASE FINANCING TO THEIR CUSTOMERS SINCE 1963, WHEN A RULING BY THE FEDERAL COMPTROLLER OF THE CURRENCY PERMITTED THEM TO LEASE PERSONAL PROPERTY. HOWEVER, FURTHER IMPETUS TO THEIR PUSH WAS GIVEN IN 1970 WHEN AMENDMENTS TO THE BANK HOLDING COMPANY ACT PERMITTED BANKING ORGANIZATIONS TO FORM LEASING SUBSIDIARIES SEPARATE FROM THE BANK. THE 1970 LAW OPENED UP
A NEW FUNDING SOURCE FOR THE BANKS. HOLDING COMPANY SUBSIDIARIES COULD ISSUE COMMERCIAL PAPER AND TAP OTHER CAPITAL MARKETS IN WAYS THE BANKS COULD NOT. THE LAW CREATED A MORE POSITIVE ATTITUDE AMONG BANKS TOWARD LEASING.

BEFORE 1970, THE BANKS WERE AN IMMENSE NEGATIVE SELLING FORCE AGAINST LEASING. IT WAS LOOKED DOWN UPON, CONSIDERED COMPETITION; BANK LOAN OFFICERS SOLD AGAINST IT. ONCE THE LEASING FUNCTION WAS PLACED OUTSIDE OF THE BANK AND PROFESSIONAL LEASING TALENT BROUGHT IN, TO RUN THE NEW HOLDING COMPANY SUBSIDIARIES, LEASING SUDDENLY BECAME RESPECTABLE AND THE NEGATIVE SELLING STOPPED.

AMONG OTHER FACTORS THAT HAVE SPURRED THE USE OF LEASING ARE TIGHT MONEY AND INFLATION. IN A RECENT ARTICLE, DICK WALTERS, EXECUTIVE VICE PRESIDENT OF GREYHOUND LEASING AND FINANCIAL CORPORATION, STATED THAT THE BASIC ATTRACTIVENESS OF LEASING IS, ITS ABILITY TO PROVIDE FINANCING AT A LOWER COST THAN MIGHT OTHERWISE BE AVAILABLE. THIS HAS NOT CHANGED, BUT TIGHT MONEY HAS CLOSED DOWN OTHER SOURCES OF CAPITAL AND ACCELERATED DEMAND FOR LEASE FINANCING.

LEASING ALSO OFFERS A HEDGE AGAINST INFLATION. FIXED MONTHLY RATES REMAIN THE SAME THROUGHOUT THE CONTRACT, EVEN IF INTEREST RATES RISE; THUS PAYING LEASE RENTALS WITH CHEAPER DOLLARS IN THE FUTURE.

THE MAIN ATTRACTION OF LEASING TO AIRLINES IS ITS CONVENIENCE AND FLEXIBILITY. LEASING SIMPLIFIES BOOKKEEPING FOR TAX PURPOSES, IN THAT LEASE PAYMENTS ARE FULLY DEDUCTIBLE BUSINESS EXPENSES.
LEASING ALSO REDUCES THE RISK OF TECHNICAL OBSOLESCENCE.

LEASING RELIEVES THE USER OF THE NECESSITY OF DISPOSING OF THE AIRCRAFT WHEN HE IS FINISHED WITH IT. ALSO, BECAUSE OF THE SOARING PRICES OF AIRCRAFT, AIRLINES WILL LOOK TO LEASING AS A MEANS OF FINANCING NEW EQUIPMENT. IN THE PAST, AIRLINES TENDED TO CONTINUE WITH THEIR EQUIPMENT. HOWEVER, NOW WHEN MORE EFFICIENT EQUIPMENT BECOMES AVAILABLE, SUCH AS THE CASE OF THE WIDE BODIES AND MORE EFFICIENT 727-200 SERIES, THEY WILL REPLACE IT BY LEASING. THIS HELPS THEM KEEP AN EFFICIENT FLEET IN OPERATION.

PROBABLY THE DECIDING FACTOR FOR AN AIRLINE CONSIDERING WHETHER TO LEASE, HOWEVER, IS COST. WHILE IT IS TRUE THAT LEASING IN SOME CASES IS MORE EXPENSIVE THAN PURCHASING THE AIRCRAFT, THERE ARE NUMEROUS CONSIDERATIONS. LEASING A $10,000,000 AIRCRAFT FOR 14 YEARS MAY COST MORE THAN A TEN-YEAR
LOAN TO BUY THIS AIRCRAFT, BUT THE INITIAL PAYMENTS ARE
ROUGHLY TWICE THOSE OF THE LEASE PLAN.

THE ADVANTAGE IS HAVING THIS CASH AVAILABLE. IF YOU
THEN TAKE THIS CASH FLOW AND DISCOUNT IT, THERE IS AN
ADVANTAGE TO LEASING. THE SAVINGS IS EVEN GREATER DURING
PERIODS OF USING SHORT-TERM MONEY COSTS SINCE THE LEASE RATE
STAYS CONSTANT OVER THE TERM IN MOST CASES.

OFF-BALANCE SHEET FINANCING IS ANOTHER ADVANTAGE OF LEASING.
THIS MEANS THAT IT IS NOT NECESSARY FOR THE AIRLINE TO SHOW A
LEASE ON THE BOOKS AS A DEBT; BUT AS A FOOTNOTE TO THE FINANCIAL
STATEMENTS.

LEASING CAN BE THE LOWEST COST FORM OF FINANCING NEW
EQUIPMENT. THIS IS PARTICULARLY TRUE FOR THE AIRLINES THAT
REQUIRE HUGE CAPITAL INVESTMENTS. IN MOST CASES, THE AIRLINES

LATELY, FINANCE LEASES ON MORE EXPENSIVE EQUIPMENT HAVE BEEN TAX-ORIENTED. FOR EXAMPLE; THE LEVERAGED LEASE, A HYBRID FORM OF THE FINANCE LEASE, HAS BECOME VERY POPULAR SINCE 1970, AS AN INSTRUMENT TO FINANCE BIG-TICKET EQUIPMENT. IN SUCH A LEASE THE OWNER-LESSOR INVESTS AT LEAST 20% OF THE COST OF EQUIPMENT AS ITS EQUITY POSITION. THE REST OF THE MONEY IS BORROWED FROM INSURANCE COMPANIES, PENSION FUNDS; OR OTHER INTERNATIONAL LENDERS; THROUGH THE SALE OF DEBT SECURED BY THE EQUIPMENT AND THE LEASE PAYMENTS.


THIS WAS SOON TO BECOME AN ESTABLISHED PATTERN OF LEASE FINANCING. AMERICAN AIRLINES IN JULY 1970, ARRANGED TO FINANCE THREE 747'S VALUED AT MORE THAN $66 MILLION THROUGH AN 18-YEAR LEASE. THIS WAS ACCOMPLISHED BY THE PUBLIC ISSUANCE OF
$47.85 MILLION IN 11% LOAN CERTIFICATES, REPRESENTING SOME
70% OF THE EQUIPMENT. HOWEVER, BY TRADING OFF THE INVESTMENT
TAX CREDIT ON THIS EQUIPMENT TO THE EQUITY OWNERS WHO PROVIDED
THE REMAINING 30% OF THE FUNDS - THUS THE OVERALL EFFECTIVE
INTEREST COST TO THE CARRIER WAS 7.56%.

TO QUALIFY AS A TRUE LEASE IN BOTH THE LEVERAGED AND NON-
LEVERAGED LEASE FOR TAX PURPOSES, CERTAIN SPECIFIC GUIDELINES
MUST GOVERN. IT IS PARAMOUNT THAT A LESSOR MUST NOT HAVE THE
LEASE RUN FOR THE ENTIRE ECONOMICAL USEFUL LIFE OF THE AIRCRAFT,
AND A MATERIAL RESIDUAL VALUE MUST EXIST AT THE EXPIRATION OF
THE LEASE. THIS CALCULATED RESIDUAL VALUE TEMPERATURES THE TERMS
OFFERED TO A LESSEE. FINALLY, THE ONLY PURCHASE OPTION THAT
CAN BE GIVEN IS AT FAIR MARKET VALUE.

A STUDY COMPLETED THIS YEAR BY THE INTERNATIONAL RESOURCE
DEVELOPMENT BUSINESS RESEARCH AND CONSULTING FIRM, INDICATES
THAT FOR THE LEASING INDUSTRY IN GENERAL THE ANNUAL GROWTH FOR THE NEXT TEN YEARS WILL BE AT LEAST 10%. THE ESTIMATED VALUE OF ALL THE GENERAL EQUIPMENT PLACED ON LEASE THIS YEAR WILL REACH SOME $16.5 BILLION, COMPARED WITH JUST OVER $15 BILLION LAST YEAR.

THE RECENT HIKE IN INVESTMENT TAX CREDIT TO 10% IS EXPECTED TO HAVE A SLOW EFFECT ON INCREASING LEASE GROWTH BUT IT WILL SHOW POSITIVE EFFECTS LATER ON THIS YEAR AND NEXT; INDICATED BY THIS STUDY.

FINALLY, THIS STUDY SHOWS THAT TODAY, LEASING HAS A MARKET SHARE OF 70% OF ALL THE AIRLINES' EQUIPMENT BEING LEASED. HOWEVER, CLOUDS ARE BEGINNING TO GATHER ON THE HORIZON FOR THE AIRCRAFT LEASING'S FUTURE PATTERN. MOST LOAN AGREEMENTS CONTAIN COVENANTS THAT REGULATE THE AMOUNT OF LEASE OBLIGATIONS. AS OF LAST YEAR, OF ALL THE EQUIPMENT IN OPERATION BY THE AIRLINES, OVER 30% OF
OF IT WAS LEASED. THIS IS UP FROM 4% IN 1960 AND 19% IN 1970.

ONE OF THE PROBLEMS IS THAT THE DOMESTIC AIRLINES IN 1974 SHOWED ONLY A 6.8% RATE OF RETURN WHICH FALLS "WELL SHORT" OF THE 12% RETURN DEEMED REASONABLE BY THE CAB. TO REACH THIS CAB'S 12% RETURN FOR AN INDUSTRY WITH $14 BILLION IN REVENUES AND $11 BILLION IN INVESTMENT WOULD REQUIRE EARNINGS OF ABOUT $800 MILLION IN 1974 AS COMPARED TO THE ACTUAL EARNINGS OF $318 MILLION. THE REASONS THAT THE AIRLINES ARE NOT OBTAINING THIS 12% RETURN, ACCORDING TO DR. GEORGE W. JAMES, SENIOR VICE PRESIDENT ECONOMICS AND FINANCE OF AIR TRANSPORT ASSOCIATION, IS THAT AIRLINE COSTS HAVE BEEN RISING FASTER THAN FARE CHANGES. HE STATES, "THAT FARES HAVE NOT BEEN INCREASING AT THE SAME RATE AS THE CONSUMER PRICE INDEX AND COSTS SUCH AS FUEL HAVE RISEN SHARPLY". COUPLED WITH FINANCIAL UNCERTAINTY AND THE LOW TRAFFIC GROWTH RATE, A REVIVAL OF MERGER TALKS AMONG AIRLINES WILL AGAIN BE A HOT ISSUE.
ANOTHER PROBLEM FACING THE AIRLINES IS THE FAA PROPOSED MODIFICATION OR PHASE-OUT OF ALL AIRCRAFT WHICH DO NOT MEET THE NOISE STANDARDS BY JULY 1, 1978. AIRCRAFT AFFECTED ARE THE DC 8'S, EARLY DC 9 MODELS, BOEING 707 AND SOME OF THE BOEING's 727 AND 737. THE PLANES AFFECTED WOULD BE FORCED TO MEET F.A.R. PART 36, NOISE AND EMISSION REGULATION OR LOSE CERTIFICATION. A BIG ITEM OF DISCUSSION IS THE DE-REGULATION OF THE U.S. TRANSPORTATION NETWORK WHICH WOULD AFFECT ALL MODES OF TRANSPORTATION. THE ISSUES IN DE-REGULATION ARE THREE: 1) WHETHER THERE SHOULD BE FREEDOM FOR NEW OR EXISTING TRANSPORTATION COMPANIES TO ENTER MARKETS; 2) WHETHER THERE SHOULD BE FREEDOM TO STOP SERVING MARKETS; AND 3) WHETHER THERE SHOULD BE FREEDOM TO LET THE MARKET PLACE SET PRICES IN OPEN COMPETITION, SUBJECT ONLY TO ANTITRUST LAWS.

MANY OF THE LESSORS ARE BECOMING CONCERNED WITH THE AIRCRAFT THEY HAVE ON LEASE TO THE AIRLINES DUE TO THE PROBLEMS AND
THE DECISIONS THE AIRLINES WILL BE FACED TO MAKE OVER THE NEXT FEW YEARS.

THE LESSORS OF THE 1960's WILL BE FACED WITH EQUIPMENT COMING OFF LEASE IN 1978. THIS EQUIPMENT MAY NO LONGER BE CERTIFIED DUE TO THE F.A.R. REQUIREMENTS. THE LESSOR CAN NO LONGER SELL THIS EQUIPMENT OUTSIDE OF THE UNITED STATES, AS WAS THE CASE IN THE PAST. UNLESS THIS EQUIPMENT IS MODERNIZED SUCH AS RETRO-FITTING THE ENGINES OR STRETCHING THE FUSELAGE. THIS REQUIRES THE LESSOR TO HAVE A WORLDWIDE MARKETING AND TECHNICAL STAFF. THUS, MANY OF THE PRESENT LESSORS NOW HAVE AN ATTITUDE OF GOING SOFT ON LEASING ADDITIONAL NEW EQUIPMENT TO THE AIRLINES, WHICH WILL HAVE AN ADVERSE EFFECT ON THE AIRLINES' FUTURE GROWTH SINCE THEY ARE SO VITALLY LINKED TO THE FINANCIAL COMMODITY.

NATIONAL AIRCRAFT LEASING, WHICH IS PART OF TIGER INTERNATIONAL, IS TRYING TO HELP BY BEING AN EQUIPMENT-ORIENTED
LESSOR AS IS THE RAIL CAR AND COMPUTER INDUSTRY. HOWEVER, WE NEED HELP IN HAVING MORE BASIC RESEARCH IN DETERMINING THE WORLD FUTURE GROWTH TRENDS AND TECHNOLOGY CHANGES. WITH THIS INFORMATION, WE CAN CONCENTRATE ON BUYING GOOD SOUND EQUIPMENT. WE CAN THEN LEASE THIS EQUIPMENT TO THE WORLD'S AIRLINES WITHOUT HAVING TO LOOK ONLY AT THE AIRLINE'S FINANCIAL STATEMENT, WHICH IS NOW THE CASE.

IN SUMMATION, NATIONAL AIRCRAFT LEASING FEEL THAT LEASING IS HERE TO STAY; JUST AS IT HAS SINCE THE TIME OF THE PHOENICIANS, HOWEVER, PATTERNS OF LEASING WILL CHANGE.
"AIRLINE MERGERS -- THE PROSPECTS FOR A NEW AIRLINE INDUSTRY"

Julius Malduitis, Jr., Ph.D.
Salomon Brothers

Delivered Before

Air Transportation Demand and Systems Analysis Symposium

Sponsored By

Civil Aeronautics Board
Department of Transportation
National Aeronautics & Space Administration
June 3, 1975
Washington, D.C.

Today the U.S. airline industry is at a fundamental turning point, a juncture which may be even more crucial, and fraught with greater uncertainties and opportunities, than the industry faced at the threshold of the jet age. Thus, in the years to come, the airline industry may bear little resemblance to the industry of today. It should not be forgotten that the airline industry has one quality possessed by few other industries, and that is the ability and capability for massive, abrupt and unexpected change.

Although the information in this report has been obtained from sources which Salomon Brothers believes to be reliable, we do not guarantee its accuracy and such information may be incomplete or condensed. All opinions and estimates included in this report constitute our judgment as of this date and are subject to change without notice. This report is for informative purposes only and is not intended as an offer or solicitation with respect to the purchase or sale of any security.

Copyright 1975/Salomon Brothers
Also, the airline industry, although similar in many respects to the railroad industry, possesses one unique characteristic which makes mergers and route rationalizations relatively easy. This is that unlike the railroads, the airlines do not have a right of way that is nailed down to the ground. As a result, I believe the airline industry is poised for a fundamental restructuring via mergers and consolidations.

Any assessment of the industry's future prospects must focus on a key, and very fundamental, trend in the industry. Since the late 1960s, the domestic airline travel growth rate has continued to weaken, with periodic and only brief recoveries. Faced with limited expansion in traffic volumes, carriers began to seek rate increases to offset cost inflation. Furthermore, carriers began to extensively compete for passengers through aircraft scheduling techniques. Excess competition led to conditions of excess capacity, and profit performance among carriers began more to reflect the temporary advantage or misfortune of a competitor, rather than the general industry's growth and health. Earnings and financial stability have been replaced with wide differences in earnings and financial strength. Excess capacity, as a result of excess competition, has become the problem of the day, with marginal ability on the part of the carriers to voluntarily reduce capacity. If the level of competition could not be reduced, then capacity reductions were sought via mutually approved agreements. Nevertheless, the public paid for the "convenience" of excess competition and excess capacity through ever-increasing fares.
Today there are almost 60 flights per day in each direction in the New York-Chicago market alone. Practically, nose to tail between the two cities, surely an economic waste by any measure or standard. Why can't airlines cut capacity? This inability to unilaterally cut capacity is a function of factors which many critics of the industry fail to appreciate. Very often it is argued that airlines should cut capacity, measured in billions of seat miles, a few percent and thereby achieve a much-needed improvement in load factors and earnings. Unfortunately, cutting a few hundred seat miles is not as simple as it may sound to the casual observer. For example, although the output or product that the airline sells is measured in billions of seat miles, in reality, seat miles are inflexible and indivisible to a very large extent. A few examples, will clearly illustrate this point. TWA's Flight #1, a Lockheed L1011 wide body aircraft operating between New York and Los Angeles produces over 500,000 seat miles in one flight or over 1 million seat miles in a round trip per day. For better load factors one might produce 950,000 seat miles per day but it is difficult to cut 5% off a plane. One could of course add lounges, piano, bars or sleepettes and thereby reduce seat miles. Thus, this daily round trip generates 400 million seat miles on an annual basis. In reality the choice is not 300 million vs. 400 million seat miles but actually zero seat miles vs. 400 million. Another example of indivisibility, TWA has only one daily New York-Phoenix non-stop which produces 197 million seat miles annually. Thus, an airline is faced with eliminating
a batch of seat miles equivalent to 197 million or in effect eliminating all non-stop service in the market. This would effectively mean that TWA's competitor which maintains non-stop service would benefit significantly since passengers prefer non-stop service over one-stop or connecting services.

This leads to several other little realized problems that illustrate the inflexibility problems airlines face. Let's take the case where you have four airlines serving a market, each having four non-stop flights per day. All other things being equal, each carrier is offering about 25% of the capacity. It literally verges on financial suicide for any one carrier unilaterally to cut capacity because it will suffer a greater relative reduction in traffic. In the example cited, the carrier cutting the one flight will reduce its capacity share from 25% to 20% while its traffic share will fall to probably 18% or less. As a result its load factors on the three remaining flights will also decline. This market share phenomenon prevents any individual airline from undertaking unilateral schedule cuts in competitive markets since it will lose more than it gains by such an action. Thus, the problem that the industry faces is not one so much of overcapacity as it is of overcompetition. Thereby, unable to adjust capacity unilaterally particularly since the financially stronger carriers have no incentive to do so, the traveling public has paid for the overcompetition and overcapacity by higher fares. If indeed the public desires lower fares then reducing wasteful competition among carriers will achieve that objective.

But underneath this illusionary equilibrium, competitive
and financial forces were already to work to reduce both the level of competition and capacity of the industry. Large differences in financial strength have resulted, for the first time, in certain carriers increasing their aircraft purchases, while those less fortunate are either unable to purchase aircraft or have deferred existing orders. This massive dichotomy of financial strength and ability to acquire aircraft implied that at some point the strong carriers would seek to dominate certain markets at the expense of their competitors. In effect, excessive competition and capacity had sown the very seeds or forces for a much-needed rationalization of the industry. As a manifestation of this rationalization process, numerous route swaps to reduce the two evils of overcapacity and overcompetition have been proposed and approved in the last several years.

Recent proposals to change the regulatory framework and philosophy will, in the whole, in our opinion act as a stimulus to this process of industry rationalization. Proposals to add the element of price competition and to improve the carriers' ability to enter or leave markets with greater ease will mean that carriers will be free to make the ultimate decision of terminating service at cities in the face of massive losses, rather than the traditional decision of cutting a flight here or there. Thus, the consumer, who at one time had the opportunity to choose one of several carriers with almost hourly departures between certain cities, may be faced with a more limited choice and less than desirable departure times.

Thus, the stage has been set for mergers and consolidations and from a public policy point of view I believe these should
be encouraged. Wasteful competition will be replaced by capacity more tailored to demand rather than in response to the excess competitive structure of the route system.

I urge your attention and research efforts into the economics of airline mergers.
INTRODUCTION

My discussion although not directed at problem areas in the aviation industry is directed at providing you with a general understanding of:

1. The general report information required of the air carriers (direct and indirect) by the Civil Aeronautics Board.

2. Of these general reports, which portions are maintained in computer data banks.

3. The information available to the public in both publication and tabular form.

Mr. Fitzgibbon will discuss other types of data available on a market basis and Mr. Wiley will discuss future data requests which are being developed in order to further our understanding of airline operations.

It is my hope that the information which I hand out to you and my discussion will better acquaint you with the data tools that we can and will be able to place at your disposal, in your research into the transportation field.
CONTENTS OF PACKET

1. List of CAB Publications and Statistical Program, a tabular summary of Bureau of Accounts and Statistics Publications and Reports.

2. Set of Blank Form 41's and revisions as of January 8, 1975.

3. Data from next edition of the Handbook of Airline Statistics
   A. Part II, contains various unit revenue and cost computations.
   B. Part VI Corporate Rate of Return
      1. 1965-1973
      2. Update information 1973 and 1974

4. Quarterly Statistical computations by Aircraft type as computed from CAB computer data base.

Direct Air Carriers

No. of Carriers U.S. Certificated Route Air Carriers
35 Form 41 Financial and Traffic Data
8 U.S. Certificated Supplemental Air Carriers
Form 41 Financial and Traffic Data

Commuter Air Carriers

224 Form 298C Selected System and Market Traffic Data

Commuter and Air Taxi Carriers

About 4100

Form 298D

Domestic--4 Items of System Traffic
Traffic Data Excluding All-Cargo
and Rotor Wing Operations
International
Same 4 Items on Market Basis

Foreign Air Carriers

All Classifications

159

Form 217
Civilian Charter Data Only
Indirect Air Carriers

<table>
<thead>
<tr>
<th>No. of Carriers</th>
<th>U.S. Air Freight Forwarders</th>
</tr>
</thead>
<tbody>
<tr>
<td>329</td>
<td>Form 244</td>
</tr>
<tr>
<td></td>
<td>Traffic and Financial Data</td>
</tr>
</tbody>
</table>

| 14               | Foreign Air Freight Forwarders |
|                 | Form 244                     |
|                 | Only Certain Traffic Schedules Required |

| 824             | IATA Cargo Agents            |
|                 | (If not an air freight forwarder) |
|                 | No Data                      |

Travel Agents

| 10,500          | IATA Approved and ATC Approved |
|                 | None, except post tour reports are required for certain types of charters for Tour Operators |

Special Purpose Reports

| Form 239--Report of Freight Loss and Damage Claims |
| Direct Air Carriers and U.S. Air Freight Forwarders |

| Form 242--Report of All-Cargo Services |
| Trunks and All-Cargo Carriers |

| Form 243--Report of Charter Service Performed For the Military Airlift Command |
| U.S. Certificated Air Carriers |
Form 250 and 251
Form 438--Monthly Report of Schedule Arrival Performance on Designated Passenger Flights
Certificated Route Carriers
Currently a proposal is being considered to expand this report from Top 100 to Top 200 markets.

The Financial and Traffic Data Section
The Financial and Traffic Data Section
(12 People including secretary)

A. Role

1. Edit general type data both for manual records and computer data banks.

2. Carrier contact for questions of Board's staff regarding reports.

3. Participates in development and inauguration of new data systems.

4. Compile and produce tabulations and publications of a general nature.

5. Handle requests for special data needs of Board's staff.

6. Handle public and other governmental agencies requests for data.

7. Provide certain recurrent data for U.S. Air Carriers to International Civil Aviation Organization.

8. Provide certain data to and work in coordination with Federal Aviation Administration (FAA) and National Transportation Safety Board (NTSB).
B. Edit Role

Data is received as:

1. Hard copy reports and tape or punched cards.
2. Hard copy reports and punched cards.
3. Hard copy reports only.

C. Information Maintained in CAB

Computer data banks

B-1--Balance Sheet
P-1--Profit and Loss Statement
P-3--Analysis of Transportation Revenues, Depreciation and Amortization and Nonoperating Income or Expense-Net
P-3a--Income Taxes
P-5--Aircraft Operating Expenses
P-6, 7, 8--Other Operating Expense Functions.
P-9--Ground Servicing Expenses by Geographic Location
T-1--Monthly Traffic Data
T-2--Quarterly Traffic Data by Aircraft Type
T-3--Quarterly Traffic Enplanements and Aircraft Departure Information by Station

D. Form 239--Freight Loss and Damage Report

Portions of Form 298C, Containing Market Traffic Data

E. Form 438--On Time Performance Report
In addition in producing our U.S. Air Carrier Aircraft Inventory, we have utilized certain data found on Schedule B-43, B-7, and B-8 to establish a system.

We developed this system under the misapprehension that FAA License Frame Numbers once assigned to an aircraft could not be changed even in subsequent ownership. When our error was discovered we realized that there could be absolutely no assurance against having duplicate counts of aircraft. Only careful screening and lengthy correspondence enable us to maintain a reasonably accurate accounting.

Many of the forms and portions of the other forms we are responsible for are reviewed based on inquiries from users, the CAB staff and others.

Certain erroneous data problems are dealt with in an expeditious manner. We give the carrier our interpretation of the correct amount and rational and a note that his records will be changed accordingly within 10 days, unless we hear from them to the contrary. This technique seems to spur the carriers into researching the problem and if necessary submitting the changes.

This technique is reserved for non-critical data and can be rectified in subsequent reflections of the same data. It results in being able to produce publications of the data with the least amount of delay.

Examples of Data Files

1. Air Carrier Financial and Traffic Data Publications

Tabulations

1. Number of Employees
2. Number of Aircraft on Hand and on Order
   U.S. Air Carriers
3. Airline Industry Economic Report
4. Interim Quarterly Financial Report
5. New Air Freight Forwarder Economic Report
Ratio of Revenue, International Operations--Generated by U.S. Air Freight Forwarders by Carrier Group March 31, 1975, Quarter--Preliminary Incomplete--Recap Per Form 244, Schedule T-1

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunks</td>
<td>24.6%</td>
</tr>
<tr>
<td>All-Cargo</td>
<td>7.3</td>
</tr>
<tr>
<td>Local Service</td>
<td>0.1</td>
</tr>
<tr>
<td>Foreign Air Carriers</td>
<td>65.1</td>
</tr>
<tr>
<td>Other Classes of Common Carriers</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

Publications

1. Airport Activity Statistics of Certificated Route Air Carriers

2. Handbook of Airline Statistics
   A. New Format
   B. Rate of Return (Handout)
   C. Selected Yield Data (Handout)
PASSENGER O&D AND SERVICE SEGMENT DATA

By James R. FitzGibbon
Civil Aeronautics Board

My presentation deals with the two largest statistical data processing systems in the Civil Aeronautics Board, namely, the origin and destination survey of airline passenger traffic and the traffic, capacity, and operating statistics program known as the service segment data. Both of these data sources contribute important information to air transport demand and system analyses.

The largest of these two systems is the passenger origin-destination survey. Its purpose is to identify the passenger travel patterns via the scheduled services of the U.S. certificated route air carriers. It provides market-type information such as:

1. The cities between which passengers traveled,
2. The routing of the passengers in term of carriers and connecting points, both inter- and intraline (including air taxi/commuter/helicopter portions of tickets interlined with the route carriers),
3. The volume of the passenger traffic,
4. Mileages (airport-to-airport great-circle distance) in terms of nonstop, average, and actual,
5. Passenger-miles,
6. Distribution of traffic in each market, by carrier, etc.

The O & D survey does not contain demographic information on the travelers, such as:

1. Purpose of travel, i.e., business or pleasure,
2. Occupation or income level, or
3. Age, etc.

The O & D data receive wide use in the Board, in the aviation community, and by the public for such purposes as:

1. Route investigations,
2. Adequacy of service investigations,

3. Rate investigations,

4. Bilateral negotiations for exchange of air traffic rights with other nations,

5. Market analysis, research, and forecasting,

6. Flight schedule planning,

7. Publication in Official Airline Guide of major connecting services,

8. Community air service evaluation and airport planning,

9. Formulation of aircraft design requirements,

10. Advertising placement, etc.

Users of O & D survey data are manifold, and include the following major categories:

1. The Civil Aeronautics Board

2. Other Federal Agencies (Congress, DOT, FAA, Bureau of Public Roads, etc.)

3. Air carriers

4. Airport commissions and authorities,

5. Aircraft manufacturers,

6. Aviation consultant firms,

7. Travel agencies,

8. Advertising agencies,

9. Hotel firms,

10. Trade press and news media,

11. Academic community, etc.

Passenger O & D surveys have been collected and compiled by the CAB continuously going back to as early as 1939, with a break during the World War II years. Changes have been made over the course of
time in the sampling basis, source documents, and content which can cause some difficulty in establishing comparability on a long-term time series basis. However, the last major change in sampling methods took place on January 1, 1968, so the survey has now been conducted on a comparable basis for the past seven years, and we are entering the eighth year. There are no plans in the immediate future to make any revisions to the survey system.

Data for the present survey are collected on the basis of a 10-percent continuous systematic sample of passenger tickets. The source documents are lifted flight coupons, i.e., the flight coupons from passenger tickets collected from boarding passengers. The 10-percent sample is obtained by selecting flight coupons with a ticket serial number ending in the digit zero. There are two exceptions. Group tickets each valid for transportation of 11 or more passengers are sampled at a 100-percent rate to prevent distortion. (Group tickets with from two to 10 passengers are sampled at the 10-percent rate.) The second exception are Eastern's tickets on the Boston-New York-Washington air shuttle service, which are sampled at a 100-percent rate. Data for these two exceptions are summarized by unique routing and then divided by 10 for merging with the 10-percent sample data.

Passenger tickets are sampled by the air carriers in accordance with instructions prescribed by the CAB (Copies of these instructions are available from the Board upon request.) Currently, 25 carriers are submitting quarterly O & D reports to the Board, which amount to approximately 700,000 summarized records per quarter, accounting for about 2.4 million sample passengers each quarter. These data are supplied to the Board by the carriers in ADP input format (mostly computer tapes) with an accompanying hard-copy listing.

The CAB evaluates the reported data for accuracy and completeness, and then edits and corrects the reported data by computer. Data are mileage, analyzed, and classified by computer, and four basic data banks are created, as follows:

1. Ticket origin and destination -- the carriers and connecting points in the entire passenger ticket in sequence of occurrence from point of origin to the point of ticketed destination. (This file is a mixture of domestic, international, or territorial itineraries, without separation.)

2. Directional origin and destination -- the first and last points on a one-way ticket, and the first and last points on each of the directional parts of a round, circle, or open-jaw ticket. (This file is separated into two sub-files, one for domestic and one for international/territorial.) Domestic covers operation between and within the 50 U.S. States and the District of Columbia.
3. On-line origin and destination -- the points at which a passenger enters and leaves the system of an airline on a one-way trip, or on each of the directional parts of a round, circle or open-jaw tickets, ignoring intermediate points of intraline transfer. (This file is created only for domestic traffic.)

4. Coupon origin and destination -- the point of enplanement and the point of deplanement covered by one flight coupon. (The smallest entity of a passenger ticket.) (This file is divided into a domestic and an international/territorial data bank.)

Tabulated survey results are produced quarterly from the directional O & D, on-line O & D, and coupon O & D data banks. (There are no tabulated outputs produced from the ticket O & D file.) As of now there are 14 output tables, 11 of which are domestic and three of which are international/territorial.

The domestic data are published in two forms -- printed, bound publications and on microfilm. The printed books consist of a two-volume set each quarter containing eight tables comprising more than 1,200 pages. Supplemental and more detailed information is presented on three tables which are produced on roll microfilm. These three tables require about 21 rolls of microfilm each quarter, and contain more than 50,000 pages of data. Currently, the domestic survey has data for more than 700 cities and over 59,000 city pairings.

The international/territorial data are contained in three tables which are issued only on microfilm. These amount to about 18 rolls of film per issue and contain nearly 50,000 pages of data.

There are some aspects to the O & D survey data that need to be emphasized: first, traffic ticketed solely on air taxis, commuter carriers, and helicopters is not included; intra-State carriers, such as PSA in California or Southwest Airlines in Texas are also not included; and purely intra-Alaska traffic is not covered; secondly, traffic ticketed solely on non-U.S. carriers is not included, since the Board does not collect O & D data from foreign carriers; and thirdly; the international data are restricted as to release and disclosure and may not be revealed to non-U.S. interests.

Time does not permit a description of each of the 14 survey outputs tabulations. However, in the package of materials given out to you this morning you will find general information statements which describe the content and availability of the survey data as well as descriptions and samples of the various tables. In addition, the Board's policy statement controlling release and disclosure is reproduced in the general information statement describing the international/territorial survey.
You will note that the Air Transport Association of America, rather than the Board, publishes the survey data. Domestic data in printed books are sold only on an annual subscription basis at a charge of $350 per year. Microfilm is sold for about $7.00 per roll.

In addition to the tabulated outputs in printed books or microfilm, copies of the basic survey data banks are available for use on a fee basis through the National Archives and Records Service of the General Services Administration. The general information statements mentioned earlier give the contact at Archives for obtaining copies of the data in the data banks. Tape record layouts for each of the seven O & D survey data banks are included in the materials given out to you.

The second largest statistical data processing system in the Board is the service segment data program. A service segment is created by the operation of an aircraft from a point of takeoff to the next point of landing. For example, a flight with a scheduled itinerary from Boston to Chicago to Los Angeles would have two service segments, one from Boston to Chicago, and the second from Chicago to Los Angeles.

Unlike the passenger O & D survey, which is a statistical sample, the service segment data are a complete count (full census) of the scheduled operations of the certificated route air carriers. The system was implemented in July of 1970 by Economic Regulation 586, and has continued with monthly reporting to date. Some modifications were made in the type of data collected which I will mention later. There are no plans to alter this system in the immediate future.

The carriers collect and report service segment data monthly pursuant to instructions in section 19 of Part 241 of the Board’s Economic Regulations (the Uniform System of Accounts and Reports for Air Carriers). Supplemental instructions are provided to the carriers in the Board’s Traffic and Capacity Data Collection Manual of ADP Instructions. Copies of these two documents are available upon request.

This system provides monthly data by service segment on traffic enplaned, traffic transported, traffic deplaned, and capacity available, plus other operating data such as aircraft departures performed, miles flown, and airborne and ramp-to-ramp time. These data are further broken down by individual flight number, by aircraft type, and by class of service. There is no breakdown by day of the month -- data are aggregates for the operations of each flight for the entire month.

The uses and users of service segment data are similar to those described earlier for passenger O & D data, but take on added significance in such areas as airport planning, evaluation of community air service requirements, aviation fuel analyses, load factor analysis, and the like. These data will also be important, along with other data, for the Board’s new Route Financial Analysis Program which has as its goal the determination of profitability by individual segment and by route. The service segment data are the only CAP source which provides recurrent information on such items as:
1. Passenger load factor and ton load factor by segment, by flight number, by aircraft type,

2. On-flight origin and destination not only of passengers but also of mail, express, and freight as well,

3. Enplaned, through, and deplaned traffic by segment, by flight number, by aircraft type,

4. Actual number of available seats and available capacity for boarding traffic, by airport, by flight number, by aircraft type,

5. Airborne (wheels off/wheels on) and ramp-to-ramp (block-to-block) time by segment, by individual flight number, by aircraft type, and

6. Scheduled and actual aircraft departures and aircraft miles by segment, by flight number, by aircraft type.

These data also permit analyses to be made in such areas as the relationship of airborne to total hours flown and of average airborne speed by segment, by flight number, by aircraft type, for comparative evaluations of the tendencies for certain segments to be more affected by ground delays, airways delays, etc.

In addition, by correlation with flight schedule data (which can be obtained on magnetic tape from a private firm) analyses of operations at airports by time of day are possible.

Due to the sensitive nature of these data, which are in the realm of "trade secrets", the carriers' competitive interests need to be protected. Therefore, the Board has placed controls upon the release and disclosure of these data. As such, except in certain situations, the domestic data are subject to restrictions as to release and disclosure for 12 months following the close of the year to which the data relate. (As of now, the latest data available publicly are the 1973 domestic data.) International data are subject to restriction at all times.

An extract of the regulations controlling disclosure of these data is contained in the package of handouts. You will see from that document that the restricted data may be disclosed in certain circumstances, chiefly among which are:

1. In formal proceedings before the Board when the data have been ruled to be relevant to the issues in the proceeding,
2. To other Federal Agencies, and

3. To persons upon a showing that release of the data are in the public interest and consistent with the Board's regulatory functions and responsibilities. In this latter area, a number of airport operating authorities have obtained the restricted data to perform demand-type analyses to study their air service requirements and to establish future plans. (The restricted international O & D survey data can also be disclosed under similar circumstances.)

The air carriers submit service segment data to the Board monthly in ADP format, without an accompanying hard copy printout. Each monthly submission currently amounts to nearly 40,000 records per month (about ½ million per year) in total. The Board edits the data by computer, verifies data, and produces a data bank on magnetic tape. There are no publications of service segment data. A few highly summarized computer tabulations are produced monthly, and also on a fiscal year and calendar year basis, which are intended primarily for staff use. The domestic data in these summary tabulations are placed in the Board's Public Reference Room for public inspection after the period of restriction has expired. These summary tabulations, however, do not show data by direction of movement or by flight number, and omit many of the data items available in the data bank. The Board services its needs primarily by direct computer interrogation of the data bank itself.

Copies of the service segment data bank are also provided to the National Archives and Records Service where users can obtain the unrestricted data by direct request to the Archives. Users, who have been authorized by the Board to receive restricted data, may also obtain such data from Archives. In such a case, though, a user seeking restricted data must first submit a written request to the Statistical Data Division clearly demonstrating that the release of the data is permissible under the provisions of section 19-6 of the Board's Economic Regulations, and must receive approval for access. (Similar procedure also applies to requests for access to international O & D survey data.)

A tape record layout for the service segment data is included among the items in the handouts given to you.

Also, among the materials handed out, you will find a photocopy of a three-page computer printout covering the operations of Allegheny's flight 691 for the month of December 1972, which illustrates the type of data included in this system.
I mentioned earlier that some modifications have been made in the data collection procedures. The major changes were as follows:

1. Hours flown and deplaning statistics were added in January of 1971.

2. Downline points were not required to be in the sequence in which served until January of 1974. Prior to that time it was difficult to trace the operations of a flight over the itinerary as it was actually flown.

3. Concurrently with the above change an itinerary code was also added in January of 1974 to identify each unique itinerary operated under a given flight number. Before then, deviations from the scheduled flight itinerary due to weather, mechanical, on-board medical emergencies, airport conditions, and the like, often confused the reconstruction of actual flight operations.

4. Up until 1972, multi-entity carriers, such as American with both a domestic and a Latin American entity, had been artificially deplaning and re-enplaning through traffic at the gateway or junction point between entities on flights moving from one entity to the other. This was done to make the enplaning statistics by entity agree with statistics in other Form 41 reports, which do double count certain traffic. This procedure also distorted the on-flight origin and destination statistics. In July of 1972, the downline data were required to be shown on an actual basis so as not to distort on-flight O & D, and the practice of artificially deplaning and re-enplaning traffic at the gateway was discontinued. Instead, a gateway code was added to the reported data to enable the Board to double count traffic when necessary to balance to the other Form 41 schedules.

Finally, I would like to point out that the Board provides a photocopy service whereby users may obtain copies of selected pages from the printed O & D reports, from the O & D microfilm, or from any other public document in the Board, including carrier reports on file, at a cost of 15¢ per page plus postage.
The title of my remarks this morning is Data in Process and Future Data Needs. The title implies that my discussion will focus on new data and information which will be reported to the Board in the near future and data which the Board would like to receive several years hence. While I will talk about these subjects, I would also like to mention new data which the Board has begun to receive in the past year or so because much of it is important and should be brought to your attention. In an effort to mention as many data items as possible, my discussion this morning will be of a very general nature.

Let's begin by discussing one of the largest and most important reporting changes contemplated by the CAB in the near future. I'm speaking of the proposed rule which would establish a product-line cost accounting system for certificated route air carriers and replace the current financial reporting system. The present CAB financial reporting system has been in effect since 1957. During this time only minor modifications have been made. The basic structure has remained in effect with no massive overhaul of the system.
Under this present system, the financial results of a carrier's various transport operations are reported on an aggregate basis to the Board. This is supplemented by separate financial reports for scheduled all-cargo service and for military airlift command operations. Despite these supplements, the present system is essentially a financial reporting system rather than a costing system geared to product or operational lines.

The new system proposed would be more cost oriented and would seek to develop airline costs by product line. Rather than have data reported as an aggregate for total operations, separate revenue and expense data would be produced for each of the following five product or operational lines.

1. Scheduled service - Passenger/cargo combination
2. Scheduled service - All-cargo
3. Non-scheduled service - Military
4. Non-scheduled service - Commercial
5. Transport related activities

For each product line expenses would be reported at three levels of detail.

1. Level 1 - Major operation - (Example: ground service)
2. Level 2 - Function (Example: cargo service)
3. Level 3 - Activity (Example: documentation and shipper contact)

The new system would provide the Board with more detailed and accurate cost information needed for fare and rate determination and should reduce the carriers' overall reporting burden. It is hoped that the product-line costing method will be put into effect by January 1, 1977.
Another important area the Board is exploring is the Route Financial Analysis Program, or RFAP for short. The primary function of this system is to develop a program which will allow CAB staff to analyze the operating profit and loss of the various segments of the airline industry in greater detail than is now possible. The program will develop operating profit and loss data for specific carriers, flights, and markets. It will help the Board gauge the relative contribution of various parts of a carrier's system to its overall profitability. It will also allow the study and comparison of several carriers serving comparable market areas.

This system is anticipated to create a data bank of profit and loss data for each flight by aircraft type. The data bank is to be used as a reference source for Board studies of profitability and traffic flow.

Data used in the development of the program include the monthly service segment data reported to the Board, a revised costing methodology, information on passenger revenue by market and flight, and tariff information.

All data except the revenue by market and flight are currently available. Collection of revenue market dilution data is being defined and will be available for input to this program.

When the Route Financial Analysis Program is implemented it will provide estimates of revenues, expenses and profit by service segment, market and flight for any time period, carrier, entity, aircraft type, or product-line such as first class, coach, freight or mail.
If the results provided by the Route Financial Analysis Program are connected to a generalized report generator system, almost unlimited varieties of analysis can be developed depending on the sort and accumulation techniques employed.

This program may be set to run by November 1975, but that is an optimistic time estimate and the actual starting time could be later.

Next I'd like to speak about discount fares.

Under Phase 5 of the Domestic Passenger Fare Investigation (DPFI), the Board laid down in general terms the principles it would apply in the future in dealing with all discount fares. The Phase 5 decision established with respect to fare level that it will be computed on a hypothetical full normal fare basis. Therefore, in order to monitor the domestic fare level, the Board needs revenue and traffic data for various categories of full-fare and discount-fare services.

The Board has deemed it essential that the ratemaking policies established in the DPFI be implemented and has tentatively concluded that this cannot be achieved by one-time information requests nor by reporting requirements established as part of a docket. The Board's experience with such information is that it is not filed on a timely basis, is often incomplete, and is not compiled and presented on a consistent basis by the carriers. These factors make industry summaries and trend analyses difficult to prepare and of questionable accuracy.

Accordingly, the Board is proposing to add a new schedule entitled Passenger Revenue and Traffic Data by Type of Fare--48 States, to existing reporting requirements. The proposed schedule would be required
to be filed by the trunk carriers only, and would report revenue passenger-miles, passenger revenue, passenger yield, revenue passenger enplanements, and average trip length for specified fare categories. It would be submitted monthly 30 days after the end of the month. This proposal has not been enacted by the Board as yet and I'm unable at this time to state when it will go into effect.

I'd like to speak now about charter fares and service. As most of you are probably aware, the Board is currently considering regulations which will liberalize prior restrictions placed on charter services. In an effort to illustrate how the Board proposes to do this, I'm going to discuss in some detail the so called "Special Event Charter", or SEC. The Special Event Charter is one part of the new one-stop inclusive tour charters currently being studied by the Board. Here is how the Special Event Charter is supposed to work.

(a)

Travel would be restricted to those persons desiring to attend a "special event", which must be a specific and significant event, and may, for example, be of a sporting, social, religious, educational, cultural, or political nature, although it would not necessarily have to fit squarely into one of these categories.

The event itself could not extend over ten days in duration. This restriction, which was originally proposed to help ensure that SEC's are used for travel to bona fide events and not as a pretext for point-to-point transportation, seems even more suitable now, since travel to events of longer duration should be arranged to conform to the general
OTC rules. On the other hand, comments received in response to the SEC Notice have tentatively persuaded the Board that they should not impose two other restrictions originally proposed, namely prohibitions on the eligibility of events sponsored by persons in the tourist industry and on events whose primary purpose is the promotion of tourism. The Board believes that both these restrictions would prove extremely difficult to enforce, and enforceability, of course, is along with discrimination, one of the reasons it sought to devise specialized charter rules to replace "prior affinity" charters.

(b) Ground Package

The Board proposes that the ground package required be essentially the same as that for an ordinary OTC: Baggage handling and all necessary ground transportation must be included. In addition, a SEC package would be required to include tickets or other documents needed for admission to the event for each day of the charter, to the extent that attendance at the event would be feasible on that day. If the charter does not involve an overnight stay, sleeping accommodations will not be required. The charter organizer may provide additional items as part of the ground package at his option.

Although the SEC price must include charges for the air transportation, each of the elements of the ground package, and compensation to the organizer, the Board did not prescribe any price minimum. It believes that no minimum price will be necessary, in view of the other restrictions on SEC operations. Nevertheless, the Board has specifically invited comments on the question of whether a minimum package price, such as
it is proposing to require for ordinary OTC's, would also be appropriate for charters operated under SEC rules.

(c) **Trip Duration**

The Board proposes that North American SEC's be limited to a maximum of three days, and that for all other SEC's the maximum be six days.

The Board also proposes that arrival at the event destination be no more than 36 hours prior to the commencement of the special event, and that the return flight depart no more than 36 hours after the termination of the event.

The special event charter is still being considered by the Board and has not been put into effect as yet.

**Data Already Being Received**

Up to this point I have been talking about information which the Board hopes to get in the very near future. Now I would like to discuss several items which the Board has recently obtained and which should be of interest to you.

First, the Board's economic regulations provide that separate data shall be reported for each on-line airport at points certificated by the CAB for scheduled services. On-line airports are defined as those airports which are used in conducting scheduled certificated air services.

In recent months the Board's staff and other interested Government agencies expressed a need for off-line as well as on-line airport activity statistics to meet various costing needs and to permit a proper evaluation of airport activities. For example, the Board has need for the total number of departures by aircraft type for both scheduled
and nonscheduled services for purposes of aircraft cost and performance studies. With regard to other agencies, the Federal Aviation Administration has on several occasions made known its desire for off-line statistics in order to determine the total activity of certificated carriers at individual airports.

Based upon the foregoing, it was the Board's view that the reporting requirements should be amended by adding a requirement to include the reporting of airport activity statistics involving off-line airports. Under the proposal, whether a point is on-line or off-line would be determined based on the air carrier's certificated authority for each operating entity. This rule was made effective as of January 1, 1975.

Other new data which the Board recently began to receive comes from the Air Freight Forwarders. The Board decided that a uniform system of accounts and reports should be devised for the Air Freight Forwarders. The Board came to this conclusion because the economics of the air freight forwarding industry changed dramatically during the past several years. The industry has grown by virtually every standard of measurement. In 1961, there were 78 air freight forwarders authorized by the Civil Aeronautics Board. By the close of calendar year 1972, there were 262. In 1972, industry air freight forwarding revenues exceeded 650 million dollars as compared to 66 million dollars reported by the 78 forwarders operating in 1961. In 1972, the weight of air freight shipments handled by this segment of the air transport industry exceeded 800,000 tons as compared with 110,000 tons reported in 1961.
The prior regulations required the use of standard forms for reporting financial and statistical data, but the data reported were not founded upon prescribed uniform accounting practices or uniformly applied reporting standards. In the absence of uniform accounting practices, the larger forwarders undertook the development of sophisticated accounting systems which varied considerably from forwarder to forwarder. At the same time, smaller forwarders were without financial and statistical guidance. As a consequence of this lack of comparability, the Board was hampered in its analysis of forwarder financial and statistical data. Moreover, the processing of tariff filings was often hampered by the absence of economic data required for the evaluation of forwarder rates in terms of costs and profits.

The Board felt that in the interest of more effective regulation, the establishment of comparability between air freight forwarders in their accounting for similar services was needed and that this would best be achieved by the establishment of a uniform system of accounts and reports.

In the development of this rulemaking, the Board, consistent with other regulations of this magnitude, balanced the benefits of the broadest possible applicability against the burden to be imposed. It was obvious that to impose the proposed system of accounts on all forwarders would be impractical. Therefore, the Board required only those forwarders whose gross air freight forwarding revenues exceeded three million dollars during a calendar year to establish and maintain
the prescribed uniform system of accounts. All forwarders whose gross air freight forwarding revenues exceeded three million dollars for the calendar year ended December 31, 1973, or any calendar year after December 31, 1973, were required to have their books of account converted to the prescribed system.

Forwarders to which the new system of accounts was not applicable were required to file a quarterly balance sheet, income statement and operating statistics schedule together with other schedules similar to those they previously filed. This did not impose an onerous reporting burden upon the small forwarders. With the exception of the filing frequency, it was essentially the same reporting imposed by the previously existing regulations.

The Board did not receive from foreign air freight forwarders information sufficient to measure their operational impact on the U.S. international air freight forwarders. To help remedy that situation the Board required foreign air freight forwarders holding 402 permits to file the following statistical schedules: an Origin Station Report for air freight outbound from the United States, a Destination Station Report for air freight inbound to the United States from foreign points, and a City-Pair Traffic Flow Report. The Board will periodically prepare a city-pair listing for this report. At least one of the city pairs will be a domestic point and the listing will be changed from time to time as the Board's information needs require. This rule was made effective January 1, 1975.
Next I'd like to talk about the fuel reporting requirements which the Board has recently instituted. Ever since the energy crunch hit the United States in the fall of 1973, the Board has been acutely aware of the airline's rapid increase in fuel costs and their effect on total operating expenses.

Thus, the Board determined to regularize its compilation of fuel data so the collection of all such data would be covered by a single uniform reporting regulation. This new regulation would enable us to conform the reported fuel data more fully with carriers' books, eliminate possible confusion from separate reports, better correlate the data with reported traffic and capacity statistics, and facilitate the evaluation of fuel price changes especially as they may affect a certain type of service and specific geographic rate areas. Accordingly, Schedule P-12 entitled Fuel Inventories and Consumption and Schedule P-12(a), Fuel Consumption by Type of Service and Specific Operational Markets were added to the CAB reporting forms. On Schedule P-12, carriers compute inventory and consumption by type of fuel ("bonded", "nonbonded", and "foreign"). Bonded fuel is the fuel produced outside the customs limits of the United States, held in bond under continuous U.S. customs custody in accordance with Treasury Department regulations, and destined for use outside of the United States, its territories or possessions. Nonbonded fuel is that fuel issued from and consumed in the domestic operations of the reporting carrier. Foreign fuel is that fuel which is loaded at points outside the United States and consumed in the foreign operations of the carrier.
Schedule P-12(a) requires carriers to summarize by type of service (scheduled and non-scheduled) the fuel consumed in the specific operating markets listed. In reporting on this schedule, route carriers complete Schedule P-12(a) for scheduled and non-scheduled service, as appropriate, while supplemental carriers complete only the non-scheduled service portion. The Board also requested that fuel data reported for operations performed pursuant to "MAC" contracts be reflected. This regulation became effective on November 1, 1974 and the Board issues monthly fuel memos showing gallons consumed, total dollars spent for fuel, and average price per gallon for most certificated route carriers.

There are three fairly new reports which the Board now issues and I'd like to mention them here because they are available to anyone who wants them and they have received enthusiastic acceptance by the airline industry, financial institutions and the general public.

First is the Quarterly Cargo Review. This publication puts into one convenient source most of the pertinent cargo data which the Board receives. It's a twenty-six page report composed of tables, text, bar graphs, and circle graphs. The data items included in the report cover:

(1) Scheduled air freight yields
(2) Scheduled freight and mail revenue ton-miles
(3) Total scheduled freight plus mail revenue ton-miles as a percent of total scheduled revenue ton-miles
(4) Scheduled freight plus mail revenue as a percent of total scheduled transport revenue
(5) Scheduled freight and mail revenue
(6) Freight ton-miles in all-cargo aircraft as a percent of total scheduled freight ton-miles

(7) Scheduled compared to non-scheduled freight revenue ton-miles.

All of these data are shown for the trunk carriers, the all-cargo carriers, the local service carriers, and the Alaskan plus Hawaiian carriers. The report covers quarterly and 12 months ended data and the first issue began with the first quarter of 1974.

The second current publication we should discuss is entitled Productivity and Cost of Employment. The Board issues two reports under this title: one for the system trunk operations and one for the local service carriers.

Both reports attempt to compare productivity among different carriers and show the following data:

(1) Average number of employees

(2) Total labor cost as a percent of total operating expense

(3) Average labor cost per employee

(4) Revenue ton-miles and available ton-miles per employee

(5) Average labor cost per revenue ton-mile and per available ton-mile

(6) Composition of total labor costs

(7) Yield and unit labor costs

(8) Operating revenues and expenses per employee

Both reports are published on an annual basis and the last issues the Board released compared calendar years 1972 and 1973. We are currently working on new publications which will compare calendar years 1973 and 1974.
The third publication I want to mention is our monthly series on seasonally adjusted capacity and traffic. This report shows both actual and seasonally adjusted revenue passenger-miles and available seat-miles. Four separate reports are issued and cover the system trunks, the domestic trunks, the international trunks, and the local service carriers.

Seasonally adjusted data shown in these reports are derived by using the X-11 Seasonal Adjustment Program, developed by the U.S. Bureau of the Census. The Board has obtained this program and we use it on our own computer equipment.

The X-11 program can be advantageously applied to airline data because it provides adjustments for four of the most important variable factors which affect airline capacity and traffic: holidays, seasonal variations, trading day variations, and strikes. The need for seasonal and holiday adjustments is self-evident. Airline traffic will generally be higher during the summer months, or at Easter, or over a long holiday weekend. But trading day variations should also be included in the adjustment process. This is necessary because a particular day of the week may occur five times in a particular month one year, but only four times in that same month in other years. For example, airline traffic is generally higher in a June with five Sundays than in a June with four Sundays.

The strike adjustment is also important because it avoids the distortion of estimated seasonal factors that prolonged strikes would cause. Large strikes (such as the one at TWA in November and December 1973)
are treated as extreme values. These extreme values are replaced by modified values which are in closer agreement with past data. The seasonal adjustment factors are then computed by the program using these modified values.

**Months for Cyclical Dominance**

The Bureau of the Census derives a statistical measure in the X-11 program called months for cyclical dominance (MCD). The MCD is an estimate of the appropriate time span over which to observe cyclical movements in a monthly series. A short MCD period (1 to 4 months) makes it easier to identify true cyclical changes and discount fluctuations caused by irregular random events such as strikes or bad weather. Longer MCD periods (over 4 months) make it more difficult to recognize true cyclical trends in any series. Thus, analyzing a carrier's revenue passenger-mile and available seat-mile data for cyclical changes is easier if the carrier's MCD's for these two data elements are of short duration, and more difficult if the MCD's are longer.

I'd like to bring this talk to a conclusion by pointing out some future data needs at the Board. The word "needs" may be inappropriate because the data items I'm going to mention may or may not be perceived by the Board as actually being necessary to their regulatory function. Actually, these data items were suggestions I gathered from competent Board personnel who felt the data would be extremely useful if it could be obtained. These suggestions do not carry official Board approval and should not be viewed as doing so.
To be brief, I'll simply list some of the data we would like to receive.

(a) Discount fare data on a regular basis for the Mainland-Hawaii market and the Mainland-Puerto Rico market.

(b) Fuel data for intrastate carriers such as PSA and commuter carriers.

(c) Improved charter statistics to compliment the increases in charter services.

(d) Currently there is no established freight origin and destination survey which parallels the passenger O&D. The Board doesn't receive sufficient freight data from the trunk carriers on a regular basis to analyze the kind of commodities being shipped, the length of haul, seasonality, etc.

(e) Expand the current Airport Activities Statistics to include the supplemental carriers, the commuter carriers, and the foreign flag carriers.

(f) Profit and loss and balance sheet data from the commuter carriers.

(g) Require foreign flag carriers to report financial and traffic data on the same basis as the domestic carriers.

(h) A continuous survey of airline traffic to study patterns of business and non-business passengers.

There are many more items we could discuss but my time is expended.

Thank you very much for your attention.
The ATA deals with air transportation data from a wide variety of sources. I will not try to cover the entire scope of these data, but instead will concentrate my remarks on some of the more formal data bases in which we participate, and briefly describe some of our major activities in the Air Transportation Data field.

For over a year, ATA has participated with American Airlines and APL Services in developing and maintaining a time-sharing data base containing most of the traffic and financial schedules of the CAB Form 41. Many of the organizations represented here today use this service.

Form 41 data is accessible through a time-sharing terminal and is fully interactive with other data bases both public and private. The system further provides for retrieval of accumulated data, and simple ratios using short near-English language statements. More complex reports can be developed by simple programs which can be developed using a series of near-English language statements.

The data base currently contains the following Form 41 schedules from 1968 or earlier:

<table>
<thead>
<tr>
<th>Form 41 Schedule</th>
<th>Series</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 -</td>
<td>Traffic and Capacity Statistics by Class of Service</td>
<td>Monthly, 1968</td>
</tr>
<tr>
<td>T2 -</td>
<td>Traffic, Capacity, Aircraft Operations and Miscellaneous Statistics by Type of Aircraft</td>
<td>Quarterly, 1968</td>
</tr>
<tr>
<td>B1 -</td>
<td>Balance Sheet</td>
<td>Quarterly, 1961</td>
</tr>
<tr>
<td>P1 -</td>
<td>Income Statement</td>
<td>Quarterly, 1961</td>
</tr>
<tr>
<td>P3 -</td>
<td>Transport Revenues; Depreciation and Amortization; Nonoperating Income and Expense; Income Taxes</td>
<td>Quarterly, 1968</td>
</tr>
</tbody>
</table>
Form 41 Schedule | Series
---|---
P5  | Aircraft Operating Expenses
P6  | Maintenance, Passenger Service, and General Services and Administration Expense Functions
P7  | Aircraft and Traffic Servicing, Promotion and Sales, and General and Administrative Expense Functions
P8  | Aircraft and Traffic Servicing, and Promotion and Sales Expense Sub-Functions
T-7 | Statistical Market Report
T-3 | Airport Activity Statistics

Planned future schedules include:

Form 41 Schedule | Series
---|---
P-10* | Payroll & Headcount by Personnel Class
P-9.2 | Distribution of Ground Servicing Expenses
P-5b | Fuel Consumption and Inventories
P-2a | Revenue Market Report (San Juan, Hawaii, etc.)
B-43 | Inventory of Airframes & Aircraft Engines

* In progress

In addition to maintaining the base, we are a major user. ATA currently maintains several major programs which operate on the basic data which is retrieved from the Form 41 Data Base. I will briefly describe some of these:

**Total Factor Productivity**

The purpose of this program is to produce meaningful and timely measures of productivity and cost trends on the airline industry. The term
Productivity has been frequently applied to ratios of total output to portions to the total input; for example, total output per man hour. Such ratios can often be misleading since they tend to attribute all of the output to a single factor of the input. A much more meaningful measure of productivity is the ratio of all the output to all of the factors of input -- total factor productivity. Based upon the work done by Dr. John Kendrick of George Washington University; the ATA, Airline Industrial Relations Conference and a Task Force of representatives of member airlines have developed a method for calculating total factor productivity for the airline industry. The method has been programmed to produce quarterly results through a time-sharing terminal.

Basically, the method deflates each item of input to the same base period in order to remove price inflation effects. Most of the deflators used are based on actual unit price increases such as: fuel cost per gallon, labor cost per employee, and landing fees per ton landed. A few are deflated using appropriate Government price indexes. By removing inflation, the inputs are reduced to a common measurement of volume, and when combined and divided into the output, produce total factor productivity. A by-product of the system is the overall unit price inflation that the industry has experienced over the same time period. Thus, comparisons can be made between productivity and yield change versus inflation.

Research in this area now is being directed toward separation of the individual contributions of the various factors such as labor, aircraft, capital, and purchased goods services to the total output.
Airline Cost Index

As you well know, inflation has become a growing concern of the industry. Outstanding is fuel cost which comprises over 17 per cent of total operating costs. It was desired to monitor inflation in all airline cost areas more closely. To accomplish this, we have developed a series of programs which determine quarterly unit cost increases for eight different items. These items which comprise approximately 80 per cent of total operating costs are:

- Labor -- Employment cost per employee
- Capital -- Interest on long-term debt
- Fuel -- Cost per gallon
- Passenger Food -- Cost per RPM
- Advertising and Promotion -- Cost per RTM
- Landing Fee -- Cost per ton landed
- A/C Maintenance Material -- Cost per ATM
- Traffic Commission - Passenger -- Cost per RPM

A price index for the remaining approximately 20 per cent of costs is estimated by the Implicit Deflator for GNP. The above indexes are volume weighted to estimate overall quarterly airline cost increase. An example of index is shown on page 5.

MIS Task Force

About a year ago, an ATA Task Force was established to investigate the requirement for and feasibility of developing industry data bases useful to carriers for economic planning, analysis and forecasting. The task force
<table>
<thead>
<tr>
<th></th>
<th>INDEX (1967=100)</th>
<th>Percent Change Over 3 Qtr 1973</th>
<th>percent of Total Cash Operating Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>LABOR (Employment Cost Per Employee)</td>
<td>192.4</td>
<td>7.3</td>
<td>40.7</td>
</tr>
<tr>
<td>CAPITAL (Interest on Long Term Debt)</td>
<td>153.7</td>
<td>12.4</td>
<td>3.3</td>
</tr>
<tr>
<td>FUEL (Cost Per Gallon)</td>
<td>250.9</td>
<td>102.3</td>
<td>18.9</td>
</tr>
<tr>
<td>PASSENGER FOOD (Cost Per Revenue Passenger Mile)</td>
<td>125.3</td>
<td>4.5</td>
<td>3.6</td>
</tr>
<tr>
<td>ADVERTISING &amp; PROMOTION (Cost Per Revenue Ton Mile)</td>
<td>92.1</td>
<td>(2.9)</td>
<td>2.0</td>
</tr>
<tr>
<td>LANDING FEES (Cost Per Aircraft Ton Landed)</td>
<td>229.2</td>
<td>17.6</td>
<td>2.5</td>
</tr>
<tr>
<td>AIRCRAFT MAINTENANCE MATERIALS (Cost Per Available Ton Mile)</td>
<td>91.8</td>
<td>15.6</td>
<td>2.9</td>
</tr>
<tr>
<td>TRAFFIC COMMISSIONS-PASSENGER (Cost Per Revenue Passenger Mile)</td>
<td>199.3</td>
<td>20.5</td>
<td>3.9</td>
</tr>
<tr>
<td>ALL OTHER (Implicit Deflator-GNP)</td>
<td>146.5</td>
<td>10.4</td>
<td>22.2</td>
</tr>
<tr>
<td>COMPOSITE</td>
<td>174.5</td>
<td>20.2</td>
<td>100.0</td>
</tr>
</tbody>
</table>

1/ Total Operating Expenses plus Interest on Long Term Debt Less Depreciation and Amortization.
has identified several data bases worthy of further investigation; namely:

- CAB Origin-Destination data
- CAB Service Segment data
- Schedules (OAG) data
- Fare (ATP) data

Development of these data bases was determined to be technically feasible. However, economic feasibility cannot be determined until detailed specifications for each are drawn up.

Therefore, the task force has recently concentrated its efforts on developing detailed specifications for a CAB-Origin-Destination survey data base. This is possibly the most difficult of the group but also probably the most important. Not only is size extremely large by data base standards, but the number of retrieval types are extensive.

We have recently completed the draft specifications for this data base which I will outline briefly:

We first found that there were over 160 different ways of useful selection from itinerary data. In order to cover this scope a very high level of detail would be required, hence an extremely large amount of storage would be necessary. A further conclusion was that to carry a data base of this size on-line would not be economically feasible. The requirement then became one of identifying subsets which could be placed on-line along with the individual retrievals which could be made from these subsets.
Some further, rather exacting requirements are:

1. The primary purpose of the proposed system is to retrieve data from the CAB's O&D Survey for analytical purposes.

2. The proposed system must be geared towards a user not trained in computer technology.

3. Accuracy of the data and the ability to duplicate numbers contained in the CAB's printed volumes (Tables 1, 3-8, and 10) and microfilm (Tables 11-13) are absolute requirements of the system.

4. The proposed system will be comprised of two parts: (1) A large Itinerary Data Base (IDB) developed from the CAB Data Bank 2C; and (2) A smaller Summary Data Base (SDB) developed either from the IDB, Data Bank 2C, other CAB summary files, such as Data Banks 3 and 4, or some combination of the foregoing depending on the technical preferences of the vendor.

5. Either data base must be accessible by more than one user at the same time.

6. The proposed system must be capable of printing reports on a quarterly batch basis. The format and contents of any such quarterly batch report will be designated by the user. Most likely, however, recurring quarterly batch reports would consist of the data contained in the summary file.

7. The proposed system must be compatible with canned programs offered by the vendor.
8. Data Bank 2C contains data relating to domestic travel only. Data Bank 2A is the corresponding data bank for international travel. Although Data Bank 2A has not been included in these specifications, the vendor should be aware of its existence since inclusion of Data Bank 2A would be a logical future expansion of the proposed system.

9. The proposed system must be capable of converting all passenger data sought to revenue passenger miles (RPM's).

10. Although both the IDB and SDB will contain directional data by quarter, most requests will probably involve the summing of four quarters and the combining of inbound and outbound data.

A general description of the data base is as follows:

The Itinerary Data Base (IDB) will contain eight (8) quarters of data developed from the CAB's Data Bank 2C. The file, as compiled by the CAB, contains duplication due to crossposting, which could be eliminated for the purposes of this project. It is estimated that after eliminating cross-posting, the base file would contain approximately 200 million bytes.

**Program Requirements**

The program which the vendor will provide can be divided into three broad categories. The first level would involve developing indexes which would allow the user to make the following basic requests:

1. Select all itineraries which have city A somewhere in the routing. City A may be: (a) the origin; (b) the destination; or (c) an intermediate
city in any of the possible intermediate positions depending on the variable length of the record.

2. Same type of extractions as above but instead of specifying a single city, a particular city-pair would be specified. This city-pair may be either (a) the origin-destination city-pair, or (b) an intermediate city-pair segment somewhere in the itinerary.

3. Select all itineraries which have a passenger volume greater than a specified level.

4. Select all records which have a specified number of coupons in the itinerary.

5. Select all records where a specified carrier participates in some portion of the itinerary.

6. Select all records for a particular time period.

7. Select all records for a particular world area code.

8. Select all records which have a certain total mileage.

9. Select all records which have a certain coupon mileage.

10. Select all records where a specified carrier participates in all of the journey.

Most probably these requests would be used in combinations and to set up a data subset for further inquiries and analysis.

The second level of requests would be more specific and would probably be used on a data subset.

Representative of these types of requests are the following inquiries:
#2 The number of passengers having an origin and destination (O&D) identical with a selected city-pair. (The user selects the city-pair (s)).

#3 The number of passengers moving between a selected pair of points and having an O&D different from the selected pair of points. (The user selects the city-pair (s)).

#4 The number of O&D passengers whose entire journey was on only one carrier irrespective of the number of intermediate cities. (The user selects the city-pair(s)).

#5 The number of O&D passengers whose entire journey involved no intermediate points between the selected city-pair. (The user selects the city-pair(s)).

#7 The number of beyond passengers whose movement between the selected city-pair was only one carrier. (The user selects the city-pair(s)).

#8 The number of beyond passengers whose movement between the selected city-pair involved no intermediate points between the selected city-pair. (The user selects the city-pair(s)).

#9 The number of O&D single-carrier passengers carried by a selected carrier. (The user selects the city-pair(s) and carrier(s)).

#10 The number of O&D single-carrier passengers carried by each carrier. (The user selects the city-pair(s) and the computer supplies the appropriate carrier(s)).

#13 The number of O&D passengers carried by a selected carrier for part or all of the journey.
#15 The number of single-carrier beyond passengers who connect to/from a different carrier at the end(s) of the selected city-pair. (The user supplies the city-pair(s).)

#16 The number of single-carrier beyond passengers who connect to/from the same carrier at the end of the selected city-pair. (The user supplies the city-pair(s).)

#17 The number of single-carrier beyond passengers who connect at both ends of the selected city-pair. (The user selects the city-pair(s) and indicates whether the connections should be both interline, intraline, or mixed).

#21 The number of O&D single-carrier passengers carried by a selected carrier via a selected intermediate connecting point. (The user selects the city-pair(s), carrier(s), and intermediate(s).)

#22 The number of O&D single-carrier passengers carried by a selected carrier via any intermediate point. (The user selects the city-pair(s) and carrier(s), and the computer supplies the appropriate intermediate point(s).)

#25 The number of O&D passengers carried by a selected carrier to a selected point between the end points of the selected city-pair. (The user supplies the city-pair, carrier, and intermediate point.)

#33 The number of single-carrier beyond passengers who connect to/from a different carrier at the first city named in the selected city-pair. (The user selects the city-pair.)
#36 The number of single-carrier beyond passengers carried by a selected carrier who connect to/from a different carrier at the first city named in the selected city-pair. (The user supplies the city-pair(s), and the carrier.)

#42 The number of single-carrier beyond passengers carried by a selected carrier who connect to/from a different carrier at the first city named in the selected city-pair and to/from a selected beyond point. (The user supplies the city-pair(s), segment carrier(s), and the beyond point(s).)

#54 The number of single-carrier beyond passengers carried by a selected segment carrier who connect to/from a second selected carrier (the connecting carrier) at the first city named in the selected city-pair and to/from a selected beyond point. (The user supplies the city-pair(s), the segment carrier(s), the connecting carrier(s), and the beyond point(s), and indicates whether the designated beyond point is the next downline point, any downline point, or the last downline point.)

#165 The number of O&D passengers carried by a selected carrier to a selected point between the end points of the selected city-pair and connected to a second carrier which may or may not be the first carrier. (The user supplies the city-pair, first carrier, second carrier, and intermediate point.)

A third level of request would involve the application of the canned programs available on the vendor's system to the data retrieved from the data base. These would be in the nature of trend analyses, seasonality, percentage relationships, etc.
These specifications have been submitted to time-sharing companies initial cost estimates and indications of intent to submit proposals. We expect to select a contractor within the next few months.

Another area of research which may be important to this group is a recent ATA analysis of Aircraft Movement and Passenger Data for the top 100 U.S. airports. This analysis is based on the average day in August 1973 and contains three technical exhibits:

I. An hourly profile of all scheduled aircraft movement by carrier type.

II. An hourly profile of domestic flight data for Trunk and Regional carrier. It includes aircraft movements by equipment category; enplaning, deplaning and through passengers, available seats and load factors.

III. Domestic city-pair data by airline for trunk and regional carriers. It includes aircraft movements by equipment type; enplaning, deplaning and through passengers; available seats and load factors.

This study, the most comprehensive of its type, was made for the specific purpose of assisting in the development of individual ATA Airline Airport Hub Demand Forecasts. However, the data will obviously be useful for many other areas of air transport research.

I have rather briefly covered some of the work we at ATA are doing in the field of air transportation data development. If there are questions regarding these or other ATA data activities I will attempt to answer them.
I want to touch on three topics today. The first is an overview of the passenger traffic and capacity data that we at The Boeing Company have in our data processing system. Secondly, I'd like to give you an idea of the resources that are required to operate such a system and some of the unique problems associated with running a large data base. Thirdly, I will comment on three problem areas that deserve attention: demographics, data aggregation, and non-reported data.

My main reason for giving an overview of the Boeing data base is to provide some insight into what types of analyses can be achieved by processing and integrating available passenger demand and capacity data.

Figure 1 is a schematic of our passenger demand data base system. It utilizes five primary source files:

1) CAB 10% Sample Directional Itinerary File
2) CAB Service Segment Data (SSD)
3) Immigration and Naturalization Service Data
4) Reuben - Donnelly QRE Schedules
5) ICAO Traffic Flow

Each of these primary source files are processed and edited so that they can be accessed and integrated. The result of this processing becomes the "data base". Today I'm going to concentrate on CAB data files and QRE schedules, since these are primary data for the U.S. Air Transport System.

There are two levels of data processing downstream from the data base itself. First, there is the data extract system, composed of programs which merely allow us to take the data out of the base. The last step is the more interesting one - reports and applications programs. At this level the extracted data are manipulated to produce derived data and statistics enabling us to analyze what's happened or happening to the air transportation system.

Now, let's back up for a moment to the data base level. There are some very important things that happen in the process of converting the source files into a usable data base. First, since most of the data deal with city-pairs, there are city codes associated with the data. However, as we move through history, certain codes have changed and new codes have entered. Part of the editing task is to make sure that the codes are identical for all time periods and for all files.
FIGURE 1
PASSENGER DEMAND DATA BASE SYSTEM

CAB 10% SAMPLE DIRECTIONAL ITINERARY FILE

CAB DOMESTIC SERVICE SEGMENT DATA

REUBEN-DONNELLY QRE SCHEDULES

O&D
ONLINE
COUPON
INS
ICAQ TRAFFIC FLOW

DATA BASE

DATA EXTRACT SYSTEM

REPORTS & APPLICATIONS PROGRAMS
within the data base. Without this step, our ability to integrate the data and do time-series studies is compromised. Similar coding problems occur with airline identifiers. Also, we must distinguish between city and airport codes.

These edit procedures must be performed every time an updated or new source file is received - monthly, quarterly, or annually, depending on the source file.

To give you an idea of what information can be gotten from the Boeing data base, I've selected two city-pairs - one domestic and one international - to look at in some detail. The city-pairs are:

- Domestic: Washington, D.C. - Chicago

Before we look at data, remember that Chicago and Washington both have two commercial airports. Thus, there are four possible airport-pairs of interest in this city-pair. We can distinguish each of these four pairs in the QRE Schedules. However, we cannot accurately distinguish between them in the CAB 10% sample data, because -- for example -- tickets written to or from Washington airports are often coded with the symbol WAS (Washington) rather than the appropriate airport code: DCA for National or IAD for Dulles.

Another fact I want to point out before I proceed is that Boeing defines O&D somewhat differently than does CAB. In our system itineraries containing more than five coupons domestically or more than nine coupons internationally are broken up into O&D's containing no more than these numbers of coupons. On the other hand, CAB "true O&D" contains itineraries with up to twenty-four coupons.

Our filtering process leads to small discrepancies between CAB "True" O&D and corresponding Boeing statistics. On the average, this process affects about five percent of the passengers in the 10% sample.

The reason for the filters is simple--economics. Most analyses using these data begin with extracts. Typically the computer will begin a sequential search process looking for data records which satisfy the extract criteria. In the unmodified data files received from CAB, such a search would require repetitively scanning itineraries containing up to twenty-four coupons. This would result in large storage capacity requirements for infrequently used itineraries and would raise the cost of extracts by a factor of two or three.
Occasionally, people object to the small differences these filters create between CAB published O&D statistics and Boeing statistics. They believe their analysis will be compromised, not in substance, but in the minds of people not trained in data processing and analysis.

The easiest way around this problem is merely to point out that the differences exist and why. Also, any definition of origin and destination for long itineraries is somewhat arbitrary. Take for example a salesman who makes ten stops between Seattle and New York, conducting business at each stop. Every stop in his itinerary is a destination in a sense, yet his "true" O&D by CAB definition is Seattle-New York.

Nothing substantive is lost in the way we handle the data. But we achieve a significant cost savings as a result.

With these differences in mind, let's look at some 1973 data from the CAB Directional Itinerary File for our two sample city-pairs:

<table>
<thead>
<tr>
<th>City-Pair</th>
<th>10% Sample O&amp;D</th>
<th>Estimated Total Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI-WAS</td>
<td>49,869</td>
<td>498,690</td>
</tr>
<tr>
<td>WAS-LON</td>
<td>4,302</td>
<td>43,020</td>
</tr>
</tbody>
</table>

The figures for WAS-LON are understated, because the 10% sample includes only passengers who flew some portion of their journey on a U.S. flag carrier. Passengers who fly exclusively on foreign airlines are not represented in the sample.

The "online" portion of the 10% sample contains trips or parts of trips flown on a single carrier. In Figure 2 we see that 23,401 eastbound passengers and 23,749 westbound passengers were "online O&D" between Chicago and Washington. In addition 7,355 eastbound and 7,635 westbound passengers had an interline connect at either Chicago or Washington. "Online O&D" is always less than "true O&D" by definition, since travelers who change airlines between two points are not "online".

Data published by CAB do not provide an airline breakdown of connecting traffic. One of our standard extracts, called the Transfer Competition Matrix, provides such visibility from the itinerary file. Figure 3-6 show these matrices for traffic connecting in Chicago and Washington. In each case the matrix shows the prior carrier, the carrier to which the passenger connected, and any "transfer loss or gain" incurred by each carrier.
FIGURE 2
ONLINE PASSENGERS
10% SAMPLE: 1973

CHICAGO
LOCAL: 23,401 →
23,749
CONNECT: 7,355 →
7,635
WASHINGTON
**FIGURE 3**

**TRANSFER COMPETITION MATRIX**

<table>
<thead>
<tr>
<th>PRIOR CARRIER</th>
<th>UA</th>
<th>AA</th>
<th>TW</th>
<th>UK</th>
<th>NW</th>
<th>EA</th>
<th>DL</th>
<th>PI</th>
<th>OZ</th>
<th>AL</th>
<th>--</th>
<th>TRANSFER LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UA</td>
<td>6855</td>
<td>384</td>
<td>148</td>
<td>32</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>581</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>119</td>
<td>1819</td>
<td>67</td>
<td>11</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>205</td>
<td></td>
</tr>
<tr>
<td>TW</td>
<td>113</td>
<td>202</td>
<td>963</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>44</td>
<td>326</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>21</td>
<td>14</td>
<td>7</td>
<td>78</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>666</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>NW</td>
<td>212</td>
<td>352</td>
<td>97</td>
<td>3</td>
<td>73</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>205</td>
<td>326</td>
<td></td>
</tr>
<tr>
<td>EA</td>
<td>9</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>140</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>DL</td>
<td>35</td>
<td>73</td>
<td>25</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1099</td>
<td>1099</td>
<td></td>
</tr>
<tr>
<td>OZ</td>
<td>490</td>
<td>502</td>
<td>95</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>11</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>AL</td>
<td>13</td>
<td>23</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>43</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>682</td>
<td>1515</td>
<td>319</td>
<td>14</td>
<td>10</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>15485</td>
</tr>
<tr>
<td><strong>TRANSFER GAIN</strong></td>
<td>1695</td>
<td>3075</td>
<td>776</td>
<td>73</td>
<td>29</td>
<td>11</td>
<td>9</td>
<td>9</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>15485</td>
</tr>
</tbody>
</table>

**NON-COMPETITORS**

- NC: 374
- BN: 51
- CO: 199
- IU: 6
- SN: 3
- UD: 1
- XV: 11
- YG: 1
- ZW: 34
- UX: 1
- PA: 1
- PP: 1
- XE: 1

**TOTAL***: 682

**TOTAL CONNECTS**: 2
### FIGURE 4
### TRANSFER COMPETITION MATRIX

<table>
<thead>
<tr>
<th>1973 ANNUAL PASSENGERS TRANSFERRING AT WAS FOR FLIGHT TO CHI ON CARRIER</th>
<th>(10 PERCENT SAMPLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRIOR CARRIER</td>
<td>UA</td>
</tr>
<tr>
<td>----------------</td>
<td>-----</td>
</tr>
<tr>
<td>UA</td>
<td>141</td>
</tr>
<tr>
<td>AA</td>
<td>74</td>
</tr>
<tr>
<td>TW</td>
<td>8</td>
</tr>
<tr>
<td>UK</td>
<td>133</td>
</tr>
<tr>
<td>NW</td>
<td>7</td>
</tr>
<tr>
<td>PI</td>
<td>864</td>
</tr>
<tr>
<td>EA</td>
<td>160</td>
</tr>
<tr>
<td>DL</td>
<td>18</td>
</tr>
<tr>
<td>AL</td>
<td>104</td>
</tr>
<tr>
<td><strong>OZ</strong></td>
<td>13</td>
</tr>
</tbody>
</table>

**NON-KOMPETITORS**

- **AK** 2
- **BA** 1
- **BN** 13 12 9 13
- **CR** 1
- **NA** 119 91 48 17 1
- **SN** 3 1
- **UQ** 1
- **VM** 2

- **FA** 3 2 1
- **PA** 1

**TOTAL CONNECTS**

<table>
<thead>
<tr>
<th>TRANSFER GAIN</th>
<th><strong>TOTAL CONNECTS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1522</td>
<td>4063</td>
</tr>
</tbody>
</table>
### FIGURE 5
### TRANSFER COMPETITION MATRIX

<table>
<thead>
<tr>
<th>1973 ANNUAL PASSENGERS TRANSFERRING AT CHI FLIGHT FROM WAS ON CARRIER</th>
<th>10 PERCENT SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARRIER</td>
<td>UA</td>
</tr>
<tr>
<td>UA</td>
<td>6924</td>
</tr>
<tr>
<td>AA</td>
<td>124</td>
</tr>
<tr>
<td>TW</td>
<td>131</td>
</tr>
<tr>
<td>NW</td>
<td>189</td>
</tr>
<tr>
<td>UK</td>
<td>56</td>
</tr>
<tr>
<td>EA</td>
<td>6</td>
</tr>
<tr>
<td>PI</td>
<td>1</td>
</tr>
<tr>
<td>OZ</td>
<td>434</td>
</tr>
<tr>
<td>DL</td>
<td>37</td>
</tr>
</tbody>
</table>

**NON-COMPETITORS**

| *BN | 103 | 79 | 20 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 205 |
| *CO | 140 | 251 | 76 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 470 |
| *IU | 4 | 15 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 22 |
| *NC | 346 | 903 | 171 | 19 | 3 | 1 | 2 | 1 | 1 | 1 | 1447 |
| *PP | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 |
| *SD | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 7 |
| *UD | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| *UX | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *XE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| *XV | 8 | 13 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 23 |
| *ZW | 35 | 78 | 26 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 140 |
| *YG | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |

**TOTAL***

| UA | 641 | 1347 | 299 | 23 | 5 | 2 | 2 | 2 | 1 | 1 | 15313 |
| AA | 1630 | 3072 | 760 | 48 | 19 | 15 | 7 | 7 | 4 | 5 | 2 | **TOTAL CONNECTS** |
## FIGURE 6
TRANSFER COMPETITION MATRIX

| 1973 ANNUAL PASSENGERS TRANSFERRING AT WAS FLIGHT FROM CHI ON CARRIER | (10 PERCENT SAMPLE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AFTER CARRIER | UA | AA | TW | UK | NW | PI | EA | DL | -- | AL | OZ | TRANSFER GAIN |
| UA | 301 | 68 | 11 | 2 | 1 | 1 | | | | | | 83 |
| AA | 90 | 279 | 41 | | | | 3 | 1 | | | | 135 |
| TW | 8 | 9 | 19 | | | | | | 1 | | | 18 |
| UK | 215 | 55 | 19 | 69 | 1 | 2 | | | | | | 132 |
| NW | 9 | 9 | 4 | 1 | | | | | | 2 | | 22 |
| PI | 826 | 820 | 266 | 4 | 6 | 8 | 3 | 2 | 1 | | | 1928 |
| EA | 128 | 165 | 44 | 4 | 2 | | | | | | | 343 |
| DL | 41 | 34 | 12 | 1 | | | | | | 1 | | 89 |
| -- | 14 | 18 | 9 | | | | | | | | | 41 |
| AL | 120 | 146 | 31 | 2 | 1 | 1 | | | | 1 | | 301 |
| OZ | 4 | | | | | | | | | | | 4 |

### NON-COMPETITORS

- *AK*: 2
- *BN*: 18, 11, 5
- *CR*: 1
- *FB*: 4, 2, 1
- *NA*: 137, 126, 36, 1, 3
- *SJ*: 4, 4, 1
- *MC*: 
- *UQ*: 1
- *VM*: 

### TOTAL

- **TOTAL**: 165, 146, 44, 1, 3, 1, 1
- **TRANSFER LOSS**: 1620, 1470, 481, 14, 14, 2, 5, 4, 4, 2, 1

**TOTAL CONNECTS**: 4298
The coupon data file contains traffic flow between city-pairs. For example, in Figure 7 the total traffic flow across the segment CHI-WAS is composed of many possible "true O&D's" from outlying cities, as well as the CHI-WAS O&D itself. The traffic flow across the CHI-WAS segment is simply the sum of all CHI-WAS coupons contained in all itineraries of the sample.

To summarize the 10% sample data for CHI-WAS, Figure 8 shows a breakdown of the true O&D, online local, online connects and coupons by airline. Note that an airline breakdown of "true O&D" is by definition "online local". The difference between the two are passengers who had an interline connect between Chicago and Washington. Thus, "online local" is a subset of "true O&D".

Also by definition, "online connects" are a subset of "true O&D's" other than CHI-WAS, but they flew on a single airline between Chicago and Washington.

Let's look now at data that can be gotten from the international portion of the 10% sample by posing a hypothetical question. How many transatlantic itineraries contained Chicago, Washington, and London, what were the U.S. gateways used, and what was the U.S. city of origin/destination? The number of itineraries which satisfy these criteria are tabled in Figure 9 by direction. From the details of this extract we also know the numbers of passengers who used Washington as a gateway to the U.S. whose origin/destination in the U.S. was Chicago. These are shown in Figure 10.

I hope this brief example will display some of the complex questions that can be addressed with the 10% sample data.

Now I'd like to focus on another CAB data file - the Service Segment Data.

The U.S. Domestic Service Segment Data contains:

- Onboard Passengers
- Enplaned passengers
- Deplaned Passengers
- Non-stop Passengers
- Load Factor

by airline, by flight number and by equipment type for every U.S. Domestic city-pair. The data are aggregated monthly totals for every month beginning in July, 1970.
FIGURE 7
TRAFFIC FLOW - EXAMPLE
10% SAMPLE - COUPON FILE

MILWAUKEE
ROCKFORD
CHICAGO
WASHINGTON
RICHMOND
NORFOLK
FIGURE 8
CAB 10% SAMPLE, CHI-WAS
1973

| AIRLINE | TRUE O&D | ONLINE | | | |
|---------|----------|--------|-----------------|--------|
|         |          | LOCAL  | CONNECTS        | COUPONS|
| AA      | -        | 22,432 | 6,908           | 36,613 |
| AL      | -        | 34     | 45              | 26     |
| BN      | -        | 7      | 6               | 0      |
| DL      | -        | 35     | 30              | 0      |
| EA      | -        | 105    | 65              | 93     |
| NW      | -        | 358    | 144             | 588    |
| OZ      | -        | 73     | 38              | 0      |
| PI      | -        | 63     | 46              | 72     |
| TW      | -        | 6,656  | 2,588           | 9,729  |
| UA      | -        | 17,047 | 4,926           | 35,616 |
| Unknown | -        | 340    | 194             | 784    |
| Total   | 49,869   | 47,150 | 14,990          | 83,521 |
### FIGURE 9
**TRANSATLANTIC ITINERARIES**
**CHI, WAS, LON**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>INBOUND*</th>
<th>OUTBOUND</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>118</td>
<td>126</td>
<td>244</td>
</tr>
<tr>
<td>1970</td>
<td>138</td>
<td>139</td>
<td>277</td>
</tr>
<tr>
<td>1971</td>
<td>120</td>
<td>131</td>
<td>251</td>
</tr>
<tr>
<td>1972</td>
<td>145</td>
<td>137</td>
<td>282</td>
</tr>
<tr>
<td>1973</td>
<td>121</td>
<td>132</td>
<td>253</td>
</tr>
</tbody>
</table>

*To the U.S.*
### FIGURE 10

WASHINGTON GATEWAY, CHICAGO ORIGIN/DESTINATION

VIA LONDON

<table>
<thead>
<tr>
<th>YEAR</th>
<th>INBOUND*</th>
<th>OUTBOUND</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>32</td>
<td>23</td>
<td>55</td>
</tr>
<tr>
<td>1970</td>
<td>24</td>
<td>25</td>
<td>49</td>
</tr>
<tr>
<td>1971</td>
<td>31</td>
<td>24</td>
<td>55</td>
</tr>
<tr>
<td>1972</td>
<td>47</td>
<td>18</td>
<td>65</td>
</tr>
<tr>
<td>1973</td>
<td>28</td>
<td>31</td>
<td>59</td>
</tr>
</tbody>
</table>

To the U.S.
Let's look at a hypothetical flight from Milwaukee, through Chicago and Washington, terminating at Richmond. Now, assume the data for this flight are as shown in Figure 11. We know that the onboard load on the CHI-WAS segment was composed of:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MKE-WAS</td>
<td>30</td>
</tr>
<tr>
<td>MKE-RIC</td>
<td>65</td>
</tr>
<tr>
<td>CHI-WAS</td>
<td>100</td>
</tr>
<tr>
<td>CHI-RIC</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>205</strong></td>
</tr>
</tbody>
</table>

for a total of 205 onboard passengers. One hundred of these (CHI-WAS: 100) were nonstop, meaning they enplaned at CHI and deplaned at WAS. The enplaned passengers at CHI were:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI-WAS</td>
<td>100</td>
</tr>
<tr>
<td>CHI-RIC</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>110</strong></td>
</tr>
</tbody>
</table>

Passengers deplaned at WAS were:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MKE-WAS</td>
<td>30</td>
</tr>
<tr>
<td>CHI-WAS</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>130</strong></td>
</tr>
</tbody>
</table>

If the flight had been flown by a 350 passenger airplane, the load factor would have been

\[
\text{Load Factor} = \frac{205}{350} \times 100 = 59\%
\]

Since connects are not contained in this file, there is no way to get at true O&D through these data. However, it's possible to make gross inferences from the Itinerary File about the likelihood of connects at each city in the flight's itinerary.

One of the most important contributions of this data file arises from the coupling of the Service Segment Data with the QRE file. By using the QRE we can tell what time the flight was scheduled—say 10:00 am—and how often—perhaps daily. Now we are able to make inferences about the time-of-day distribution of demand by looking at nonstop passengers for all flights in the market versus departure times.

The data we've discussed today are just a fraction of what can be derived from the source files. Possible applications are endless.

In total Boeing maintains 32 major data bases or files of which the files I've discussed are a part.
FIGURE 11
SERVICE SEGMENT DATA EXAMPLE

MKE-CHI: 50
MKE-WAS: 30
MKE-RIC: 65
CHI-WAS: 100
CHI-RIC: 10
WAS-RIC: 70
These data bases contain approximately 20 million records. The size of these files is growing at more than 30% per year. Maintenance and operations of the system requires a full-time staff of 15 people at a current annual cost of $850,000. Our total investment to date has been in the neighborhood of $3 million.

Another gross measure of the size of the system is the number of magnetic tapes maintained in our computer centers at McLean, Virginia and Kent, Washington (Figure 12). The total is more than 2,400.

In short, the cost of operating our system is high. By implication the cost of thorough analyses of the U.S. air transportation system, with all its complexities, must also be high.

I hope these figures give those contemplating setting up data bases for the U.S. air transport system some perspective on the magnitude of the resources required.

There is one subtle problem that is not obvious in any dollars and cents or manpower figures. Data Systems are run by people, and detailed knowledge of a data system is not easily transferred from person to person. As a result, continuous training costs have to be absorbed. As people leave the support staff, new people have to be brought in and trained and the system must continue to function in the interim. Failure to recognize this problem can lead to severely underestimating the manpower costs of a data system.

Where do we go from here? I'm not personally convinced that many people in our industry really understand what data are available today and what can be done with the data. Making better use of currently available data ought to have priority over the creation of new data bases.

Following that, there are three rather obvious gaps in our data as an industry.

First, there are no demographic data on a basis compatible with CAB traffic data. We don't know who is flying, why, how often, or what their income, age or sex is. Airlines may know these facts about their clientele, but they don't generally know such characteristics for the whole market. Also such data that may exist are usually proprietary.

A useful project for an appropriate government agency or industry association would be the establishment of a system for routinely collecting and disseminating demographic data.

The second data gap results from the aggregation of data in basic source files. For example, the Service Segment Data contains data aggregated over one month. The aggregation of daily data disguises both day-of-week and random fluctuations
## Figure 12

**Data Bases Tapes**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>MCLEAN</th>
<th>KENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Tapes</td>
<td>526</td>
<td>307</td>
</tr>
<tr>
<td>Created from Source</td>
<td>493</td>
<td>325</td>
</tr>
<tr>
<td>Working - Maintenance</td>
<td>187</td>
<td>228</td>
</tr>
<tr>
<td>Working - Extract</td>
<td>230</td>
<td>130</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,436</strong></td>
<td><strong>990</strong></td>
</tr>
</tbody>
</table>
in demand levels. We know, for example, that time-of-day variations in demand differ considerably between days of the week. Moreover, the fact that the data are aggregated over the month eliminates the possibility of analyzing such effects.

My third and last point: the CAB 10% sample essentially reports information contained on ticket coupons. There is valuable information on coupons which is not reported-dates. Availability of dates could lead to better definitions of origin/destination and to better understanding of desirable service patterns.

In summary, I've briefly described a small part of the Boeing data base system. Although it's an expensive system, it's one that is absolutely necessary for our work. In my opinion, future development work should focus on more thorough use of currently available data, rather than the construction of new data bases.
"International Traffic Forecasting and the Problem of Statistics"
By Lawrence Hughes, Pan American

Compared to the forecasting of domestic United States traffic for which there is much data available, international forecasting is fraught with uncertainty. Not only is it essential to review future trends in the various geographical areas of the air world separately, but we must ensure that historical statistics are valid and comparable to enable accurate determinations of those trends. Unfortunately, statistics are not altogether clean, adequate, easily accessible or, in some cases, available under any circumstances.

The general thrust of this discussion is to consider the forecasting process of international traffic demand we have developed at Pan Am. I will review the implication of the underlying data which is fundamental to that process. I hope this will clearly present the problems that arise in attempting to reduce forecasting errors. I will briefly review the specific elements that are considered in a forecast, but I would like to primarily focus on the traffic data available that comprises the historical base upon which future projections are made.

There is no doubt that international forecasting is more art than science, if not because of the lack of certainty among the various elements affecting traffic then because of the inadequacy of the underlying data available. Nonetheless, forecasting is an essential ingredient to the profitability planning of any airline. It must be approached with particular caution and understanding of the limitations. Aircraft manufacturers, for
example, can review potential aircraft requirements in far more aggregate terms than can an airline that serves many different and varied locations throughout the world, as does Pan Am. When manufacturers perform market research tests for specific customers, they have the resources to adequately develop, on a one-time basis, detailed surveys. They could not, however, do so on a continuing basis. It is essential, therefore, that considerable, yet practical, effort be spent analyzing the historical traffic statistics as well as evaluating the major factors influencing traffic. The analysis cannot be ponderous and the data convoluted; otherwise, more time would be spent sorting it all out than in analyzing, as is now the case.

I have developed a brief outline of the forecasting process at Pan Am for the development of scheduled passenger traffic. It is within this framework that I will review the traffic data. (Appendix A illustrates this process.)

The Forecast Process

The flow is a reasonable and logical one that is not dissimilar to others presented many times before. The historical base reflects the economic, political and sociological environment as well as the specific traffic and yields that have historically materialized. From the economic and statistical bases, a set of assumptions can be formulated concerning the various elements. These assumptions, coupled with an analysis of market trends, are then used to base an industry traffic forecast on. From the industry forecast, a Pan Am forecast is developed considering the relative positions of Pan Am and competitors in the marketplace.
I have digressed somewhat from other forecast descriptions in that I have emphasized both macro and micro elements in the industry and Pan Am forecasts. Pan Am develops a macro traffic forecast as well as a micro forecast so that there can be an adequate set of controls and tests of reasonableness in the forecasting process which, hopefully, will result in a more accurate forecast.

The macro forecast is developed from the industry estimates for a defined geographical area, as large or as small as can be realistically depicted. This forecast does reflect the competitive impacts of both services and marketing effectiveness in the relevant geographical domain. The micro projections relate to the specific markets Pan Am serves, concentrating on the specific competitive assumptions and attributes of the sectors. Both processes begin by using a common set of initial assumptions.

From the two initial industry forecasts, Pan Am macro and micro forecasts are developed with the additional consideration of the market shares, the service shares and the anticipated development of the competitive services that impact the development of the Pan Am forecasts. Following the development of these independent forecasts, the resultant levels are reconciled by considering differences in assumptions and testing for reasonableness. The product is a Pan Am corporate forecast which is then financially evaluated. Obviously, the profitability evaluation can cause numerous iterations to be required through the process to improve the profitability.

Within the framework of this overall process, and underlying the analysis that is required, the historical data must be evaluated. Whatever data is
available for both the external environment and traffic and yields would be included in an effective analysis.

Judgmental Factors

We must first put the external judgmental elements of the forecasting process in their proper perspective and then discuss the traffic data that is available for analysis.

Economic statistics are generally available from either governmental or private organizations. Governmental agencies include the various governments' Department of Commerce-type repositories as well as United Nations accumulated data. Private sources, such as the Organization for Economic Cooperation and Development (OECD), banks and economists, all provide data for national product and the major economic factors' results. In the more industrialized countries, the data is more detailed and probably more valid; in the lesser developed countries, the data is less reliable. It would take more reliable statistics than those currently available to adequately evaluate the impact corporate profits in Brazil have on business travel generation from Brazil. To the extent possible, however, the overall economic levels, as exemplified by gross national product or gross domestic product and associated inflationary levels, are reasonable approximations for an understanding as to how traffic has developed. There simply is no more data. The more desirable elements of corporate profit levels and disposable personal incomes would be better indicators but, in most cases, the data is not available and relationships would be difficult to define in any event. From the historical economic material, however,
forecasts can be developed for the major elements which provide some indication as to the ultimate traffic potential out of or into particular countries.

Economic assumptions are generally considered in terms of the real economic growth that can be expected, the impact of changing inflationary levels on the ground portions of travel, expansion of tourism and changes in investment. The political environment in various countries is also of concern, for the level of political stability will obviously impact both business and tourist-related travel. Those countries that are in rather unstable positions internally will most likely suffer in their tourist traffic, but business traffic as well will fall off depending upon the direction and uncertainty of whatever government is in power. For long term traffic forecasts, however, a general assumption is that the political environment would reflect as much turmoil or stability as there has been in the past without identifying specific areas in which there could be instability, an obviously futile task. In addition, the political aspect of regulations on air travel, the impact of various charter programs and the willingness of governments to allow or disallow charter movements must all be recognized, along with route awards, new carriers and the like.

The sociological factors that must be considered in developing forecasts include the distribution of income, the length of vacations that are involved, the length of the work week in the sense of estimating leisure time available and the increasing familiarity of society with air travel.
Competing with air travel, of course, are the alternative modes of transportation and the relative cost differences among them; certainly the fuel crisis, for example, substantially dampened the cost attractiveness of vacation air travel, but did benefit short-haul business traffic. Air travel fare increases have caused air travel to become much higher priced relative to other modes of transportation than had previously been the case. Certainly as part of this analysis, the relationship between scheduled service and the charter market is an important ingredient recognizing the overall current desire of the public towards cheaper transportation.

All of these factors influence the direction of traffic and to the extent that an analysis of them can determine meaningful associations, the ultimate direction and magnitude of impact can be accurately estimated.

**Traffic Statistics**

More critical, however, is the adequacy and availability of historical traffic and the patterns of traffic that have existed. There are a number of repositories of historical statistics.

The broadest umbrella covering world air transport traffic levels is the International Civil Aviation Organization (ICAO), which publishes quarterly and annual reports. Most of the world carriers are either members or are associates of the ICAO. ICAO statistics cover all of the sectors for which traffic is reported by carrier and
is summarized in a variety of cross-sectional ways. The data is only developed in this detail for one month in each quarter, however, and does not indicate any more than sector loads, not origination/destination. In addition, this data is not very timely.

The International Air Transport Association (IATA) also accumulates traffic statistics and is the second major source. Monthly reports are published on the North Atlantic and annual traffic is categorized for the other major geographical areas. The breakdown is essentially along broad area lines rather than specific markets and is only sector traffic and not origination/destination. IATA statistics, however, represent only 90% of total world traffic. In addition, the statistical breakdown is not timely, except for North Atlantic traffic.

The Civil Aeronautics Board (CAB) publishes only that origination/destination traffic that has been carried on one sector by a U.S. carrier. The data is not at all useful for market sizing since it is limited to U.S. carriage and on lesser sectors, it becomes even less meaningful.

The Air Transport Association (ATA), primarily a domestic source, also publishes statistics related mostly to foreign markets served by U.S. carriers along the borders.

The Immigration and Naturalization Service (INS) publishes statistics which do break down the traffic by scheduled and nonscheduled, U.S. carrier and foreign carrier and by citizenship. The INS data covers only U.S.-related traffic and represents roughly one half of world demand. An additional
problem with these statistics is again the source of foreign originations, in that the city immediately preceding arrival in the United States defines the source of the traffic. Obviously, this is not necessarily the true origination of the traveling passengers.

These sources then comprise the primary traffic data bases - none directly comparable to each other - that are available for use in forecasting. There are a number of other organizations or agencies that provide more detailed and more limited sources of information not available from preceding groups. The Institute of Air Transport (ITA), for example, offers detailed studies of traffic flows among areas; the Hawaiian Visitors Bureau supplies detailed breakdowns of traffic in the Hawaiian market. There are numerous similar tourist, trade, airport or government groups throughout the world which provide limited, but more detailed explanations or statistical details of the traffic entering the particular areas of concern. The physical task of reviewing them on a regular basis would be monumental, and far exceed an airline's ability to handle it.

Basic Questions on Validity

There are some fundamental questions that need to be raised about this data. None of the sources are without their limitations, yet they are the sole sources upon which any traffic analysis and forecasting must rely. As contrasted with the fairly detailed statistics available for the domestic industry, whether trunk line or regional, the international traffic is rather limited.

The basic questions that I would raise about the available data is its quality, its quantity and definition, its level of detail and its timeliness.
Quality relates to how accurate it is, how complete it is, how comparable to previous data it is. The question of quantity and the definition of traffic does not suggest uniformity and comparability. For example, within the United States we now define nonrevenue traffic as any traffic paying less than 50% of the price of the ticket. On the other hand, the international sources define traffic for nonrevenue as paying 25% or less. This comparability problem in terms of the definition of traffic is just one more roadblock in the path of easier analysis. The quantity of data and the detail in which it is provided is inadequate for traffic flow analysis. It is also difficult to ascertain if it is comparable to previously reported data covering the same areas.

Another problem relates to the level of traffic detail readily available to describe small geographical entities; broad general "North America-South America" descriptions are less than adequate.

A fourth major concern about international data is one of timeliness; the North Atlantic IATA data, for example, is published monthly two or three months after the fact, but more traffic data is only published annually. ATA data, for example, is published fairly regularly along with border statistics surrounding the United States. The CAB data is substantially late, generally three fourth of a year to a year after the fact. The ICAO data is similarly delayed.
These questions concerning the quality, quantity, definition, timeliness and comparability of the data are of great concern and present a challenge in trying to minimize the degree of forecast error that occurs in the process.

As I have tried to indicate in the forecasting process in which all this data is used, an attempt is made to minimize error by maintaining the dual forecasting systems of the macro and micro approaches. All of the industry data applicable to sectors comes from ICAO estimates, for example, supplemented by additional available market estimates.

Through these two independent forecasting efforts, we are then able to reconcile the differences. The macro forecast provides the constraint of recognizing Pan Am's participation in an integral whole, whereas the micro forecast is better able to determine the impact of specific Pan Am competitive capacity in particular markets on the resultant Pan Am traffic.

Obviously, through this process, the validity of the historical data is essential to reduce the degree of error in analysis that would affect a forecast. As I have tried to indicate in the international arena, there is more judgment and less analysis than there should be in forecasting.
The structure of the major reporting organizations - ICAO, IATA, CAB - do not have absolute control of the adequacy or completeness of the data when they are basically reporting the results of their member states. As a result, it is essential for the carriers to develop their own traffic history in the particular areas that they serve for the industry so that they can more accurately measure their performance in the marketplace. With everyone having to perform this role, decision-making must be based on more uncertainty than desirable. None of the general statistics available adequately addresses this problem.

For a carrier like Pan Am, we break down the traffic areas into eighteen geographical regions comprising four divisions. The Pacific Division, for example, is made up of the South Pacific, Central Pacific and North Pacific, three separate groups along with a fourth group called Pacific Extensions. In like manner, we break down the Atlantic, Latin American and Domestic Divisions. No published statistics adequately describe traffic in the detail of these eighteen generalized areas. Within these areas, however, we have numerous services that must be evaluated to assist in the development of our schedule planning, traffic and revenue forecasting.
Industry estimates must be developed, traffic flows must be estimated and a profile of traffic by fare category approximated to provide the basis for meaningful profitability analysis. With the current array of international traffic data that is available, only the crudest and broadest of assumptions throughout the forecast process can be made applicable to many markets. This is not at all satisfactory, but it is what we must live with.

There is no way that one could reasonably combine all of the Pacific into one forecast and expect the results to be reasonable when Australian traffic is substantially different from Japanese traffic; African traffic is significantly different from Italian traffic, which is also different from German traffic.

From this brief description of a logical forecasting process and the associated data requirements, the adequacy of this data looms as an immense problem that is not getting easier as traffic and service patterns become more complex. The challenge of properly defining and accumulating appropriate statistics into a straightforward logical and meaningful definition for analysis and forecasting awaits someone’s tremendous effort.
APPENDICES

A  Forecasting Process

B  Primary/Secondary Traffic Sources
FORECASTING PROCESS - INTERNATIONAL TRAFFIC

HISTORY
ECONOMIC
- Corporate Profits
- Disposable Income
- Inflation
- GNP
Consider major economies of the world.

TRAFFIC AND YIELDS
- Volume
- Composition by purpose
- Disbursement by geographical region
- Fare structure
- Total package costs

ASSUMPTIONS
Economic Forecast
- GNP
- Inflation
- Disposable Income
Political Environment
Sociological Factors

INDUSTRY FORECAST
MACRO
- RPM
- Passenger
- Yields
Forecasts for geographical area

PAN AM FORECAST
MACRO
RPM's

PAN AM CORPORATE TRAFFIC FORECASTS RECONCILED

MICRO
Passenger for major sectors
Passengers
Pan Am Market Share
Competitive Services
Pan Am Service Share
- geographical areas and sectors

TEST OF REASONABLENESS

Pan Am Market Share

FINANCIAL EVALUATION

ITERATION PROCESS, AS REQUIRED
Primary/Secondary Traffic Sources

**Primary**

- International Civil Aviation Organization
- International Air Transport Association
- Civil Aeronautics Board
- Air Transport Association
- Immigration and Naturalization Service

**Secondary**

- Institute of Air Transport, and other research organizations
- Tourist Bureaus - private and government-related
- Airport Authorities
- Government Agencies (i.e., New York Port Authority)
Workshop on Air Transportation Demand
and Systems Analysis
Presentation Outline

DOT Air Transportation Data Activities
by Mr. Alan Pisarski

The following briefly summarizes some of the developing activities of the DOT in the generation of Air Transportation Data, and identifies some future high priority data requirements.

International O-D

One new activity undertaken by the DOT this year has been the processing and tabulation of the Immigration and Naturalization Service I-92 forms. This is a jointly funded undertaking of the U.S. Travel Service and the Civil Aeronautics Board with the Department. This provides a major source of International O-D information.

National Travel Survey

Discussions have begun with U.S. Bureau of Census for a major expansion of the National Travel Survey. A set of specifications have been drafted for the bureau to employ in performing a feasibility study. A greatly expanded survey is envisioned including trips of all length and mode for a much larger sample of the population.

General Aviation Survey

The FAA will be field testing a revised survey instrument for an update to the 1972 Survey. This will be followed by the full survey to be done in cooperation with the Civil Air Patrol during the summer. The survey identifies flights, by purpose, by type of aircraft, at a representative sample of airports.
National Transportation Study

The aviation data base from the National Transportation Study has been described elsewhere in this Conference. Among the items of significant information are reports on the percentages of populations in cities over 2500 with reasonable access to airports.

Merger Criteria Date Base

The merger criteria data base used in assessing and evaluating air markets is being updated. It was last produced as a limited report in November 1971.

Air Freight O-D Information System

No new action has been taken on the implementation of an Air Freight O-D system. This was originally designed several years ago as a joint CAB-DOT effort by MIT. DOT continues its interest in seeing this system implemented.

On-Board O-D Surveys

DOT continues its interest in a full scale national air traveler survey, probably done as an on-board survey. Our interests would be in obtaining air traveler socio-economic statistics, and true Origin-Destination patterns.

Alan E. Pisarski
What the air transport industry really needs is the mythical rubber airplane! When traffic loads are high, it would stretch; when they're low, it would shrink. All of this, of course, should take place with constant unit production.

Load factors would approach 100%; regulatory agencies would be happy, because the efficiency of the system would be high -- by definition. Airline schedulers would have one of their biggest headaches eased -- how to match capacity to varying demand levels. Manufacturers would be happy to have a new technological advancement and long production runs. Travelers would be assured that a seat would be available, and the fares they paid were the lowest possible.

Unfortunately, the mythical airplane is a physical absurdity.

However, perhaps production management concepts could help airlines overcome the problems associated with the fixed-size airplanes of the real world while maintaining or improving the service quality of our scheduled air transportation system.

Let's look at a typical problem faced by manufacturers of consumer goods. Such firms try to maintain constant production rates, since these typically are the least costly. To do this, the firm will look at future sales prospects and set constant production rates for a period of time. Inevitably, there are variances between sales forecasts and actual demand. To cope with this fact, the firm sets its production rate at such a level that it will build up and maintain a buffer stock of inventory to meet unanticipated demand. If the firm sets its buffer stock too low, it risks lost sales if demand is higher than expected. If, on the other hand, buffer stocks are set too high, excessive, costly inventories are built up. Production management has, through the years, developed extremely sophisticated management tools to deal with this situation - applications of statistical analysis to define "optimal" inventory levels, while considering costs of production, inventory holding costs, costs of lost sales and variations between actual and forecast sales levels.

Airlines face a similar problem. A schedule defines the production rate of seat-trips. Also, capacity changes can be made only in large, indivisible chunks. Schedules are set for some period of time based upon expected sales.
However, in the airline's case, inventory cannot be stored, since a seat-trip is a perishable commodity. Once a flight departs, its empty seats can never be sold.

Some of those empty seats, though, are the "buffer stock" used for inventory management which a scheduled airline requires to enable it to absorb variances between expected and actual demand and provide the would-be traveler with an acceptable probability of being able to go where and when he wants. Let's call the rest of the empty seats "surplus seats."

Unfortunately, there has been much criticism of the air transport industry in recent years. The charges of "inefficiency and wasteful low load factor" have been directed at all of the empty seats, including both the necessary buffer and the surplus seats which the airlines did not want.

We think there is a way to combine the analytical techniques of inventory management and control with a particular type of discount fare plan to make better use of the industry's truly surplus seats.

But, before we discuss the management tool, let's talk about discount fares: why do they go wrong, and what the ingredients of a good discount fare plan might be.

In the past, discount fare plans have gone awry for one basic reason - they have lowered yields without lowering airline operating costs. Figure 1 describes the process that has historically occurred. In essence, what has happened is that, while discount fares stimulated demand, the industry responded by increasing both capacity and system operating cost. Average overall load factors stayed about the same, but a closer look would show that full fare loads declined. Average passenger yields were lowered in the process. The increased costs, coupled with yield erosion, all too often produced a loss rather than the intended profit.
DISCOUNT FARES – WHY THEY GO WRONG

- GIVEN A CHOICE, ALL CLASSES OF PASSENGERS CONCENTRATE AT PEAKS.
- LOW-FARE PEAK PASSENGERS BUMP HIGH-FARE PASSENGERS.
- TO AVOID THIS, CAPACITY IS INCREASED.
- INCREASED CAPACITY = INCREASED COST.
- BOTH FULL-FARE AND LOW-FARE DEMAND ARE OVERSERVED.
- COSTS GENERALLY EXCEED ADDED REVENUE.
- SOME FULL FARE DIVERTS TO LOW FARE.
- COMPETITION FOR SHARE FURTHER OVERSERVES MARKETS.
Don't we wish that the mythical rubber airplane existed? If it did, we would estimate the average demand for each departure and add the buffer stock of seats to cover variability in demand and thereby protect service quality. Every departure would have exactly the right size airplane and load factors could be increased.

While the rubber airplane is a physical myth, it may be possible to develop an analytical and marketing approach to achieving some of its desired characteristics. Through appropriate statistical analysis of airline data and the special application of standard inventory management programs, one can determine the difference between the seats required for regular scheduled service and the seats assigned as "surplus capacity" for the low fare segment of the market. If discounted tickets were appropriately marketed only for the predictable, surplus seats in the system, the net effect would be higher load factors and lower unit costs.

The discount fare plan that sells these surplus seats must be constructed in such a way that diversion from full-fare to low-fare is controlled at an acceptable level. Also, low-fare passenger service must not be allowed to erode the service quality being paid for by the full-fare passengers.

It appears that a financially viable discount fare plan could be built along the lines shown in Figure 2. During the past couple of years, Boeing has conducted experimental surveys with United States domestic trunk airlines to define the necessary ingredients of a controllable discount fare plan and to measure the stimulation and diversion that might result. We believe a great deal was learned in the process.

Although the measures of stimulation and diversion produced were not as precise as we'd like, they were good enough to demonstrate that significant discounts can be offered while maintaining airline profitability - when used within the framework of Surplus Seats Management.
PROPOSAL FOR A GOOD "LOW FARE" CONCEPT

- Plan capacity to fit normal markets.
- Assign resources and stick to plan.
- Predict "surplus" capacity contained within plan.
- Sell only "surplus" capacity at low fare.
- Prevent full-fare diversion to low fare.
- Prevent full-fare displacement by low-fare passengers.
- Assign low-fare passengers to "surplus" seats only.
Further, conditions can be attached to a discount fare plan which controls no-shows and diversion, yet allows the airline to place the passenger in the airline's surplus seats (Figure 3). These conditions include non-refundable deposits, advanced booking and passenger assignment to airline determined routings and schedules. Basically, the traveler who wants a big fare reduction must allow the airline to assign him to the off-peak flight of their choice, if the flight of his choice does not have surplus seats available.

The real key to all of this is that the airline has to know where to assign the passenger, and that's no simple task.

Now, how do we predict Surplus Seats. To begin, we can no longer consider things like average system load factors. We must examine individual flight-by-flight loads. With some precision, we must look at a single flight segment, a single flight number, one direction only and a period of time during which the loads are fairly uniform (say mid-winter or summer). Also, load data must be screened for holidays, special events, etc. (Figure 4). We then examine loads which occur only on the same day of the week. This produces a set of data which can yield some very important answers. Now let's look at the probability plot of on-board loads for a single flight number for one day of the week during one season of the year. This is a real case for a major carrier (Figure 5).

This chart merely plots the actual passenger load on the vertical scale against the probability of a load of that size or smaller occurring on the horizontal scale. In this case, the horizontal scale is a Normal, or Gaussian distribution. Thus, if these data are normally distributed, the plot should be a straight line, which it approximates closely in this case. The mean is at the center, and the slope of the best fit straight line is the standard deviation. Since the airplane used on this flight had 86 seats, points near the upper right corner lie below the "best fit" line drawn through the rest of the data. These points are full - or nearly full - flights.
FIGURE 3

IMPLICATIONS OF COST/PREFERENCE FOR NEW FARE PLANS

NO-SHOW CONTROL

- NONREFUNDABLE DEPOSIT ACCEPTABLE
- NO NEGATIVE IMPACT UP TO 30% OF TICKET PRICE

DIVERSION CONTROL

- ADVANCE BOOKING ALONE
  - VERY EFFECTIVE CONTROL OF BUSINESS TRAVELER DIVERSION AT ANY LEAD TIME
  - EFFECTIVE CONTROL OF PLEASURE TRAVELER DIVERSION AT LONG LEAD TIMES
  - NOMINAL COST SAVINGS FOR CARRIER

- FLEXIBLE SCHEDULING ALONE
  - VERY EFFECTIVE CONTROL OF BUSINESS TRAVELER DIVERSION
  - PRODUCES MODERATE PLEASURE TRAVELER DIVERSION
  - SIGNIFICANT CARRIER COST SAVINGS POSSIBLE

- COMBINED ADVANCE BOOKING/FLEXIBLE SCHEDULING
  - MOST EFFECTIVE IN CONTROLLING BUSINESS TRAVELER DIVERSION
  - MORE EFFECTIVE IN CONTROLLING DIVERSION THAN ADVANCE BOOKING ALONE FOR PLEASURE TRAVELERS
  - SIGNIFICANT CARRIER COST SAVINGS POSSIBLE
  - MINIMUM INTERFERENCE WITH STIMULATION OF LOW-FARE PLEASURE MARKET

- OTHER OPTIONS RELATIVELY UNPRODUCTIVE
SEGMENTATION OF FLIGHT LOAD DATA

0 SEGMENT BY DAY OF WEEK

LOAD DATA FOR A SINGLE DAY OF WEEK

0 TIME PERIOD SCANNED FOR HOLIDAYS, SPECIAL EVENTS, ETC.
0 DROP PREDICTABLE PEAK LOADS FROM DATA BASE (HOLIDAYS, SPECIAL EVENTS, ETC.)
0 FORECAST PERIODS OF SIMILAR EXPECTED PEAK LOAD
0 DETERMINE SEASONAL SCHEDULE CHANGE OR SWITCH POINTS (OPERATIONAL SEASONS)
0 CONFIRM LOAD DATA SEASONAL SHIFTS CORRESPOND TO OPERATIONAL SWITCH POINTS
0 EXTRACT AND SEGMENT LOAD DATA FOR ALL SELECTED FLIGHTS
EXAMPLE OF PROBABILITY PLOT
(AIRPLANE CAPACITY - 86)

REJECTED DATA
(WITHIN 6 OF CAPACITY)

LOAD DATA

RECORD LOADS

BEST FIT TO RETAINED DATA

SLOPE = STD DEVIATION OF DEMAND

LOAD PROBABILITY

DERIVED DEMAND DISTRIBUTION

<table>
<thead>
<tr>
<th>MEAN</th>
<th>ST DEV</th>
<th>RES SS</th>
<th>RES MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>63.700</td>
<td>18.293</td>
<td>94.83</td>
<td>3.95</td>
</tr>
</tbody>
</table>

USING PTS 1 THROUGH 26
The "best fit" line defines both the mean and the standard deviation of a normal distribution which characterizes the demand distribution underlying the load data (Figure 6). Note that the "demand" distribution is the distribution that would have existed had there been no capacity limit. This is shown as the dashed line in the right-hand chart in Figure 6. Thus, the load distribution which we actually see in the recorded data is nothing more than a truncated normal distribution. What we have done here is convert load data into a usable demand distribution curve.

It's been our experience that as demand grows in a specific market, the relationship between the mean and standard deviation of these distributions remains approximately the same. Since this is true, we can calculate the shape of the demand distribution, given a demand level - a forecast - and the ratio of the standard deviation to the mean derived from historical data.

Further, if we know the capacity of the flight, we can calculate the probability that the flight will "spill", or turn away passengers and the probability that an individual passenger will be "spilled" (Figure 7). Carrying this one step further, a capacity can be calculated or derived such that the probability of spilling passengers is limited to an acceptable level. This spill rate is manageable and defines one aspect of the quality of service to be provided: namely, the likelihood of full-fare passengers getting a seat on the flight of their choice.

This calculation defines the number of seats that the airline will reserve for its full-fare passengers (Figure 8), given a forecast of its demand or mean load. Since we don't have that mythical rubber airplane, though, the seats which will need to be reserved will almost never be the airplane's physical capacity. In some cases, more seats will need to be reserved than are on the airplane. Unfortunately in many cases, though, surplus seats will be available,
CONVERSION OF PROBABILITY PLOT TO NORMAL DISTRIBUTION CURVE

FIGURE 6

CAPACITY

REJECTED DATA

DERIVED NORMAL DISTRIBUTION

REV PAX LOAD

0.01 50 99.99

PROBABILITY

FREQUENCY OF OCCURRENCE

LOAD DISTRIBUTION

REVENUE PASSENGER LOAD

DERIVED NORMAL DEMAND DISTRIBUTION

REJECTED DATA

CAPACITY
FIGURE 7

ESTIMATING SPILL

0 0 BOTH FLIGHT AND PASSENGER SPILL CAN BE PRE-SELECTED
0 0 SEATS REQUIRED FOR BOTH CAN BE DERIVED

FLIGHT SPILL = PROBABILITY THAT A FLIGHT WILL TURN AWAY PASSENGERS
PASSENGER SPILL = PROBABILITY THAT A PASSENGER WILL BE TURNED AWAY
DERIVATION OF REQUIRED AND SURPLUS SEATS

SEATS REQUIRED ARE USUALLY DERIVED FOR FLIGHT SPILL PROBABILITY OF 1% - 4%

FREQUENCY OF OCCURRENCE

PASSenger LOAD

MEAN LOAD (FULL FARE)

SEATS RESERVED (FULL FARE)

SURPLUS SEATS (LOW FARE)

CAPACITY OF AIRPLANE

0 SURPLUS SEATS MAY BE POSITIVE (AS IN THIS CASE)
0 SURPLUS SEATS MAY BE NEGATIVE (INDICATING ADDITIONAL CAPACITY REQUIRED)
and these can be sold to low-fare passengers. Figure 9 summarizes the steps needed to predict these surplus seats. The mean is most accurately forecast by a good market analyst. The K factor is held constant based on previous years data, and the new standard deviation is calculated for the forecast period.

We've been working with certain airlines to develop this concept into a workable management tool. For example, Figure 10 shows a report generated by processing actual load data from a United States market. The program calculates, by day of the week, the average, maximum and minimum loads, load factor and estimates mean demand, standard deviation of the normal demand distribution, the ratio of standard deviation to mean (K), flight and passenger spill rates, required seats and surplus seats.

Going another step, the full-fare demand distribution can be adjusted for diversion caused by the low-fare plan (Figure 11). This diversion can be controlled on a market-to-market basis by appropriate combinations of the three primary control variables mentioned earlier: fare reduction, advanced booking and passenger schedule flexibility.

The introduction of the surplus seats marketing simultaneously introduces so many variables into the profit impact equation that simple back of the envelope calculations and intuitive judgment are not good enough. Non-recurring and recurring low-fare service and management costs must be accounted for along with the impact on an airline's profit of variations in fare plan conditions affecting stimulation and diversion rates. Figure 12 presents a Low-Fare Profit impact model that could be useful in such assessments. Surplus Seat Management offers a sound basis for managing discount fare plans while avoiding the financially debilitating effects the industry has seen in the past. However, much work remains to be done.
FIGURE 9
FORECAST OF REQUIRED AND SURPLUS SEATS

OBJECTIVE: PREDICT THE DEMAND DISTRIBUTION, SEATS REQUIRED AND SURPLUS SEATS IN FUTURE SEASON.

DERIVE MEAN AND STANDARD DEVIATION FOR PAST SEASONS ($\mu$, $\sigma$, & K)

ESTIMATE K FACTOR FOR FORECAST YEAR
- K NORMALLY SIMILAR SAME SEASON EACH YEAR
- WHERE SIMILAR, SELECT HIGHER K AND USE FOR PREDICTION
- WHERE DISSIMILAR, SELECT A CONSERVATIVE HIGHER VALUE FOR K (.35 - .4)

FORECAST MEAN DEMAND
- DERIVED TREND USABLE (NOT RECOMMENDED)
- EXTERNALLY DERIVED SEGMENT/MKT GROWTH(RECOMMENDED)

DERIVE FORECAST STANDARD DEVIATION $\sigma = \mu K$

FORECAST KNOWN PEAK DAYS (HOLIDAYS, ETC.) AND BLACK OUT*

CALCULATE REQUIRED SEATS FROM FORECAST DEMAND

CALCULATE SURPLUS SEATS FROM PLANNED CAPACITY - SEATS REQUIRED
**Figure 10**

The SSS Analysis Program Report

Example - Major U.S. Market (Jan 74 Thru May 74)

<table>
<thead>
<tr>
<th>Day</th>
<th>Load</th>
<th>Demand</th>
<th>Flight Pax</th>
<th>Seats Required</th>
<th>Surplus Seats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EQUIP</td>
<td>LOAD</td>
<td>DEMAND</td>
<td>FLIGHT</td>
<td>PAX</td>
</tr>
<tr>
<td></td>
<td>GDP</td>
<td>CAP</td>
<td>MAX</td>
<td>AVE</td>
<td>MIN</td>
</tr>
<tr>
<td>SUN</td>
<td>747</td>
<td>289</td>
<td>206</td>
<td>165</td>
<td>97</td>
</tr>
<tr>
<td>MON</td>
<td>747</td>
<td>289</td>
<td>208</td>
<td>140</td>
<td>101</td>
</tr>
<tr>
<td>TUE</td>
<td>747</td>
<td>287</td>
<td>267</td>
<td>202</td>
<td>129</td>
</tr>
<tr>
<td>WED</td>
<td>747</td>
<td>284</td>
<td>284</td>
<td>167</td>
<td>96</td>
</tr>
<tr>
<td>THU</td>
<td>747</td>
<td>287</td>
<td>268</td>
<td>194</td>
<td>96</td>
</tr>
<tr>
<td>FRI</td>
<td>747</td>
<td>289</td>
<td>289</td>
<td>248</td>
<td>140</td>
</tr>
<tr>
<td>SAT</td>
<td>747</td>
<td>289</td>
<td>288</td>
<td>217</td>
<td>98</td>
</tr>
<tr>
<td>FLIGHT SUMMARY</td>
<td>2021</td>
<td>191</td>
<td>0.66</td>
<td>191.0</td>
<td>50.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1729</td>
<td>335</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*If growth factor other than 1.0 is applied:
0 Mean demand is grown
0 Standard deviation is estimated such that K factor remains constant
0 Seats required are estimated using forecast \( \mu \) and \( \sigma \)
0 Surplus seats are estimated based upon predicted capacity
ADJUST FORECAST REQUIRED AND SURPLUS SEATS FOR LOW FARE DIVERSION

0 ASSUME DIVERSION RATE IS KNOWN*

\[ D = d \mu \]

\[ D = \text{DIVERSION} \]
\[ \mu = \text{NORMAL FULL FARE MEAN DEMAND} \]
\[ d = \text{RATE OF DIVERSION} \]

NORMAL FULL FARE DEMAND (WITHOUT LOW FARE)
ADJUSTED DEMAND
ADJUSTED SEATS REQUIRED
SEATS REQUIRED

\[ D = \frac{d}{4} \mu \text{ (DIVERSION RATE)} \]
\[ \mu = \text{MEAN DEMAND} \]
\[ d = \text{RATE OF DIVERSION} \]

0 DEMAND MEAN, STANDARD DEVIATION AND SEATS REQUIRED ARE ADJUSTED BY DIVERSION RATE (K ASSUMED CONSTANT)

*KEY MARKETS SHOULD BE TESTED TO ESTIMATE DIVERSION AND STIMULATION RATES.
LOW FARE PROFIT IMPACT MODEL

FARE PLAN

DISC.  ADV. BOOK.  DEPART. FLEX.  PAX DEMANDS

FORECAST DEMAND DISTR.  FLIGHT SPILL RATE

DIVERSION ADJUSTMENT

SEAT ALLOCATION MODULE

AIRCRAFT CAPACITY

FULL FARE REQUIRED SEATS

FARES

FINANCIAL CALCULATIONS MODULE

△ FLIGHT LOADS PRODUCED BY TEST FARE PLAN

△ FLIGHT PROFIT PRODUCED BY TEST FARE PLAN

BUS./Pleasing SPLIT

NON-FLYING PUBLIC STIMULATION

FLIER + HOUSEHOLD STIMULATION

FARE PLAN MODULE

DIVERSION

△ ADDED COST PER ADDITIONAL PASSENGER

△ ADDED COST PER LOW FARE PASSENGER
Operating systems need to be developed by airlines to process their historical data and interface the resulting analysis of surplus seats with their planning and reservations systems. Market researchers throughout the air transport industry face the challenge of devising better techniques to measure stimulation and diversion. Such measures must be sensitive to specific, but varying market conditions.

Putting Surplus Seat Management into practice will not be cheap or easy. But such a concept would provide a means for acquiring and maintaining an optimally balanced air transportation system: a system in which the full-fare passenger receives the service availability he is paying for; the "surplus seats" are made available to a segment of the public willing to accept more flexibility and restrictions in exchange for lower fares; and improved airline profitability to insure the continued development of our air transportation service.
The present methodology concentrates on the total domestic market or else on specific defined city-pair markets. However, there is a great variance among the traffic growth rates between the many geographic areas of the country. If future traffic flows can be forecast in broad terms on the basis of past traffic trends, regional production, personal income, population, and other socio-economic indicators, it would enable forecasting the growth of individual airlines much easier. The output could be used to measure the need for future route awards by the CAB, capacity and schedule requirements for the airlines, and aircraft market size (number and type) for the manufacturers.

One method being developed at Lockheed assigns all domestic airports to one of 15 geographic regions, as shown in Exhibit 1. These regions may include a number of states (i.e., Northeast Region 1 includes the six New England states), two states (West Coast Region 2 consists of California and Nevada), or single states with unique demand characteristics (Alaska, Hawaii, and Florida). Historical socio-economic data for each region were collected and correlations made with historical origin-destination data (intra-regional and inter-regional) of the CAB. The independent variables were then forecast into the future for each region and then intra-regional and inter-regional traffic forecasts made through regression analysis. As an initial step, the assumption was made that traffic growth rates would be the same between all O-D's within a region and between all O-D's in a particular inter-regional flow. Thus passenger traffic growth rates would be same between Boston - Los Angeles and Hartford - San Francisco.

We are not satisfied with the methodology as yet and are continuing to experiment with it. However, when the various growth rates (15 regions internally and between all 15 regions) are applied to each domestic trunk airline O-D traffic, we have derived a preliminary growth factor for each carrier. The range is from a low of 5.7 percent annually (TWA)
to a high of about 7.8 percent annually (DL and BN), with the latter two airlines serving in and between regions with higher than average growth trends of the socio-economic indicators used. Results for all domestic trunk airlines for the period 1973 - 1980 are shown in Table 2.

The top ten markets under this regional forecasting methodology are shown historically for 1965, 1969, and 1973 and forecast for 1985 in Exhibit 3. The market is shown to be disbursing, with the top ten markets declining from 45.29 percent of total RPM's in 1965 to 38.24 percent in 1985. The NE2-WC2 market which was the largest through 1973 is predicted to fall to second position in 1985, being surpassed by the MW2-WC2 market, even though the latter also declines as a percent of total RPM's.

Our major roadblocks to further development of this model are a lack of adequate time and manpower to pursue it and, truthfully, a lack of capability to do an adequate job of forecasting the independent variables (production, employment, personal income, population, etc.) by region. Also we are not even sure that 15 regions is the proper number in that each state is wholly within a given region. Different economic influences probably are at work in St. Louis and Kansas City, in Houston and El Paso, in Los Angeles and San Francisco, etc. Perhaps some states should be sub-divided and assigned to different regions. We also may have overlooked factors which establish a community of interest between various geographical areas. However, this certainly appears to be a research area ideally suited for academic pursuit.
## EXHIBIT 2
### AIRLINE PERCENT OF TOTAL DOMESTIC TRUNK RPMs

<table>
<thead>
<tr>
<th>Airline</th>
<th>AA</th>
<th>BN</th>
<th>CO</th>
<th>DL</th>
<th>EA</th>
<th>NA</th>
<th>NW</th>
<th>TW</th>
<th>UA</th>
<th>WA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>17.08</td>
<td>3.81</td>
<td>4.91</td>
<td>13.44</td>
<td>12.28</td>
<td>4.58</td>
<td>4.06</td>
<td>11.22</td>
<td>23.78</td>
<td>4.85</td>
</tr>
<tr>
<td>1980</td>
<td>16.20</td>
<td>4.04</td>
<td>5.11</td>
<td>14.23</td>
<td>12.82</td>
<td>4.53</td>
<td>4.17</td>
<td>10.35</td>
<td>23.43</td>
<td>5.11</td>
</tr>
</tbody>
</table>

### Actual RPM (Billions)

<table>
<thead>
<tr>
<th></th>
<th>1973</th>
<th>1980</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>16.78</td>
<td>6.32</td>
</tr>
<tr>
<td>1980</td>
<td>25.36</td>
<td>8.00</td>
</tr>
</tbody>
</table>

### Average Annual Growth Rate

<table>
<thead>
<tr>
<th></th>
<th>1980/73</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.1</td>
</tr>
</tbody>
</table>
EXHIBIT 3
TOP TEN REGIONAL MARKETS, 1965 - 1985

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NE2-WC2</td>
<td>8.66</td>
<td>NE2-WC2</td>
<td>8.03</td>
<td>NE2-WC2</td>
<td>7.25</td>
<td>MW2-WC2</td>
<td>6.09</td>
</tr>
<tr>
<td>MW2-WC2</td>
<td>7.26</td>
<td>MW2-WC2</td>
<td>6.99</td>
<td>MW2-WC2</td>
<td>6.42</td>
<td>NE2-WC2</td>
<td>5.97</td>
</tr>
<tr>
<td>MW2-NE2</td>
<td>6.31</td>
<td>MW2-NE2</td>
<td>5.14</td>
<td>FL-NE2</td>
<td>5.77</td>
<td>FL-NE2</td>
<td>4.75</td>
</tr>
<tr>
<td>FL-NE2</td>
<td>5.03</td>
<td>FL-NE2</td>
<td>4.68</td>
<td>MW2-NE2</td>
<td>4.23</td>
<td>FL-MW2</td>
<td>4.63</td>
</tr>
<tr>
<td>HA-WC2</td>
<td>4.15</td>
<td>HA-WC2</td>
<td>3.98</td>
<td>HA-WC2</td>
<td>3.68</td>
<td>HA-WC2</td>
<td>3.84</td>
</tr>
<tr>
<td>FL-MW2</td>
<td>2.82</td>
<td>FL-MW2</td>
<td>2.98</td>
<td>FL-MW2</td>
<td>3.51</td>
<td>TO-WC2</td>
<td>3.58</td>
</tr>
<tr>
<td>NE3-WC2</td>
<td>2.54</td>
<td>ML1-WC2</td>
<td>2.81</td>
<td>ML1-WC2</td>
<td>2.45</td>
<td>MW2-NE2</td>
<td>2.68</td>
</tr>
<tr>
<td>MW1-WC2</td>
<td>2.37</td>
<td>TO-WC2</td>
<td>2.53</td>
<td>TO-WC2</td>
<td>2.40</td>
<td>WC1-WC2</td>
<td>2.29</td>
</tr>
<tr>
<td>TO-WC2</td>
<td>2.24</td>
<td>NE3-WC2</td>
<td>2.27</td>
<td>NE3-WC2</td>
<td>2.22</td>
<td>MT2-MW2</td>
<td>2.22</td>
</tr>
<tr>
<td>MW1-MW2</td>
<td>2.17</td>
<td>MW1-MW2</td>
<td>1.97</td>
<td>MT2-MW2</td>
<td>2.13</td>
<td>MW2-NE1</td>
<td>2.19</td>
</tr>
</tbody>
</table>

Total        | 45.29                     | 41.38                    | 40.06                    | 38.24                    |
THE OUTLOOK FOR THE U.S. AIRLINE INDUSTRY
(AN ECONOMETRIC APPROACH)
By Yves G. Aureille, Douglas Aircraft Company

Ladies and Gentlemen:

During this conference, several important issues and problem areas facing the Airline Industry were adumbrated and clearly identified. Among the numerous problem areas that were mentioned by the panelists, and particularly by the representatives from the financial community, several items have attracted my attention as being of strategic importance: The impact of the general economic situation on the airline industry is clearly very important to those concerned with forecasting market demand, as well as investment requirements. Secondly, the impact of changes in fuel costs and labor costs on the airline industry, and the ability to forecast operating costs is evidently important to planners and financial analysts. Thirdly, the ability to quantitatively assess fare elasticities is relevant to both Government policy makers and airline marketing specialists. I believe, we would all agree here on the importance and urgency of developing an integrated system approach to systematically organize the data and to assess the impact of changes in the economic environment and in policy on the airline industry.

Although most panelists have displayed considerable insight and wisdom in identifying these problems, very little has been offered so far in terms of solutions or even research strategies to systematically tackle these problems. The purpose of this presentation is to suggest a possible systems approach to these problems and present the results of the research program currently in progress at the Douglas Aircraft Company.

Reading the agenda, the title of my presentation today was going to be "The Outlook for the Airline Industry: An Econometric Approach" - As the
title suggests, I was planning to focus on results and forecasts. However, in the light of the themes and interests expressed in this conference, I would like to somewhat shift the emphasis of my presentation away from the current outlook. As you know, outlooks are always somewhat volatile and contingent. Rather, I propose to discuss in more details the methodological issues involved in assessing the impact of the external economic environment on the airline industry.

At Douglas Aircraft, we are currently in the process of constructing an econometric model of the U.S. Airline Industry. The purpose of the model is to simulate and forecast the impact of changes in the economic environment and in air transportation and airline policy on all the major facets of the airline industry.

. THE WHARTON ANNUAL INDUSTRY MODEL

As you know the econometric approach has been successfully used during the last decade to simulate the behavior of national economies. These large scale macroeconometric models are now widely used by Government agencies and the Council of Economic Advisors as well as large corporations in the private sectors as a forecasting and planning tool. Among the better-known macroeconometric models are those developed by Wharton E.F.A., Inc., Data Resources Inc., and Chase Econometrics.

At McDonnell Douglas, we use the Wharton Annual Industry Model developed by Professors L. R. Klein and R. S. Preston in order to prepare the economic assumptions to our corporate plan.

The Wharton Annual Industry Model is in essence an annual macrosectoral model
of the U.S. economy, designed to provide medium-term forecasts of major macroeconomic variables as well as key indicators for some 63 industrial sectors, and to provide a simulation tool for analyzing the effects of alternative economic policies. The model is a theoretical and simplified representation of the functioning of the U.S. economy, formulated in terms of a simultaneous system of equations. In its present version, the model comprises about 800 variables, among which 100 are exogenous (i.e., determined or "explained" outside of the model) and 700 are endogenous determined or explained within the framework of the econometric model).

In order to forecast these 700 endogenous variables, we have to solve a system of 700 simultaneous equations. Among these equations, one can distinguish two kinds, identities that must be satisfied (either definitional identities or national accounts identities) and behavioral relationships, that are statistically estimated from historical time series, and which describe the dynamic behavior of various economic agents with respect to various economic functions.

Given a scenario, i.e., a complete set of forecasts assumed by the exogenous variables, one can exercise the econometric model and simulate the dynamic effects of these assumptions on all 700 endogenous variables.

At Douglas Aircraft, we have the capability to develop our own scenarios using the Wharton Annual Industry Model. The specific scenario, on which our current economic outlook is based, is predicated upon significantly
different assumptions on population, the budgetary and monetary policy and exogenous factors affecting the housing market, so that our economic forecast involves a much slower recovery than Wharton's best forecasts.

The macroeconomic forecast obtained is then used as an input to the MDC Econometric Model of the U.S. Airline Industry.
MDC AIRLINE INDUSTRY ECONOMETRIC MODEL

WHARTON ANNUAL INDUSTRY MODEL

TRAFFIC DEMAND SUBMODEL

LOAD FACTOR

CAPACITY (ASM, ATM)

USER COST OF CAPITAL

INVESTMENT SUBMODEL

RETURN ON ASSETS

OPERATING COSTS SUBMODEL

YIELD

OPERATING REVENUES
. THE MDC ECONOMETRIC MODEL OF THE AIRLINE INDUSTRY

Let me now discuss the general structure of the Econometric Model of the Airline Industry, which is now being built at Douglas Aircraft.

First of all, this model is conceived as a satellite model to the Wharton Annual Industry Model. This means that the key macroeconomic explanatory variables used as exogenous variables to the Airline Industry Model are endogenous to the Wharton Annual Industry Model. However, there is no formal explicit feedback from the Airline Industry Model into the macroeconomic model.

The second major characteristic of the MDC Airline Industry Model is that it is an aggregate model of the industry, although it is fully compatible to some airline by airline traffic forecasting models which we have developed at Douglas Aircraft.

The third feature is that the model attempts to explain and account for all the major facets of the industry in a simultaneous fashion. When it is fully developed with all the relevant feedbacks, we shall be in a position to simulate the short and long-term repercussions of any change, either in the economy or in air transportation not only on traffic demand and revenues, but also on costs, profitability and capital expenditures.
For expository purposes, the model can be described in terms of several inter-related submodels:

- The Traffic Demand Submodel will comprise several behavioral equations to forecast traffic demand. The total domestic system will be broken down between scheduled and non-scheduled. In addition, the total domestic scheduled system will be further disaggregated between the Passenger/Cargo Carriers and the All Cargo Carriers. A similar breakdown will be available for the international system. For each relevant category of carriers, separate econometric behavioral equations will be constructed for passenger traffic, cargo, mail and excess baggage. Most of the passenger traffic equations have been so far estimated and we shall have an opportunity to describe some of them momentarily.

- Although yields are exogenous to the traffic demand submodels, they will be endogenously explained in the airline industry model in terms of the discrepancy between the CAB guidelines on rates of return on assets and moving average of actual rates of return. Additional variables characterizing changes in fleet mix, class mix, and technological changes will also be incorporated in the yield equations.

- Operating revenues will be simply derived from traffic and yields using identities.
As far as Capital Expenditures and Capacity are concerned, we are planning to proceed in the following fashion. First, we shall construct user cost of capital variables, along the lines of neo-classical investment theory. These user cost of capital variables measure the rental cost of capital and subsume together with the unit price of capital, interests, the rate of economic depreciation, as well as institutional factors such as the corporate income tax, the tax depreciation schedule and the investment tax credit. Secondly, the optimal long-term capital stock (i.e., the amount of capital stock consistent with the maximization of the present value of the cash-flow) is determined from net output and the ratio of the price of output to the user cost of capital. Thirdly, to account for information, decision and implementation lags, a short-term adjustment process is superimposed, so that investments will be determined as a function of the discrepancy of the lagged actual capital stock from the optimal level of capital stock. Finally, the available capacity, measured in terms of Available Seat Miles (ASM) and Available Ton Miles (ATM) is determined from the capital stock and utilization.

Load factors will be computed as a ratio of traffic to capacity.

The purpose of the Operating Costs Submodel is to forecast direct and indirect operating costs broken down into several cost categories. This Submodel will comprise several blocks: The Labor Requirements and Cost Block, which is already operational, provides forecasts of labor requirements and wage.
rates by skill category. The Fuel Cost Block, which provides forecasts of aircraft demand and prices, is also operational to date. The Material Cost Block pertains to the cost of materials and aircraft parts. Given these forecasts of the various factors of production, each cost item will then be determined using simple behavioral equations.

Finally, the rate of return on assets will be determined from Revenues, Costs and Capital Stocks.

Having discussed the general structure of the Airline Industry Model, I would like to describe now in more detail some of the blocks that are already operational and, particularly, the passenger demand equation, the labor requirements and costs block and the jet fuel demand and price block.
For the last six years or so, we have developed at Douglas Aircraft some econometric models to forecast passenger demand, at an aggregate level for the whole U.S. Airline Industry, but also for individual airlines, for each of the domestic trunk carriers. In some cases, we have developed disaggregated models for airline subsystems or country-pair traffic. Currently, we are focusing our efforts to the construction of traffic models for cargo and mail, in order to be in a position to forecast total operating revenues.

Most of our traffic models are annual; however, we also have quarterly models for the U.S. Scheduled Domestic Traffic and for selected airline customers.

Our annual model of the U.S. Domestic Scheduled Traffic provides a good illustration of our traffic forecasting methodology.

Basically, we explain passenger demand in terms of an income variable, a substitution variable, a quality variable, a proxy for wealth and a variable characterizing changes in credit conditions.
U.S. SCHEDULED DOMESTIC TRAFFIC BEHAVIORAL RELATIONSHIP 1946-1974
ANNUAL MODEL

\[ LRPM = -2.1642 + 2.0372 (LPC\_E\_40) + 1.0557 (LVEL) + 0.0907 (LRINT) - 1.3470 (LTYLD.\_8) \]
\[ T = -4.0317 \quad T = 14.6626 \quad T = 7.9204 \quad T = 1.6632 \quad T = -9.1242 \]
\[ + 0.8216 (LPTL) - 0.0257 (DUMMY) \]
\[ T = 3.0524 \quad T = -1.7744 \]

\[ R^2 = 0.9988 \quad DURBIN WATSON = 1.7963 \]
\[ S.E. = 0.0170 \quad F \text{ STATISTIC } (6,22) = 3097.5857 \]

WHERE:
- \( L \) = LOGARITHM BASE 10
- \( RPM \) = U.S. SCHEDULED DOMESTIC REVENUE PASSENGER-MILES
- \( LPC\_E\_40 \) = A PERMANENT INCOME MEASURE OF PERSONAL CONSUMPTION EXPENDITURES - 1958 DOLLARS
- \( VEL \) = VELOCITY OF MONEY (GROSS NATIONAL PRODUCT/MONEY SUPPLY INCLUDING TIME DEPOSITS)
- \( RINT \) = RATIO BETWEEN THE LONG (MOODY'S BOND RATE) AND SHORT (PRIME COMMERCIAL PAPER 4-6 MONTHS) TERM RATES OF INTEREST
- \( TYLD.\_8 \) = U.S. SCHEDULED DOMESTIC YIELD IN CONSTANT 1958$/MILE. DEFLATOR = 0.8 (PCED) + 0.2 (GASOLINE PRICE INDEX)
- \( PTL \) = U.S. SCHEDULED DOMESTIC AVERAGE ON-LINE PASSENGER TRIP LENGTH
- \( DUMMY \) = DUMMY VARIABLE HAVING VALUES OF ZERO FROM 1946-1968 AND ONE FROM 1969-1981. THIS IS TO CORRECT FOR THE DEFINITIONAL CHANGE OF DOMESTIC TRAFFIC TO A 50-STATE BASIS.
TOTAL U.S. TRAFFIC
SCHEDULED DOMESTIC TRAFFIC
GOODNESS-OF-FIT COMPARISON

YEAR

1946  53  60  67  74

0.0  20.0  40.0  60.0  80.0  100.0  120.0  140.0

PASSENGER-MILES (BILLIONS)

ACTUAL
ESTIMATED

PR5-GEN-21284
Income Effect

As far as the income effect is concerned, we use a distributed lag of real Personal Consumption Expenditures. We have found that Personal Consumption Expenditures are statistically more significant and more reliable than Disposable Personal Income. Furthermore, the macroeconomic model already solves for the breakdown between consumption and savings. The rationale for using a distributed lag of income is that one can interpret it as a measure of permanent income. The theory, whose leading proponents include James S. Duesenberry and Milton Friedman, basically states that consumption (i.e., air travel) in time $t$ depends not only upon income in time $t$, but also is affected by past and/or expected future levels of income. A simple example should make this point clearer. If an individual undergoes a drop in his income level, the theory states that his consumption expenditures will also decrease but at a slower rate and his consumption expenditures are likely to be greater than his income. This "ratchet effect" is accomplished through dis-saving. The theory states that this occurs due to an individual's desire to maintain past levels of consumption regardless of present income. Another interpretation of this theory is that consumption in time $t$ is dependent upon expected future income, which in turn is estimated on the basis of a distributed lag function of present and past incomes. If an individual believes that his income is going to increase in the future, he is likely to dis-save at the present and replenish his savings from the higher levels of future income.
The exact formulation for this permanent income hypothesis used in this report is shown below:

\[
PCE^*_t = \sum_{\theta} \omega_\theta \ PCE_{t-\theta}
\]

Where \( t \) = time in years

- \( PCE^*_t \) = Permanent Income measure of Personal Consumption Expenditures - 1958 dollars
- \( \omega_\theta \) = Coefficients applied to lag values of \( PCE_t \)
- \( PCE_{t-\theta} \) = Lagged values of Personal Consumption Expenditures - 1958 dollars

The decision on whether or not to use the permanent income hypothesis in a specific model was made by examining its effect on the overall goodness-of-fit for the model as shown in the \( R^2 \) and \( F \) statistics.

Specifically, the coefficients of the lag distribution were assumed to decrease according to a truncated geometric progression:

\[
\omega_\theta = k \rho^\theta \text{ with } 0 < \rho < 1
\]

\( k \) being interpreted in such a fashion that

\[
\sum_{\theta=0}^5 \omega_\theta = 1
\]

In practice, a search routine was performed to determine that value of \( \rho \) which maximizes the overall goodness-of-fit of the model, thereby
estimating the optimal lag structure and the other parameters of the model in a simultaneous fashion.

The specification which optimized the goodness-of-fit for the U.S. domestic market is

$$PCE_{40, t} = 0.6025(PCE_t) + 0.2410(PCE_{t-1}) + 0.964(PCE_{t-2}) + 0.0386(PCE_{t-3}) + 0.0154(PCE_{t-4}) + 0.0062(PCE_{t-5})$$

which implies a value of the decay coefficient $\rho = 0.40$

Since the model is log-linear, one can interpret the coefficients as elasticities. The long-term elasticity of the U.S. Scheduled Domestic Traffic obtained is 2.0372, i.e., an increase of 1 percent in real Personal Consumption Expenditures will result in a cumulative increase of more than 2 percent in traffic. However, this increase will be distributed over a period of 5 years, proportionally to the weights of the lag distribution, so that the short-term elasticity is only 60 percent of the long-term elasticity.

**Monetary Variables** - Consumption is affected by other more subtle variables than the level of income, prices, and the quality of the commodity. Our results indicate that monetary variables also have an effect upon the amount of air travel. Two such variables have proved to be significant in their contributions toward explaining the demand for air travel in many of the models.
Velocity of money - The velocity or turnover rate of money is related to the income factors by expression:

\[ M \times V = P \times Q \]

Where \( M = \) Money supply including time deposits and large CD's

\( V = \) Velocity of money

\( P = \) Average price level (GNP price deflator)

\( Q = \) A measure of real National Product

This expression can be rewritten as

\[ V = \frac{\text{GNP}\$}{M} \]

Where \( \text{GNP}\$ = \) Gross National Product in current dollars.

The purpose of introducing the velocity of money is to account for short-term fluctuations in traffic arising from specific monetary (versus real income) phenomena, such as monetary illusion in a period of inflation.

The velocity of money can also be interpreted as the ratio between real GNP and the real value of the money supply. Whereas real Personal Consumption Expenditures is an appropriate income variable for the pleasure segment of the market, Real GNP is the proper income variable for the business portion. The real value of the money supply is a proxy for wealth. For statistical reasons, however, i.e., to avoid multicollinearity between the distributed lag of Personal Consumption Expenditures, real GNP and the real value of the Money Supply, we have combined the last two into a ratio, which happens to be the velocity of money.
The elasticity of traffic with respect to the velocity of money is not significantly different than 1.

Spread of Interest Rates - The ratio of the long and short term rates of interest was introduced to measure the easing or tightness of credit and its effect on air travel. The measure of the long term rate of interest was selected to be Moody's All Bond Rate. The measure of the short term rate was chosen to be the rate of Prime Commercial Paper (4-6 months). The ratio is expressed as:

\[
\frac{\text{Long Term Rate}}{\text{Short Term Rate}}
\]

Because of the lags involved in the reaction of the long-term rates of interest, a relaxation of credit conditions will be characterized by an increase in the spread between the long-term and the short-term rates of interest. This relaxation of credit conditions has proved to increase the demand for air travel in many of the models, and vice versa.

To some degree, these monetary variables appear to characterize the same phenomena as measured by the Permanent Income hypothesis since both variables reflect expectations as to the future course of the economy. This was found to be very apparent in the case of the spread between the long and short term interest rates. In some of the models the effect of introducing the permanent income variable was to increase the overall goodness-of-fit
while simultaneously reducing the significance of the interest rate variable. This relationship between these independent variables appears to be consistent with Friedman's calculation of the permanent income. In his theory a person's expected income in the future must be discounted into present values by the interest rate and the amount of time into the future before the income is realized. Hence the interrelationship between the permanent income variable and the interest rate.

**Cost of Travel Variable -**

U.S. Domestic Model - The yield variable, used to measure the substitution effect or the cost of travel, was defined in the previous study (ref. CI-805-3084):

\[
TYLD_s^t = \frac{REV_s^t(1-TAX_t)}{RPM_t}
\]

Where:
- \( TYLD_s^t \) = Total current dollar yield including transportation tax
- \( REV_s^t \) = Passenger Revenues
- \( TAX_t \) = Transportation tax rate in effect in year \( t \) including an estimate of airport and security taxes paid by the consumer
- \( RPM_t \) = Revenue Passenger Miles

This current dollar yield was then deflated by the implicit price deflator for Personal Consumption Expenditures:

\[
TYLD2 = TYLD_s^t / PCED
\]
where: \( TYLD2 \) = Constant dollar yield  
\( PCED \) = Implicit price deflator for Personal Consumption Expenditures

This served to compare the price of air travel to the prices of all other consumer goods and services. However, with the dramatic effects of the oil embargo and subsequent increases in the price of automobile gasoline, it became apparent that the model must compare air travel prices not only with the prices of other goods and services but must also compare them directly with the price of alternative modes of transportation.

For the domestic market the major competitive mode of transportation is the automobile. In order to incorporate this phenomenon into the models the yield variable was redefined as follows:

\[
TYLD\alpha = \frac{TYLD\$}{\alpha(PCED) + (1-\alpha)GPI}
\]

where:

\( TYLD\alpha \) = A constant dollar yield as deflated by a combination of the Implicit Price Deflator for Personal Consumption Expenditures and the index of Automobile Gasoline Prices

\( TYLD\$ \) = Current dollar yield including taxes paid by the consumer

\( PCED \) = Implicit Price Deflator for Personal Consumption Expenditures \( 1958 = 100 \)

\( GPI \) = Index of Gasoline Prices as published by Platt's Oilgram, \( 1958 = 100 \)

\( \alpha \) = A weighting coefficient for the deflators defined such that \( 0 < \alpha < 1 \)
The inclusion of this variable allows the model to better simulate the inter-modal substitution of air travel from auto than the model as previously specified.

This procedure of deflating the yield variable by the Gas Price Index was not used in the U.S. International model since there is very little substitutability of air for auto in international travel.

The results of the statistical estimation reveal that the elasticity of traffic with respect to real yield is -1.347, i.e., an increase of 1 percent in nominal yield over and above the prevailing rate of inflation, as measured by our corporate price index, will result in a 1.347 percent decrease in traffic.

Quality of Service Variable - Since the beginning of the sample period, air travel has become a more attractive commodity in terms of speed, convenience, safety and the growth of airline route structures. In the attempt to quantify these factors, two variables were examined: the average airborne speed; and the average on-line passenger trip length. On the basis of statistical testing it was decided to include in the models the average on-line passenger trip length. It is important to note that this variable is closely related to the income and substitution effects. As income increases, it would be expected that the average length of the trip would increase. Also the advantages of air travel in
terms of speed, convenience, safety and expanded route structure have been achieved in conjunction with a decreasing cost to the traveler during the sample period when expressed in real terms.

**Dummy Variable** - Another problem stems from the inclusion of the 1970 data. On 1 January 1970, the Civil Aeronautics Board announced a new definition for Domestic and International travel. Although Alaska and Hawaii were granted statehood in 1960, the CAB continued to classify Mainland-Alaska and Mainland-Hawaii traffic as International. The national income accounts such as Gross National Product, began to include Alaska and Hawaii in 1960. Due to the fact the CAB as yet has not published historical data on a 50-state basis there is an inconsistency in the data. This leads to a situation where the series for traffic and the operational variables are available on a 48-state basis including intra-Alaska and intra-Hawaii for 1946-1968, and on a 50-state definition for 1969-1974 and throughout the forecast period. In absence of appropriate series to account for the difference in definition, this inconsistency was rectified on an ad hoc basis by including a dummy variable having values of zero for 1946-1968 and values of one for 1969-1983.

Overall the goodness-of-fit is excellent and the model explains 99.88 percent of the variation in the historical series.
Traffic Forecasts - Using the model, we are currently forecasting a 2.4 percent decline in the U.S. Scheduled Domestic Traffic for 1975, the recovery taking place during the third quarter. For 1976, we forecast a 6.6 percent increase in traffic, as a result of an acceleration of the economic recovery and fare increases lower than inflation. Traffic growth should continue to accelerate in 1977 (growth rate: 8.2%), and then slow down to a growth rate of 6.7 percent in 1978 and 5.4 percent in 1979.
### U.S. Scheduled Domestic Traffic

**Revenue Passenger-Miles**

<table>
<thead>
<tr>
<th>Year</th>
<th>RPM (Billions)</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>104.1</td>
<td>1.4</td>
</tr>
<tr>
<td>1971</td>
<td>106.4</td>
<td>2.2</td>
</tr>
<tr>
<td>1972</td>
<td>118.1</td>
<td>11.0</td>
</tr>
<tr>
<td>1973</td>
<td>126.3</td>
<td>6.9</td>
</tr>
<tr>
<td>1974</td>
<td>129.7</td>
<td>2.7</td>
</tr>
<tr>
<td>1975</td>
<td>126.6</td>
<td>-2.4</td>
</tr>
<tr>
<td>1976</td>
<td>135.0</td>
<td>6.6</td>
</tr>
<tr>
<td>1977</td>
<td>143.0</td>
<td>8.2</td>
</tr>
<tr>
<td>1978</td>
<td>155.3</td>
<td>6.7</td>
</tr>
<tr>
<td>1979</td>
<td>164.2</td>
<td>5.4</td>
</tr>
<tr>
<td>1980</td>
<td>174.9</td>
<td>6.5</td>
</tr>
<tr>
<td>1981</td>
<td>188.7</td>
<td>7.9</td>
</tr>
<tr>
<td>1982</td>
<td>200.4</td>
<td>6.2</td>
</tr>
<tr>
<td>1983</td>
<td>210.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>
AIRLINE LABOR COSTS MODEL

EXOGENOUS VARIABLES

WHARTON INDUSTRY FORECASTING MODEL

AIRLINE TRAFFIC MODEL

EMPLOYMENT FORECASTS

PAYROLL FORECASTS

WAGE-RATE, UNIT LABOR COSTS, LABOR PRODUCTIVITY FORECASTS
U.S. DOMESTIC SCHEDULED SERVICE
PERSONNEL EMPLOYED (1958-1973)

\[
\log_{10} PC + C_{t} = 1.4232 + 0.2341 \log_{10} ASM_{t} + 0.5525 \log_{10} PC + C_{t-1}
\]

\[ (2.2522) \quad (2.3705) \quad (2.8122) \]

\[ R^2 = 0.9713 \quad \text{DURBIN WATSON} = 1.8196 \]
\[ \text{S.E.} = 0.0253 \quad \text{F STATISTIC (2,15)} = 220 \]

WHERE:

\[ PL + CO = \text{NUMBER OF PILOTS AND COPILOTS EMPLOYED} \]
\[ ASM = \text{AVAILABLE SEAT-MILES} \]

(NOTE: \( t \)-VALUES APPEAR IN PARENTHESES BELOW COEFFICIENTS)
U.S. DOMESTIC SCHEDULED SERVICE
PAYROLL (1958-1973)

\[
\text{LOG}_{10} \text{PAY PIL} = -0.0390 + 0.4947 \text{LOG}_{10} \text{PL} + \text{CO} + 1.2012 \text{LOG}_{10} \text{PCED} + 0.5042 \text{LOG}_{10} \text{ASM}
\]

\[
(0.0905) \quad (5.1774) \quad (6.8083) \quad (8.4850)
\]

\[R^2 = 0.9986\]
\[\text{DURBIN WATSON} = 1.8196\]
\[\text{S.E.} = 0.0110\]
\[\text{F STATISTIC (3, 15) = 2847}\]

WHERE:

- \text{PAY PIL} = \text{PAYROLL EXPENSES, PILOTS AND COPILOTS}
- \text{PL + CO} = \text{NUMBER OF PILOTS AND COPILOTS EMPLOYED}
- \text{PCED} = \text{PERSONAL CONSUMPTION EXPENDITURES DEFLATOR}
- \text{ASM} = \text{AVAILABLE SEAT-MILES}

(NOTE: \text{t-VALUES APPEAR IN PARENTHESES BELOW COEFFICIENTS})
WAGES, LABOR PRODUCTIVITY AND UNIT LABOR COST IN THE U.S. AIRLINE INDUSTRY

INDEX
(1960 = 100)

ULC
(¢/ASM)

WAGE RATE

LABOR PRODUCTIVITY

ULC


100 200 300 400 500 600

*LABOR PRODUCTIVITY MEASURED IN ASM PER MAN-YEAR.
**UNIT LABOR COST = AVERAGE LABOR COSTS PER ASM.
AIRLINE LABOR COST SUBMODEL

The Airline Labor Cost Submodel is another block of the Airline Operating Cost Submodel. The function of this block is to forecast employment, the wage rate, the wage bill, labor productivity and unit labor costs by skill category, for seven distinct categories of airline personnel. For each category, for example - pilots and copilots, we have two behavioral equations, one to determine the labor requirements and the other to determine the wage bill. The other variables are derived by simple identities.

The labor requirements equation is based on the idea that the long-term equilibrium labor requirements are a function of the volume of activity in the airline industry, measured in terms of ATI's. We then superimpose a short-term adjustment process to account for the transition from a disequilibrium situation to the long-term equilibrium state.

The wage bill is determined as a function of three variables, the volume of activity in the airline industry (ASM), the number of employees in the given skill category and consumer prices. The results obtained suggest that the elasticity of the wage bill with respect to consumer prices is in the order of 1.2, which means that an increase of 1 percent
in the implicit price deflator for personal consumption expenditures results in a 1.2 percent increase in the total wage bill of pilots and copilots.

Although the hazards of attempting to predict cost changes at a time when economic forecasts are subject to extreme risks are evident, the forecasts do point out some of the problems the airlines will have to face over the next decade. The forecasts were generated using a portion of the Airline Industry Model being developed by the Economic Research Department. In this model, cost determination depends upon output of the industry as measured in ASM's, employment within the industry, interest rates, the personal consumption expenditures deflator, airplane departures, yield per revenue passenger mile, unit labor cost and wages.

The results displayed here reveal that the large increases in labor productivity achieved during the Sixties, as a result of the introduction of jet aircraft, outpaced the increased wage costs. As a result, significant declines in unit labor costs were achieved, i.e., the labor costs per available seat-mile decreased.

In contrast with the Sixties, labor productivity has remained stagnant from 1971 to 1974. The stagnation in labor productivity is due largely to the excess capacity resulting from the combination of a decline in traffic growth rates, significantly below previous airline expectations, with large increases in capacity. During the same period, significant
wage rate increases were obtained as a result of a buildup of inflationary pressures. As a result, large increases in unit costs per seat-mile were experienced.

The dramatic increase in unit labor costs experienced in 1974 was the result of a combination of large wage rate increases with a substantial decrease in available seat miles.

No dramatic increases in labor productivity are anticipated during the forecast period, 1975-1983. The new equipment will be evolutionary in nature, and the rate of introduction of new aircraft types will be slower. These labor productivity gains will be more than offset by increases in the wage rate.

The forecasts show large increases in payroll costs over the next few years as a result of inflationary pressures. With a lessening of these pressures and continuing high employment rates, the increases will subside as we look further into the future. Thus there will be an increase in unit labor cost, expressed as average labor cost per ASM, declining from 9% per year in 1975 to approximately 4% in 1983.

The airlines face a severe cost-price squeeze in view of projected increases in labor, fuel and other costs combined with a decline in long-term traffic growth rates.
AIRCRAFT FUEL COST SUBMODEL

Let us now turn to the Aircraft Fuel Cost Submodel, which is itself a block of the Operating Cost Submodel. Basically, the function of the Aircraft Fuel Cost Submodel is to forecast jet fuel demand and price and to provide an analytical tool to simulate the effects of changes in crude prices and energy policy on the airline industry.

The next viewgraph describes the structure of the block. Given assumptions on the prices of imported and domestic old and new oil together with assumptions on the mix between these three components, one can compute a composite average price for crude oil. We then translate this forecast in terms of the price of distillate fuel, using a behavioral equation in which the price of distillate fuel depends on the average crude price and the relative size of distillate fuel stocks at the refineries, measured in terms of days of consumption.

The next step is to develop a behavioral equation to relate the price of kerosene jet fuel to the price of distillate fuel, allowing for lags. The third behavioral equation pertains to the demand for jet fuel and is somewhat more complex.

Demand for jet fuel depends on Available Ton Miles, which is an activity variable for the airline industry, and a three year distributed lag on the price of jet fuel. In addition, we have included a special feature
in the equation to enable us to simulate the impact of a phasing out of long-term contracts, since the refineries are no longer willing to extend long-term contracts in periods of price instability and uncertainty. The estimation results suggest that the elasticity of jet fuel demand with respect to the volume of activity in the airline industry is \( 1.1 \), i.e., an increase of 1 percent in ATM results in a 1.1 percent increase in demand. A possible interpretation for the fact the elasticity slightly exceeds one is that when ATM's grow particularly fast, the airlines have to use less energy-efficient aircraft to increase their capacity.

The long-term elasticity of the jet fuel demand with respect to prices is \(-0.196\). This means that, ceteris paribus, an increase of 1 percent in the price for jet fuel will eventually result in a 0.196 percent reduction in demand for jet fuel. The impact, however, is distributed over three years, more than 40 percent of the impact begin felt the same year, 32 percent the following year and the remainder, the next year. The result of phasing out long-term contracts would obviously be to reduce the response lag of price increases to less than three years.

We have recently used the model to simulate the impact of energy policy alternatives on jet fuel prices and demand.
Fuel Situation

Although fuel is only one of the cost components in airline operations, the recent escalation of fuel prices coupled with limited availability have placed special emphasis on this issue. While the airlines have adapted to the changed conditions with respect to fuel supply and prices with great managerial skill, the concern for this issue is expected to continue because its future is closely linked with overall energy policy.

More than one and a half years have gone by since the Oil Embargo in October of 1973. The level of petroleum imports — though the U.S. economy is in a recession — is perilously high. In 1975, the nation is expected to require 39 percent of its oil supply from foreign sources with 22 percent provided by the Middle East and Africa. This constitutes a marked increase over 1972, when 29 percent of total supply came from all foreign sources and 10 percent from the Middle East. The trend towards increasing dependence is not expected to be reversed before 1978. Government initiatives to lessen dependence on petroleum imports, to increase domestic supplies and practice conservation are progressing at a very slow rate. Reducing the volume of imports would decrease the vulnerability of the United States in the event of a new embargo as well as mitigate the adverse short and long-run implications of high petroleum import levels on the balance-of-payments. Measures affecting supply are particularly critical because of the inherent lag in developing new sources.
For the purpose of this analysis, the technology of the present generation of aircraft was assumed constant. The relationships developed indicate clearly that demand does respond to variations in price, albeit with some lags.

Four distinct scenarios which appear possible in the light of present information on announced policy measures were examined, and their impact on jet fuel prices and consumption was assessed:

(a) continuation of present status quo, i.e., two-tier pricing system for U.S. domestic crude oil and escalation of the world crude oil price in line with expected price increases for industrial goods which is consistent with OPEC declared price policy.

(b) superimposed upon (a) a gradual decontrol of "old" oil (i.e., that fraction of domestic production which is subject to price controls) over a three and one half year period starting in 1976.

(c) superimposed upon (b) a duty of $2 per barrel on imported petroleum products starting in 1976, as a result of a possible compromise between President Ford's energy program and Congress.

(d) superimposed upon (c) an excise tax of $1 per barrel on all crude, starting in 1978, another interpretation of the ultimate outcome of the dialogue between the Administration and Congress. The intent of this measure would be to dampen the resurgence of demand as additional crude supply from the North Slope come on stream.
Conservation efforts, so far have had only modest results. Measured in terms of overall demand for petroleum products, the reduction for 1974 was only 3.9 percent compared to 1973. Depending upon type of end use, however, there are sizeable differences. While, for example, gasoline demand declined by only 2.2 percent, jet fuel demand for the domestic trunk carriers alone declined by 11.7 percent for the year.

Despite all the uncertainty involved, forecasts of fuel prices and consumption are helpful in understanding the problems faced by the airlines, the aerospace industry and policy makers. Differences in fuel price development will not only affect the airlines’ cash flow and profit position, but also their equipment use and in turn have an impact on equipment design and manufacturing. To assess the effect of alternative government policies, a technique was developed to make predictions on jet fuel price and demand development.

This technique can be briefly described as a simple system of behavioral equations. The price of jet fuel is essentially determined by the price of crude oil. Demand for jet fuel by the domestic passenger cargo carriers has been found to be mainly dependent on the overall level of service planned, measured in terms of available ton miles and the price of jet fuel. For the past, the stabilizing effect of long-term fuel purchasing contracts has been taken into account. These contracts are expected to be phased out.
Figures 1 to 5 illustrate the effect of alternative government policies on the composite price of crude oil, the price of jet fuel, jet fuel consumption and jet fuel cost for total domestic passenger cargo carriers. While a continuation of the status-quo would entail relatively small increases of jet fuel prices in the near term, it would bring relatively large increases in the long term because of domestic crude supply constraints. The cumulative impact of gradual decontrol, an import duty and an excise tax on crude oil, on the other hand, is expected to result in a "price bulge" for jet fuel in the medium term, followed by more moderate price increases towards the end of the forecast period, as additional supplies become available.

By 1978 the gallon price of jet fuel would be ten cents higher in Scenario (d) than in Scenario (a). In absolute terms, this change is almost equivalent to the dramatic change that occurred between 1973 and 1974 as a result of the Oil Embargo. Approximately half of this increases is due to decontrol alone.

As a result of the vigorous growth in traffic and available seat miles experienced by the airline industry in the Sixties, demand for jet fuel increased dramatically from 3 to 8 billion gallons between 1965 and 1970. The introduction of fuel efficient wide-bodied aircraft in the first half of the Seventies halted the growth in fuel consumption, in spite of a substantial increase in Available Seat Miles. In response to the fuel allocation program implemented early in 1974, the airlines achieved substantial fuel savings by curtailing frequencies, grounding or phasing
out fuel-inefficient aircraft and by implementing various fuel-conservation measures.

This large decline in jet fuel demand in 1974 is expected to be followed by virtual stagnation for 1975 and 1976. Several factors contribute to halt growth in jet fuel consumption. Low growth in the level of ATM's, further price increases and availability constraints will continue to prompt conservation through restructuring of fleets, lower speeds and increased load factors. The extent, however, to which these conservation measures can be effective in increasing fuel productivity is limited. Once these short-term adjustments are made, further growth in Available Ton Miles becomes possible, barring technological advances, only with increased fuel consumption.

Considering the long-term development of jet fuel cost presented in Table 4, the large increases expected for 1975 to 1983 are not unprecedented. While the large increases that occurred during the second half of the Sixties, however, were almost entirely due to volume growth, the cost increases during the latter half of the Seventies are strictly attributable to price escalation. The implication of these developments is a sharp increase in fuel costs per seat-mile.
STRUCTURE OF AIRCRAFT FUEL COST SUBMODEL

TRAFFIC SUBMODEL

AVAILABLE SEAT-MILES

AVAILABLE TON-MILES

ENERGY POLICY PRICES' AND SUPPLY FOR

IMPORTED CRUDE OIL

DOMESTIC "OLD" CRUDE OIL

DOMESTIC "NEW" CRUDE OIL

COMPOSITE PRICE OF CRUDE OIL

PRICE OF DISTILLATE FUEL

PRICE OF KEROSENE JET FUEL

DEMAND FOR JET FUEL

FUEL COST

FUEL COST PER ASM
U.S. COMPOSITE PRICE OF CRUDE OIL

\[ PC_t = \sum_{k=1}^{3} \omega_{k,t} \cdot PC_{k,t} \]

WHERE:

- \( PC_t \) = COMPOSITE PRICE OF CRUDE OIL
- \( \omega_{k,t} \) = PERCENTAGE OF CRUDE OIL FROM SOURCE \( k \) OF TOTAL U.S. SUPPLY OF CRUDE OIL
- \( PC_{k,t} \) = PRICE OF CRUDE OIL FROM SOURCE \( k \)
  - \( k=1 \) = DOMESTIC "OLD" OIL
  - \( k=2 \) = DOMESTIC "NEW", RELEASED OIL AND OIL FROM STRIPPER WELLS
  - \( k=3 \) = IMPORTED CRUDE OIL
PRICE OF DISTILLATE FUEL
BEHAVIORAL RELATIONSHIP 1964-1974

\[ \text{PD}_t = 5.3304 + 1.3569 \text{PC}_t - 27.4032 \text{DISTDAYS}_t \]
\[ \text{PD}_t \sim (4.2972) \quad \text{PC}_t \sim (42.7394) \quad \text{DISTDAYS}_t \sim (-4.5360) \]

\[ R^2 = 0.9963 \quad \text{F STATISTIC} (3, 8) = 1080.2546 \]
\[ \text{S.E.} = 0.3459 \quad \text{DURBIN WATSON} = 1.2518 \]

WHERE:
- \( \text{PD}_t \) = PRICE OF DISTILLATE FUEL
- \( \text{PC}_t \) = COMPOSITE U.S. PRICE OF CRUDE OIL
- \( \text{DISTDAYS}_t \) = NUMBER OF DAYS OF INVENTORY FOR DISTILLATE FUEL

WITH:
- \( \text{DISTDAYS} = \frac{\text{DISTST}_{t-1}}{\text{DISTDT}_t} \)

WHERE:
- \( \text{DISTST}_{t-1} \) = STOCK OF DISTILLATE FUEL AT END OF PERIOD \( t-1 \)
- \( \text{DISTDT}_t \) = DISTILLATE DEMAND FOR PERIOD \( t \)
PRICE OF KEROSENE JET FUEL
BEHAVIORAL EQUATION 1964-1974

\[ P_{Jt} = 1.3564 + 0.8976 (0.7P_{Dt} + 0.3 P_{Dt-1}) \]
\[ (3.5046) \quad (28.1769) \]

\[ R^2 = 0.9888 \quad F \text{ STATISTIC (1, 9) = 793.9424} \]
\[ \text{S.E.} = 0.4018 \quad \text{DURBIN WATSON = 1.6442} \]

WHERE:
\[ P_{Jt} = \text{PRICE OF KEROSENE JET FUEL} \]
\[ P_{Dt} = \text{PRICE OF DISTILLATE FUEL} \]
DEMAND FOR KEROSENE JET FUEL FOR SCHEDULED DOMESTIC PASSENGER/CARGO CARRIERS

BEHAVIORAL EQUATION 1962-1974

\[
\log_{10} J_{Dt} = -0.5230 + 1.1029 \log_{10} \text{ATM}_{t} - 0.1961 \log_{10} \sum_{\theta=0}^{2} \omega_{\theta} \delta_{\theta} P_{Jt-\theta} - 0.0529 \log_{10} \text{DUMMY}
\]

(-7.2199) (34.6858) (-2.9995) (-3.4696)

\[ R^2 = 0.9975 \]

\[ \text{S.E.} = 0.0130 \]

\[ \text{F STATISTIC (3, 9) = 1211.0393} \]

\[ \text{DURBIN WATSON} = 1.9097 \]

WHERE:

- \( J_{Dt} \) = DEMAND FOR KEROSENE JET FUEL
- \( \text{ATM}_{t} \) = AVAILABLE TON MILES

\[ \sum_{\theta=0}^{2} \omega_{\theta} \delta_{\theta} P_{Jt-\theta} = \text{CONTRACT PRICE OF KEROSENE JET FUEL WITH} \]

\[ \omega_{0} = 0.4098 \text{ AND FOR 1962-1973} \delta_{0} = \delta_{1} = \delta_{2} = 1.0 \]

\[ \omega_{1} = 0.3279 \text{ FOR 1974} \delta_{0} = \delta_{1} = 1.36 \]

\[ \omega_{2} = 0.2623 \]

\[ P_{Jt} = \text{AVERAGE ANNUAL PRICE OF KEROSENE JET FUEL} \]

\[ \text{DUMMY} = \text{DUMMY VARIABLE FOR CHANGE IN TERRITORIAL DEFINITION} \]

(0 FOR 1962-1969, 1 FOR 1969-1974)
U.S. COMPOSITE PRICE OF CRUDE OIL

$/BARREL

TIME

- SCENARIO (a)
- SCENARIO (b)
- SCENARIO (c)
- SCENARIO (d)
PRICE OF KEROSENE JET FUEL

CENTS/GALLON

TIME

SCENARIO (d)
SCENARIO (c)
SCENARIO (b)
SCENARIO (a)
### COMPOSITE PRICE OF CRUDE OIL ($/BARREL)

<table>
<thead>
<tr>
<th>Year</th>
<th>SCENARIO A</th>
<th>%</th>
<th>SCENARIO B</th>
<th>%</th>
<th>SCENARIO C</th>
<th>%</th>
<th>SCENARIO D</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>10.53</td>
<td>4.1</td>
<td>11.83</td>
<td>9.4</td>
<td>12.52</td>
<td>9.0</td>
<td>13.52</td>
<td>17.7</td>
</tr>
<tr>
<td>1978</td>
<td>11.24</td>
<td>6.7</td>
<td>13.07</td>
<td>10.5</td>
<td>14.09</td>
<td>12.5</td>
<td>15.09</td>
<td>11.6</td>
</tr>
<tr>
<td>1979</td>
<td>11.90</td>
<td>5.9</td>
<td>14.12</td>
<td>8.0</td>
<td>14.77</td>
<td>4.8</td>
<td>15.77</td>
<td>4.5</td>
</tr>
<tr>
<td>1980</td>
<td>12.35</td>
<td>3.8</td>
<td>14.54</td>
<td>3.0</td>
<td>15.18</td>
<td>2.8</td>
<td>16.18</td>
<td>2.6</td>
</tr>
<tr>
<td>1981</td>
<td>12.84</td>
<td>4.0</td>
<td>14.84</td>
<td>2.0</td>
<td>15.46</td>
<td>1.8</td>
<td>16.35</td>
<td>1.1</td>
</tr>
<tr>
<td>1982</td>
<td>13.34</td>
<td>4.0</td>
<td>15.22</td>
<td>2.6</td>
<td>15.72</td>
<td>1.7</td>
<td>16.72</td>
<td>2.3</td>
</tr>
<tr>
<td>1983</td>
<td>13.85</td>
<td>3.8</td>
<td>15.42</td>
<td>1.3</td>
<td>15.97</td>
<td>1.7</td>
<td>16.97</td>
<td>1.5</td>
</tr>
</tbody>
</table>

### TABLE 1

<table>
<thead>
<tr>
<th>Year</th>
<th>SCENARIO A</th>
<th>%</th>
<th>SCENARIO B</th>
<th>%</th>
<th>SCENARIO C</th>
<th>%</th>
<th>SCENARIO D</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>10.53</td>
<td>4.1</td>
<td>11.83</td>
<td>9.4</td>
<td>12.52</td>
<td>9.0</td>
<td>13.52</td>
<td>17.7</td>
</tr>
<tr>
<td>1978</td>
<td>11.24</td>
<td>6.7</td>
<td>13.07</td>
<td>10.5</td>
<td>14.09</td>
<td>12.5</td>
<td>15.09</td>
<td>11.6</td>
</tr>
<tr>
<td>1979</td>
<td>11.90</td>
<td>5.9</td>
<td>14.12</td>
<td>8.0</td>
<td>14.77</td>
<td>4.8</td>
<td>15.77</td>
<td>4.5</td>
</tr>
<tr>
<td>1980</td>
<td>12.35</td>
<td>3.8</td>
<td>14.54</td>
<td>3.0</td>
<td>15.18</td>
<td>2.8</td>
<td>16.18</td>
<td>2.6</td>
</tr>
<tr>
<td>1981</td>
<td>12.84</td>
<td>4.0</td>
<td>14.84</td>
<td>2.0</td>
<td>15.46</td>
<td>1.8</td>
<td>16.35</td>
<td>1.1</td>
</tr>
<tr>
<td>1982</td>
<td>13.34</td>
<td>4.0</td>
<td>15.22</td>
<td>2.6</td>
<td>15.72</td>
<td>1.7</td>
<td>16.72</td>
<td>2.3</td>
</tr>
<tr>
<td>1983</td>
<td>13.85</td>
<td>3.8</td>
<td>15.42</td>
<td>1.3</td>
<td>15.97</td>
<td>1.7</td>
<td>16.97</td>
<td>1.5</td>
</tr>
</tbody>
</table>

### PRICE OF JET FUEL ($/GALLON)

<table>
<thead>
<tr>
<th>Year</th>
<th>SCENARIO A</th>
<th>%</th>
<th>SCENARIO B</th>
<th>%</th>
<th>SCENARIO C</th>
<th>%</th>
<th>SCENARIO D</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>27.71</td>
<td>25.8</td>
<td>27.71</td>
<td>25.8</td>
<td>27.71</td>
<td>25.8</td>
<td>27.71</td>
<td>25.8</td>
</tr>
<tr>
<td>1976</td>
<td>29.84</td>
<td>7.7</td>
<td>31.24</td>
<td>12.7</td>
<td>32.64</td>
<td>17.8</td>
<td>32.64</td>
<td>17.8</td>
</tr>
<tr>
<td>1977</td>
<td>30.99</td>
<td>3.9</td>
<td>34.22</td>
<td>9.6</td>
<td>36.24</td>
<td>11.0</td>
<td>36.24</td>
<td>11.0</td>
</tr>
<tr>
<td>1978</td>
<td>32.53</td>
<td>5.0</td>
<td>37.37</td>
<td>9.2</td>
<td>40.06</td>
<td>10.6</td>
<td>42.96</td>
<td>12.3</td>
</tr>
<tr>
<td>1979</td>
<td>34.42</td>
<td>5.8</td>
<td>40.52</td>
<td>8.4</td>
<td>42.72</td>
<td>6.5</td>
<td>45.63</td>
<td>6.2</td>
</tr>
<tr>
<td>1980</td>
<td>35.92</td>
<td>4.4</td>
<td>42.30</td>
<td>4.4</td>
<td>44.15</td>
<td>3.3</td>
<td>47.05</td>
<td>3.1</td>
</tr>
<tr>
<td>1981</td>
<td>37.30</td>
<td>3.9</td>
<td>43.26</td>
<td>2.3</td>
<td>45.08</td>
<td>2.1</td>
<td>47.76</td>
<td>1.5</td>
</tr>
<tr>
<td>1982</td>
<td>38.75</td>
<td>3.9</td>
<td>44.29</td>
<td>2.4</td>
<td>45.84</td>
<td>1.7</td>
<td>48.52</td>
<td>1.6</td>
</tr>
<tr>
<td>1983</td>
<td>40.21</td>
<td>3.8</td>
<td>45.03</td>
<td>1.7</td>
<td>46.58</td>
<td>1.6</td>
<td>49.33</td>
<td>1.7</td>
</tr>
</tbody>
</table>
BILLIONS OF GALLONS

JET FUEL CONSUMPTION
BY DOMESTIC PASSENGER/CARGO CARRIERS

SCENARIO (a)
SCENARIO (b)
SCENARIO (c)
SCENARIO (d)

TIME
### JET FUEL DEMAND (BILLIONS OF GALLONS)

<table>
<thead>
<tr>
<th>Actuals</th>
<th>1962</th>
<th>2.047</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1963</td>
<td>2.342</td>
</tr>
<tr>
<td></td>
<td>1964</td>
<td>2.722</td>
</tr>
<tr>
<td></td>
<td>1965</td>
<td>3.368</td>
</tr>
<tr>
<td></td>
<td>1966</td>
<td>3.993</td>
</tr>
<tr>
<td></td>
<td>1967</td>
<td>5.325</td>
</tr>
<tr>
<td></td>
<td>1968</td>
<td>6.455</td>
</tr>
<tr>
<td></td>
<td>1969</td>
<td>7.885</td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>7.783</td>
</tr>
<tr>
<td></td>
<td>1971</td>
<td>7.728</td>
</tr>
<tr>
<td></td>
<td>1972</td>
<td>7.886</td>
</tr>
<tr>
<td></td>
<td>1973</td>
<td>8.241</td>
</tr>
<tr>
<td></td>
<td>1974</td>
<td>7.721</td>
</tr>
</tbody>
</table>

### Forecasts

<table>
<thead>
<tr>
<th>Scenario A</th>
<th>%</th>
<th>Scenario B</th>
<th>%</th>
<th>Scenario C</th>
<th>%</th>
<th>Scenario D</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>7.913</td>
<td>2.5</td>
<td>7.913</td>
<td>2.5</td>
<td>7.913</td>
<td>2.5</td>
<td>7.913</td>
</tr>
<tr>
<td>1976</td>
<td>7.919</td>
<td>0.1</td>
<td>7.849</td>
<td>-.8</td>
<td>7.782</td>
<td>-1.7</td>
<td>7.782</td>
</tr>
<tr>
<td>1977</td>
<td>8.367</td>
<td>5.7</td>
<td>8.207</td>
<td>4.6</td>
<td>8.116</td>
<td>4.3</td>
<td>8.030</td>
</tr>
<tr>
<td>1978</td>
<td>8.836</td>
<td>5.6</td>
<td>8.600</td>
<td>4.8</td>
<td>8.483</td>
<td>4.5</td>
<td>8.368</td>
</tr>
<tr>
<td>1979</td>
<td>9.000</td>
<td>1.9</td>
<td>8.718</td>
<td>1.4</td>
<td>8.627</td>
<td>1.7</td>
<td>8.571</td>
</tr>
<tr>
<td>1981</td>
<td>10.382</td>
<td>7.2</td>
<td>10.037</td>
<td>7.5</td>
<td>10.005</td>
<td>7.5</td>
<td>9.892</td>
</tr>
<tr>
<td>1982</td>
<td>11.041</td>
<td>6.3</td>
<td>10.757</td>
<td>6.6</td>
<td>10.684</td>
<td>6.8</td>
<td>10.566</td>
</tr>
<tr>
<td>1983</td>
<td>11.594</td>
<td>5.0</td>
<td>11.342</td>
<td>5.4</td>
<td>11.267</td>
<td>5.5</td>
<td>11.140</td>
</tr>
</tbody>
</table>
JET FUEL COST AND CHANGE*
FOR DOMESTIC PASSENGER/CARGO CARRIERS

*FORECAST CORRESPONDS TO SCENARIO (d).
# JET FUEL COST
(BILLIONS OF DOLLARS)

### ACTUALS

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario A</th>
<th>Scenario B</th>
<th>Scenario C</th>
<th>Scenario D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>.265</td>
<td>.323</td>
<td>.383</td>
<td>.517</td>
</tr>
<tr>
<td>1965</td>
<td>.323</td>
<td>.403</td>
<td>.468</td>
<td>.645</td>
</tr>
<tr>
<td>1966</td>
<td>.383</td>
<td>.486</td>
<td>.555</td>
<td>.829</td>
</tr>
<tr>
<td>1967</td>
<td>.517</td>
<td>.699</td>
<td>.767</td>
<td>1.047</td>
</tr>
<tr>
<td>1968</td>
<td>.645</td>
<td>.879</td>
<td>.948</td>
<td>1.701</td>
</tr>
<tr>
<td>1969</td>
<td>.829</td>
<td>1.081</td>
<td>1.163</td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>.856</td>
<td>1.114</td>
<td>1.201</td>
<td></td>
</tr>
<tr>
<td>1971</td>
<td>.904</td>
<td>1.201</td>
<td>1.302</td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>.969</td>
<td>1.286</td>
<td>1.394</td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td>1.047</td>
<td>1.372</td>
<td>1.479</td>
<td></td>
</tr>
<tr>
<td>1974</td>
<td>1.701</td>
<td>2.193</td>
<td>2.363</td>
<td>2.593</td>
</tr>
</tbody>
</table>

### FORECASTS

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario A</th>
<th>Scenario B</th>
<th>Scenario C</th>
<th>Scenario D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>2.193</td>
<td>2.452</td>
<td>2.193</td>
<td>2.193</td>
</tr>
<tr>
<td>1976</td>
<td>2.363</td>
<td>2.808</td>
<td>2.540</td>
<td>2.540</td>
</tr>
<tr>
<td>1977</td>
<td>2.593</td>
<td>3.214</td>
<td>2.941</td>
<td>3.072</td>
</tr>
<tr>
<td>1978</td>
<td>2.874</td>
<td>3.685</td>
<td>3.398</td>
<td>3.595</td>
</tr>
<tr>
<td>1982</td>
<td>4.278</td>
<td>5.248</td>
<td>4.898</td>
<td>5.127</td>
</tr>
<tr>
<td>1983</td>
<td>4.662</td>
<td>5.495</td>
<td>5.248</td>
<td>5.495</td>
</tr>
</tbody>
</table>
JET FUEL COST PER SEAT MILE
FOR DOMESTIC PASSENGER/CARGO CARRIERS
(CENTS/MILE)
**JET FUEL COST PER AVAILABLE SEAT MILE**

\((\$ / \text{MILE})\)

### ACTUALS

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>.329</td>
</tr>
<tr>
<td>1965</td>
<td>.341</td>
</tr>
<tr>
<td>1966</td>
<td>.366</td>
</tr>
<tr>
<td>1967</td>
<td>.387</td>
</tr>
<tr>
<td>1968</td>
<td>.387</td>
</tr>
<tr>
<td>1969</td>
<td>.402</td>
</tr>
<tr>
<td>1970</td>
<td>.402</td>
</tr>
<tr>
<td>1971</td>
<td>.408</td>
</tr>
<tr>
<td>1972</td>
<td>.428</td>
</tr>
<tr>
<td>1973</td>
<td>.428</td>
</tr>
<tr>
<td>1974*</td>
<td>.708</td>
</tr>
</tbody>
</table>

### FORECASTS

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario A</th>
<th>Scenario B</th>
<th>Scenario C</th>
<th>Scenario D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>.885</td>
<td>.885</td>
<td>.885</td>
<td>.885</td>
</tr>
<tr>
<td>1976</td>
<td>6.2</td>
<td>10.2</td>
<td>14.1</td>
<td>14.1</td>
</tr>
<tr>
<td>1977</td>
<td>3.9</td>
<td>8.5</td>
<td>9.7</td>
<td>14.6</td>
</tr>
<tr>
<td>1978</td>
<td>4.8</td>
<td>8.2</td>
<td>9.2</td>
<td>10.6</td>
</tr>
<tr>
<td>1979</td>
<td>4.7</td>
<td>6.7</td>
<td>5.4</td>
<td>5.0</td>
</tr>
<tr>
<td>1980</td>
<td>4.9</td>
<td>4.9</td>
<td>4.1</td>
<td>3.9</td>
</tr>
<tr>
<td>1981</td>
<td>4.0</td>
<td>2.9</td>
<td>2.7</td>
<td>2.1</td>
</tr>
<tr>
<td>1982</td>
<td>4.1</td>
<td>2.7</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>1983</td>
<td>3.8</td>
<td>2.1</td>
<td>2.0</td>
<td>2.1</td>
</tr>
<tr>
<td>Year</td>
<td>ASM (Billions)</td>
<td>%</td>
<td>ATM (Billions)</td>
<td>%</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>------</td>
<td>----------------</td>
<td>------</td>
</tr>
<tr>
<td>1974</td>
<td>233.878</td>
<td>-4.42</td>
<td>34.852</td>
<td>-4.83</td>
</tr>
<tr>
<td>1975</td>
<td>247.812</td>
<td>5.96</td>
<td>37.010</td>
<td>6.19</td>
</tr>
<tr>
<td>1976</td>
<td>251.372</td>
<td>1.44</td>
<td>37.563</td>
<td>1.50</td>
</tr>
<tr>
<td>1977</td>
<td>265.507</td>
<td>5.62</td>
<td>39.756</td>
<td>5.84</td>
</tr>
<tr>
<td>1978</td>
<td>280.789</td>
<td>5.75</td>
<td>42.131</td>
<td>5.97</td>
</tr>
<tr>
<td>1979</td>
<td>288.123</td>
<td>2.61</td>
<td>43.273</td>
<td>2.71</td>
</tr>
<tr>
<td>1980</td>
<td>309.510</td>
<td>7.42</td>
<td>46.610</td>
<td>7.71</td>
</tr>
<tr>
<td>1981</td>
<td>330.982</td>
<td>6.94</td>
<td>49.971</td>
<td>7.21</td>
</tr>
<tr>
<td>1982</td>
<td>351.539</td>
<td>6.21</td>
<td>53.195</td>
<td>6.45</td>
</tr>
<tr>
<td>1983</td>
<td>369.232</td>
<td>5.03</td>
<td>55.974</td>
<td>5.23</td>
</tr>
</tbody>
</table>
CONCLUSIONS

It is rather obvious from the previous analysis that deregulation of old oil, even if it is gradual would exert deleterious effects on the profitability of the airline industry, by dramatically increasing fuel costs, at a moment when traffic is barely recovering from a recession and other costs are still escalating at a high rate. Even if the jet fuel cost increases were to be fully passed on to the customer in the form of fare increases, it would have negative effects on the airlines profitability by depressing traffic growth.

Evidently, deregulation of old oil would have an even more disastrous impact on the profitability of the airline industry, if, for lack of a compromise between Congress and the Administration, deregulation were to be implemented at once. Consequently, I feel that it is most important that the Administration would be informed on the consequences of its oil policy or this important industry, let alone the inflationary pressures deregulation would impose on other segments of the economy.

Another conclusion that can be drawn from this presentation, is that an econometric model of the U.S. Airline Industry such as the one outlined here would constitute a powerful tool to analyze the full repercussions of changes either in the economic environment or in policy, and to forecast the outlook for our industry.
You have mentioned that you have also developed traffic forecasting models for individual airlines. Could you comment on the model specification you used?

Yes, indeed, we have constructed traffic forecasting models for each U.S. domestic trunk carrier. The methodology and the model specification used are basically the same, with one qualification: when we deal with individual carriers, we have to incorporate a variable characterizing the relative share of Available Seat Miles offered by the given airline relative to the ASM's provided by all airlines. This variable is usually quite significant and is especially useful to characterize the effect of strikes, either the airline's strikes or competitors' strikes.

What about foreign international carriers? Have you done any econometric modelling for them?

Yes, we have done a fair amount of work for several of our foreign airline customers at their request, at various levels of disaggregation (Total System, by regional subsystem or even by country-pair). Generally speaking we have to construct a composite income variable, which characterizes not only the
economy of the airline's country, but also the economies involved in the network. We construct a weighted average of real GNP's, the set of weights being proportional to the relative importance of each country in generating travelers on the network. In addition, we deflate yield by a composite GNP deflator which is adjusted for exchange rate variations, so that we are in a position to simulate the impact of currency realignment on the airline's traffic.

**QUESTION:** (Paul Brestyanszky, I. P. Sharp, Inc.) - I wonder to which extent the price elasticity of the jet fuel demand is constant?

**YVES G. AUREILLE:** Obviously, our model of jet fuel demand is still preliminary and provides us just with an estimate of the average price elasticity of jet fuel demand over the sample period. In the real world, the reactions of airlines to jet fuel price changes relative to other factor inputs and output prices are quite complex. In the first place, it is likely that airlines don't react at all to small changes in relative input prices; in other terms, there is probably a threshold effect. Secondly, if relative jet fuel price changes are large enough to induce reactions on the part of the airline, these reactions are likely to be quite complex. Airlines can make once-for-all changes in their flight pattern policy to minimize jet fuel consumed, if there are constraints on the quantity of jet fuel they can buy. They can
also minimize jet fuel costs as opposed to total direct operating costs. Further, they can in the short-term, change the utilization of the various aircraft types existing in the fleet, by increasing the utilization of more fuel-efficient aircraft, and by reducing frequencies. In the longer term of course, they can modify the fleet mix itself, by phasing-out fuel-inefficient aircraft and gearing their investment programs toward fuel-efficient airplanes. Perhaps more important in achieving substantial jet fuel savings, is the policy of the regulatory body regarding frequency reductions on a mass scale. We are planning to incorporate some of the facts of life in our model, but this will involve a substantial amount of disaggregation and the explicit incorporation of engineering wisdom and changes in institutional factors. Another problem stems from the fact that the dramatic change in jet fuel prices which took place last year has been very unique during the sample period. Furthermore, the frequency reductions which took place concomitantly somewhat muddy the water, so that we don't have enough degrees-of-freedom with our annual data to properly separate the specific effects of each factor. All this to say that the price elasticity estimates are just averages and that considerable refinements in modelling jet fuel demand are required. I should add that to obtain the full repercussions of jet price increases, one should solve the Airline Industry Model simultaneously, to get all the proper feedback effects. On a system-wide basis, most of the long-term elasticity with
respect to jet fuel prices, will stem from the investment equation, rather than the fuel demand equation. This is why the fuel demand equation has only a 3 year distributed lag on prices.
There is an old saying to the effect that the man who says he is the master of his own house will lie about other things too. I tend to view in the same vein the forecaster who says he can produce an accurate long range air traffic forecast. As we can observe from the current economic turmoil even a record of good past accuracy does not give high confidence in future forecasts. The question is not whether a forecast is right or wrong; instead, it is how wrong the forecast likely to be.

In spite of all the grossly inaccurate forecasts of the past couple years, forecasting is getting more management attention than ever before. This is due to the recognition of the need for better planning - especially in an economic downturn - and the realization that there is no viable alternative to forecasts.

At General Electric, as in many other corporations, we have learned to compensate for the inaccuracies of the forecasts. Instead of accepting a single forecast as the gospel, we prepare alternate forecasts reflecting the uncertainties of the business. Our business plans are typically based on the best estimate forecast; however, contingency plans are prepared for the alternate forecasts. Another practice is to continually monitor the relevant economic variables and frequently update the forecasts to take into consideration new developments. Lastly, we have an ongoing program to continually strive to improve our forecasting tools.

The subject of improving forecasting tools for better planning is of great interest to me; therefore, I welcome this opportunity to touch on some of the specific problems we face and to hear some of the problems faced by others.
Hopefully in these discussions existing forecasting tools will be identified of which I am not aware, or others may recognize our problems to be of sufficiently general interest that future research at universities and elsewhere directed toward finding solutions to these problems may be warranted.

Before discussing some of our problem areas in forecasting, let me give you a brief description of the importance and role of forecasting in the commercial jet engine business of the General Electric Company.

The nature of our product, the jet engine, demands long range planning. It costs in the neighborhood of half a billion dollars and takes from 5 to 10 years to develop a new jet engine from the concept stage to commercial service. As you can well appreciate, an error in determining the potential market for a given engine can have very grave consequences in our business. Obviously, the minimizing or avoidance of such costly errors is a necessity. For this reason, forecasting is recognized in General Electric as one of the major elements of our business.

Our market forecasting effort has four basic objectives:

1. To identify product market opportunities.
2. To estimate the size of the potential markets.
3. To project the share of the market available to GE.
4. To identify prospective customers for our engines.

These objectives are intended to support management in its decision making processes, finance in its profit planning, engineering in its preliminary design efforts and sales in its marketing efforts. How well we achieve these objectives determines how successful our business will be.

Our business is rather unique in that we are three steps removed from determining demand for our product. The principal customers for jet engines are the aircraft manufacturers who sell their product to the airlines.
The airlines, in turn, sell aircraft seats to the traveling public. Thus, our ultimate market is dependent not on our principal customers or even their customers, but on the air traveler. For these reasons the key to our future plans is the forecast of air traffic. However, since one of our objectives is to identify sales opportunities to specific airlines, our forecasts have to go into considerable market segment detail.

Considering the United States as a market segment, forecasting U.S. traffic is quite straightforward. Airline traffic statistics, historic economic variables and economic forecasts are readily available from which statistically determined mathematical equations can be developed to forecast traffic as a function of fluctuations in the economy. The forecasts for the traffic of specific airlines and other market segments presents a greater challenge necessitating the application of trend analysis, market share analysis and a liberal sprinkling of judgement.

Once the traffic is forecast for an individual airline, the next step is to identify the current fleet of the airline, the delivery schedule of any additional aircraft on order, and the retirement schedule for the existing aircraft. Multiplying this fleet by the productivity of each aircraft type produces the traffic carrying capability of the fleet. Comparing the fleet capacity to the annual traffic forecast for the airline determines new capacity requirements. The type of aircraft required to satisfy the additional capacity requirements is determined by analysis of the airline's route structure. The productivity of the new aircraft required determines the quantity and approximate timing of needed deliveries.

This type of individual airline analysis is conducted for the principal airlines of the world which account for about 85% of total commercial traffic. By applying some rather gross assumptions for the 15% balance of the world traffic not analyzed by individual airline, a reasonable approximation of the total world market as well as individual airline requirements can be made. An alternate "top down" approach is used
as a reasonability check on our results but I'll not go into that here.

With this brief description of one of our methods of forecasting aircraft requirements as a background, I would like to present three areas in our analytical procedure for which we could use sharper forecasting tools. These areas are:

1. Econometric forecasts of non-U.S. market segments.
2. Forecasts of traffic between regions.
3. Forecasts of aircraft retirements.

Econometric models have both advocates and detractors. Both have valid arguments in favor and against the use of these models for forecasting purposes. We recognize that models have their limitations, but feel that they have the valuable capacity to identify and quantify mathematically, relationships between dependent and independent variables which do help to explain movements in the dependent variables. Obviously, such econometric models are only as good as the forecasts of independent variables on which they are based. It must also be recognized that the use of such models does not relieve the forecaster of his responsibility to produce a good forecast. The model itself is only one of the tools available. It is up to the forecaster to decide which tool to use and how much weight to assign to the product of that tool.

As I previously mentioned, for the United States traffic segment we have reasonably good historic data on air traffic and economic variables. Also available for the United States are forecasts of economic variables provided by several reputable universities and firms, including the General Electric MAPCAST Service. These economic forecasts are similar in that they do not have a proven record of accuracy. They are, however, generally accepted as the best that can be done with the present state of the art and are therefore useful as a basic air traffic forecasting tool.
For the rest of the world's market segments we have had rather limited success in finding reliable and timely data. Furthermore, we find that in general, econometric relationships developed for the United States market do not apply to other economies of the world.

Since the traffic segments outside the United States represent over half of the world traffic and show greater growth potential than the maturing domestic markets, it becomes imperative to our business to develop a good understanding of the key economic relationships in these market segments, such that we may better serve these markets by correctly anticipating their engine requirements.

We recognize three areas of weakness in developing econometric forecasts for non-U.S. market segments in which further research is warranted. These are:

1. Determination of the key economic variables which provide the causal basis of air traffic for the various regions of the world for use in our own forecasting research efforts.

2. Identification where possible of those economic forecasting firms located in the various world regions which have a reputation for reliable forecasts in order to obtain expertise on local economies with which we are not familiar.

3. Development of economic forecasts for those regions of the world where reliable prognostications are not currently available.

These are areas in which we are devoting considerable effort. Any further enlightenment gained through the research efforts of others would be most welcome.

The second forecasting tool we would like to see developed for practical application is a technique for forecasting traffic between regions. For the U.S. market segment it can be readily observed that different airlines show different growth rates for the same time periods.
Certainly changes in route structures account for part of the shift in airline market shares. There remains, however, a growth differential yet to be explained. Some of this can be attributed to management actions, such as increased marketing emphasis on specific markets. When viewed over time, however, it appears that to a large degree the variations in growth rates may be attributable to regional economic factors influencing the traffic of the airlines providing service between the regions. Thus, a reliable tool for forecasting traffic between regions could provide a better basis for forecasting the aircraft requirements of individual airlines serving these markets.

Efforts have been made to solve the problem of forecasting traffic between two geographic areas by many analysts using a variety of techniques. The most intuitively appealing approach to forecasting traffic between regions that I have found is the use of gravity models.

Newton's law of gravity states that the force between two bodies is proportional to the product of the mass of each body and inversely proportional to the square of the distance between the bodies. By substituting traffic for the force between two bodies or regions and defining the mass of each region by population or some other common economic measure of each region, one can adopt the gravity model for use in traffic forecasting. In theory the approach might be used to forecast traffic between city pairs, between geographic regions of the United States, between countries and between continents. Unfortunately, we have had little practical success with this approach. A primary difficulty has been the lack of adequate historic data by region and the non-existence of reliable forecasts of regional data.
The third forecasting area in which we have a strong need for improvement is in predicting the retirement of aircraft from an airline's fleet. In our approach to forecasting the market for new aircraft and engines, the retirement schedule for aircraft in service is very critical. The airlines are in an enviable position in that they really do not need to commit themselves to aircraft retirements or new purchases very far in advance. However, the success of failure of costly development programs requiring 5 to 10 year lead times are very sensitive to aircraft retirement forecasts.

In aircraft retirement forecasting, two approaches warrant further exploration. One approach is to develop an empirical model based on demonstrated experience of historic aircraft retirements by airlines. The second approach is to develop a model which would take into consideration factors such as operating costs, structural fatigue, marketing obsolescence and the cost of replacement aircraft to determine an optimum time to retire an aircraft.

The first approach merits attention because of the similarities of the present outlook with the past. The outlook for traffic growth in 1960 and 1961 was not unlike that of today. As today, a new generation of aircraft and engines were being introduced in that period. Of course many factors are different today. Energy prices and availability were not a constraint on planning in the early sixties. The appeal of wide-body jets over narrow-body jets is not as big an advantage as was the appeal of the first jets over the propeller airplanes.

The second approach is an attempt to identify the causal factors and duplicate the logic exercised in airline fleet retirement decisions. This approach has the advantage of recognizing emerging environmental factors and defining the logic with which to evaluate these factors. The problem here lies in our ability to forecast the key factors and predict the weights to be associated with the emerging influencing factors.
In summary there are many areas where opportunities exist for the thoughtful researcher to make a contribution to the field of demand analysis and forecasting. The three areas that are particularly troublesome for us are:

1. Forecasting traffic of non-U.S. market segments.
2. Forecasting the volume of air traffic between regions or cities.
3. Forecasting aircraft retirements.

These are areas of substantial need and your help in satisfying these needs would be most welcome. Thank you for this opportunity to discuss this subject.
AIR TRANSPORTATION

DIRECTIONS FOR FUTURE RESEARCH

JUNE 4, 1975

by Mr. N. George Avram

PRATT & WHITNEY AIRCRAFT
A survey recently conducted by Bruskin Associates found that people have a very favorable opinion of the forecasting accuracy of:

Sportswriters
Sports Announcers
Weathermen
WHO GOT THE LOW MARKS?
STOCK BROKERS
ASTROLOGERS
ECONOMISTS
SINCE ECONOMICS IS THE CORNERSTONE OF OUR UNDERSTANDING OF THE PRESENT AND THE FUTURE . . . WE GOT A LOT OF WORK TO DO!
CHANGES IN AIR TRANSPORTATION ENVIRONMENT

- RAPID MOVEMENT TOWARD FULL MATURITY
- GROWING IMPORTANCE OF THE NON-U.S. SYSTEM
- GREATER INTERDEPENDENCE OF WORLD ECONOMY
- WIDER DISTRIBUTION OF WEALTH
- CHANGES IN REGULATION, COMPETITION & SUBSIDY
- CHANGING AIR TRAVELER PROFILES
- SLOWDOWN IN TECHNOLOGICAL ADVANCES
PRIMARY IMPACT OF CHANGED ENVIRONMENT

- More sophisticated methodology and larger, more reliable and more timely data bases to evaluate world markets.
- More passenger oriented methodology — less theoretical and more empirical in nature.
- Shifting in weights of demand parameters.
- Operators becoming increasingly profit oriented, thereby changing system operational characteristics and equipment selection criteria.
CURRENT STATUS

- MANY UNKNOWNS AND DEFICIENCIES IN OUR UNDERSTANDING OF THE FUNCTIONS AND REQUIREMENTS OF THE SYSTEM.
- ALMOST TOTAL IGNORANCE OF SYSTEM DYNAMICS IN EITHER THE GROWTH OR MATURITY STAGE.
- THE FUTURE INCREASINGLY HOLDS MORE PROBLEMS THAN PROMISE.
OR

- OUR UNDERSTANDING OF STEADY STATE CONDITIONS IS INADEQUATE.
- OUR UNDERSTANDING OF TRANSIENTS IS NIL.
- AND THE PROGNOSIS IS IN DOUBT
  BUT OTHERWISE . . .
  EVERYTHING IS FINE
PROBLEM AREAS

- THE TRAVELER
- THE AIR CARRIER
- THE MANUFACTURER
- THE GOVERNMENT
- TRAVELER SUPPORT
- CARRIER SUPPORT
QUESTIONS THAT BUG US THE MOST
TRAVELERS

- Why are most surveys proprietary, and all leave something to be desired?
- Would a master plan for surveys help?
- How can we acquire statistics on all aspects of the traveler?
- Why neglect the foreign traveler? U.S. traveler is critical to breaking even in many markets.
- How does the traveler perceive destination homogenization?
- Is any given pleasure trip the first choice or the nth choice?
- How does price elasticity change with trip length?
- Communications and travel have been complementary up to now — will they ever substitute for each other?
CARRIERS

- How to predict basic future needs? How to evaluate a non-optimizing problem?
- What are the criteria of evaluation, and how much do intangibles contribute?
- What are market shares, and how does this portend the future?
- How can utilization and load factor be made controllable cost factors?
- What should constrain routing and scheduling, and what should be maximized?
- How do you trade off seats, range, speed and comfort? Then against aircraft flexibility?
- How much does frequency influence demand and market share?
MANUFACTURERS

- HOW DO THEY GET ACROSS THE MESSAGE THAT THEY ARE PRIMARILY IN THE EXPORT BUSINESS?

- HOW TO DEMONSTRATE INVESTMENT REQUIREMENTS AND DEGREE OF RISK TO SATISFY REQUIREMENTS FOR FUNDING SUPPORT?

- HOW SHOULD ANTITRUST LAWS BE RESET TO MEET TODAY'S SITUATION FOR PUBLIC GOOD? WHEN IS COMPETITION DOMESTIC AND WHEN INTERNATIONAL?

- FOR AN INDUSTRY IN TRANSITION FROM GROWTH TO MATURITY, HOW TO EASE THE SHOCK FOR ALL IN THE OPERATING ENVIRONMENT?

- TECHNOLOGY IS RISK ... NEW VENTURES WILL BE FEWER BUT LARGER ... AND MISTAKES COSTLIER ... WHITHER THE FUNDS?

- WHERE WILL WE GET OUR CHROMIUM, COBALT, COLUMBIUM, MANGANESE, NICKEL AND TITANIUM? OR SUBSTITUTES?
GOVERNMENT

- Since government policy and international agreements are reactive, not innovative, and since we don't understand incentives operative in government, how to predict response to stimuli?

- What is required to coordinate government policy? Can it be accomplished?

- When and how much does government constrain growth? When is growth good, and when is it bad?

- When does government's desire to promote competition conflict with its role and mission?

- When commercial aviation consumes less than 3% of energy and contributes less than 1% to pollution, how should cost-benefit decisions be structured for regulatory legislation?
TRAVELER SUPPORT

- Is there demand elasticity for destination?
- When does tourist pollution become important?
- Have travel agents adequately exploited their service capability?
- What are the pros and cons of regulating hotel capacity in some markets?
- Should another look be taken at integrated air and ground transportation?
- What are the least resource-effective aspects of traveler support? Can they be improved?
- Which services are most vulnerable to maturity? How will this impact demand?
- Is more industry planning possible or desirable?
CARRIER SUPPORT

* WHERE DO AIRPORTS COME FROM? WILL WE EVER BE ABLE TO ESTABLISH POLICY IN MATTERS INVOLVING THE COMMON GOOD?

* HOW COME WE ENACT POLLUTION LEGISLATION WHERE WE THINK WE KNOW PAYOFF BUT NOT COST, AND PASS UP AREAS WHERE WE DEFINITELY KNOW BOTH?

* HOW CAN AIRPORTS INCREASE PEOPLE THRU-PUT? WHEN AND WHERE WILL THIS BE A CONSTRAINT TO GROWTH?

* WHEN ALL THE COSTS OF AIR TRANSPORTATION BECOME SELF-SUPPORTING, WHAT WILL HAPPEN TO AIR TRAVEL?

* HAVE AIRPORTS EXPLOITED ALL POSSIBLE FUNCTIONAL AND SERVICE OPPORTUNITIES?
I DON'T WANNA . . .
ACCENTUATE THE NEGATIVE
ELIMINATE THE POSITIVE
A LOT OF BRIGHT PEOPLE . . .
USING SOME GOOD TOOLS . . .
HAVE MADE A LOT OF PROGRESS . . .
AND SOMETIMES I'D LIKE TO
TALK ABOUT THAT TOO . . .
SURVEY OF PROJECTED GROWTH AND PROBLEMS
FACING AIR TRANSPORTATION, 1975-1985

By Louis J. Williams and Ann Wilson

INTRODUCTION

This brief report presents the results of a survey conducted during a workshop on "Transportation Demand and Systems Analysis," held June 2-4, 1975, in Washington, DC. The purpose of the survey was to determine the current opinion of people working in air transportation demand forecasting on the future of air transportation. In particular, the survey included questions on future demand growth, load factor, fuel prices, introduction date for the next new aircraft, and the priorities of problems facing air transportation.

PARTICIPANTS

The survey participants included a good cross section of the organizations involved in air transportation or air transportation research. There were 42 participants: 12 from airlines, 8 from manufacturers, 9 from universities, 8 from government agencies, and 5 from other organizations (financial institutions, private research companies, etc.) A blank survey form is included as Attachment 1.

RESULTS

The results are shown for the average responses within the organizations represented as well as the overall averages. In most cases, the results are shown in both tabular and graphical form.
GROWTH

The first six survey questions were on the projected average yearly growth for various air transportation markets over the next 10 years, 1975-1985. The results of this section of the survey are given in Table I and shown graphically in Figure 1. The overall averages and the average responses according to affiliation are shown for growth rates in each of the six transportation markets surveyed. The lowest growth rate, 5.3% per year, was forecast for scheduled domestic air carrier revenue passenger miles (RPM's). The highest growth rate, 12.2% per year, was forecast for international air cargo ton miles. For the purposes of this survey, international is defined as including all air transportation other than U.S. domestic service. The charter and air cargo markets were forecast to grow considerably faster than the scheduled passenger market. It is also interesting to note that all the government affiliated responses were at the high or optimistic end of the scale and the airline affiliated responses were at the low or conservative end of the scale.

LOAD FACTOR

The forecast average passenger load factor in 1985, for scheduled domestic service is given in Table II. The average responses show an expected increase to about 61% in 1985. This compares with an average value of 55.7% for the scheduled U.S. domestic trunk airlines in 1974 and 52.2% for the first six months of 1975.
FUEL PRICES

The forecast increases in domestic and international jet fuel prices are given in Table III. The wide differences in the responses reflect a great uncertainty with regard to future fuel prices. The airline and "other" affiliated responses were most pessimistic, with the airlines forecasting a doubling of 1975 fuel prices. The remaining participants were much less pessimistic and forecast much smaller increases ranging from 16 to 34%. The overall average forecast a fuel price increase of about 55% in both the domestic and international markets.

NEW AIRCRAFT INTRODUCTION

The forecast year of introduction for the next new (non-derivative) U.S. commercial transport aircraft is given in Table IV. The average response according to affiliation ranged from 1983 for the manufacturer participants to 1987 for the university participants. The overall average was 1985.

AIR TRANSPORTATION PROBLEM PRIORITIES

In this part of the survey, six transportation problem areas were listed and the survey participants were asked to rank them from 1 to 6 in order of decreasing concern (1 = highest priority, 6 = lowest priority).
The transportation problems listed were emissions, noise, airside congestion, ground access, fuel cost, and other costs. The number of responses of each rank for these problems is shown in Figure 2. As might be expected because of the wide range of responsibilities for the participants, the results are quite varied. For example, with the exception of emissions, there were some responses ranking each of the other problems as first priority. The average responses according to affiliation are given in Table V and shown graphically in Figure 3. The rank based on these averages is shown in Table VI.

The overall averages place the problems in order of the following priorities: (1) fuel cost, (2) ground access, (3) other costs, (4) airside congestion, (5) noise, and (6) emissions. The results for fuel cost problem priority are consistent with the higher forecasts for fuel price increases, shown in Table III, by the airline and "other" participants. The government participants' second priority ranking for aircraft noise reflects a much greater concern for this problem relative to the others than that expressed by the remaining participants.

CAB RESTRUCTURING

This question addresses the possibility of a significant change in the current form of air transportation regulation by the Civil Aeronautics Board. Asked whether there would be a substantial restructuring of the CAB during the next ten years, 14 participants (34%) answered yes, and 27 participants (66%) answered no.
The results by organizational affiliation are shown in Table VII. As shown in this table, the university participants were unanimous in answering no. The results from the other affiliations were mixed, with the consensus of the airline and manufacturer participants being no and the government and "other" participants being yes.
# Table I - Forecast Air Transportation Growth

1975-1985, Average %/Year

<table>
<thead>
<tr>
<th>AFFILIATION</th>
<th>NUMBER OF RESPONSES</th>
<th>SCHEDULED DOMESTIC RPM's</th>
<th>CHARTER DOMESTIC RPM's</th>
<th>DOMESTIC AIR CARGO TON-MI.</th>
<th>SCHEDULED INTERNATIONAL RPM's</th>
<th>CHARTER INTERNATIONAL RPM's</th>
<th>INTERNATIONAL AIR CARGO TON-MI.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airline</td>
<td>12</td>
<td>4.3</td>
<td>8.5</td>
<td>7.3</td>
<td>6.8</td>
<td>9.4</td>
<td>10.9</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>8</td>
<td>5.1</td>
<td>9.3</td>
<td>7.6</td>
<td>8.9</td>
<td>11.5</td>
<td>11.0</td>
</tr>
<tr>
<td>University</td>
<td>9</td>
<td>5.8</td>
<td>10.0</td>
<td>8.3</td>
<td>6.3</td>
<td>11.9</td>
<td>13.4</td>
</tr>
<tr>
<td>Government</td>
<td>8</td>
<td>5.8</td>
<td>11.8</td>
<td>11.4</td>
<td>9.2</td>
<td>11.6</td>
<td>14.9</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>6.3</td>
<td>9.2</td>
<td>8.8</td>
<td>7.5</td>
<td>9.0</td>
<td>10.8</td>
</tr>
<tr>
<td>ALL</td>
<td>42</td>
<td>5.3</td>
<td>9.7</td>
<td>8.5</td>
<td>7.6</td>
<td>10.7</td>
<td>12.2</td>
</tr>
</tbody>
</table>
### TABLE II - FORECAST PASSENGER LOAD FACTOR
SCHEDULED DOMESTIC SERVICE, 1985

<table>
<thead>
<tr>
<th>AFFILIATION</th>
<th>NUMBER OF RESPONSES</th>
<th>LOAD FACTOR, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airline</td>
<td>12</td>
<td>60.3</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>8</td>
<td>61.1</td>
</tr>
<tr>
<td>University</td>
<td>9</td>
<td>61.3</td>
</tr>
<tr>
<td>Government</td>
<td>8</td>
<td>63.3</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>59.4</td>
</tr>
<tr>
<td><strong>ALL</strong></td>
<td><strong>42</strong></td>
<td><strong>61.1</strong></td>
</tr>
</tbody>
</table>

### TABLE III - FORECAST FUEL PRICE INCREASE IN 1985
PERCENT INCREASE IN CONSTANT DOLLARS RELATIVE TO 1975

<table>
<thead>
<tr>
<th>AFFILIATION</th>
<th>NUMBER OF RESPONSES</th>
<th>DOMESTIC JET FUEL PRICE</th>
<th>INTERNATIONAL JET FUEL PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airline</td>
<td>12</td>
<td>100.5</td>
<td>112.6</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>8</td>
<td>30.3</td>
<td>23.1</td>
</tr>
<tr>
<td>University</td>
<td>9</td>
<td>24.7</td>
<td>11.0</td>
</tr>
<tr>
<td>Government</td>
<td>8</td>
<td>29.0</td>
<td>33.9</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>69.6</td>
<td>92.5</td>
</tr>
<tr>
<td><strong>ALL</strong></td>
<td><strong>42</strong></td>
<td><strong>53.6</strong></td>
<td><strong>56.4</strong></td>
</tr>
</tbody>
</table>
TABLE IV - FORECAST YEAR OF INTRODUCTION FOR NEXT NEW U.S. COMMERCIAL TRANSPORT AIRCRAFT
(Non-Derivative Model)

<table>
<thead>
<tr>
<th>AFFILIATION</th>
<th>NUMBER OF RESPONSES</th>
<th>YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airline</td>
<td>12</td>
<td>1985</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>8</td>
<td>1983</td>
</tr>
<tr>
<td>University</td>
<td>9</td>
<td>1987</td>
</tr>
<tr>
<td>Government</td>
<td>8</td>
<td>1985</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>1985*</td>
</tr>
<tr>
<td>ALL</td>
<td>42</td>
<td>1985</td>
</tr>
</tbody>
</table>

*One response of 2050 not included.
TABLE V - AIR TRANSPORTATION PROBLEM PRIORITIES
AVERAGE RESPONSE (1 = Highest, 6 = Lowest)

<table>
<thead>
<tr>
<th>AFFILIATION</th>
<th>NUMBER OF RESPONSES</th>
<th>EMISSIONS</th>
<th>NOISE</th>
<th>AIRSIDE CONGESTION</th>
<th>GROUND ACCESS</th>
<th>FUEL COST</th>
<th>OTHER COSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airline</td>
<td>12</td>
<td>5.3</td>
<td>4.4</td>
<td>3.3</td>
<td>3.6</td>
<td>2.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>8</td>
<td>5.1</td>
<td>3.5</td>
<td>3.4</td>
<td>2.8</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td>University</td>
<td>9</td>
<td>4.9</td>
<td>3.7</td>
<td>3.4</td>
<td>2.1</td>
<td>2.9</td>
<td>3.4</td>
</tr>
<tr>
<td>Government</td>
<td>8</td>
<td>4.5</td>
<td>2.9</td>
<td>3.5</td>
<td>2.9</td>
<td>3.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>4.0</td>
<td>5.4</td>
<td>4.2</td>
<td>4.0</td>
<td>1.8</td>
<td>3.2</td>
</tr>
<tr>
<td>ALL</td>
<td>42</td>
<td>4.9</td>
<td>3.9</td>
<td>3.5</td>
<td>3.0</td>
<td>2.7</td>
<td>3.2</td>
</tr>
<tr>
<td>AFFILIATION</td>
<td>NUMBER OF RESPONSES</td>
<td>EMissions</td>
<td>Noise</td>
<td>Airside</td>
<td>Congestion</td>
<td>Ground Access</td>
<td>Fuel Cost</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------</td>
<td>-----------</td>
<td>-------</td>
<td>---------</td>
<td>------------</td>
<td>---------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Airline</td>
<td>12</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>University</td>
<td>9</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Government</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>ALL</td>
<td>42</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>AFFILIATION</td>
<td>YES</td>
<td>NO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-----</td>
<td>----</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airline</td>
<td>4</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td>2</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>0</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ALL</strong></td>
<td>14</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1.- Forecast Air Transportation Growth 1975 - 1985
Figure 2.- Air Transportation Problem Priorities Response Distribution
Figure 3.- Air Transportation Problem Priorities Average Response
DEMAND FORECASTING SURVEY
(Fill in the blanks.)

<table>
<thead>
<tr>
<th>Ave. Yearly Growth Rate</th>
<th>Over Next Ten Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Scheduled Domestic Air Carrier Passenger Miles</td>
<td>_____ %</td>
</tr>
<tr>
<td>2) Charter Domestic Air Carrier Passenger Miles</td>
<td>_____ %</td>
</tr>
<tr>
<td>3) Domestic Air Cargo Ton Miles</td>
<td>_____ %</td>
</tr>
<tr>
<td>4) Scheduled International Air Carrier Passenger Miles</td>
<td>_____ %</td>
</tr>
<tr>
<td>(Everything other than U.S. Domestic)</td>
<td></td>
</tr>
<tr>
<td>5) Charter International Air Carrier Passenger Miles</td>
<td>_____ %</td>
</tr>
<tr>
<td>6) International Air Cargo Ton Miles</td>
<td>_____ %</td>
</tr>
<tr>
<td>7) Average Scheduled Domestic Load Factor in 1985</td>
<td>_____ %</td>
</tr>
<tr>
<td>8) Increase in 1985 Domestic Jet Fuel Price Relative to Today's Prices (in constant dollars)</td>
<td>_____ %</td>
</tr>
<tr>
<td>9) Increase in 1985 International Jet Fuel Price Relative to Today's Prices (in constant dollars)</td>
<td>_____ %</td>
</tr>
<tr>
<td>10) Initial Year of Introduction in Service of the Next New U.S. Commercial Transport Aircraft (Non-Derivative Model)</td>
<td>_____ %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>11) Priorities of Problems for Air Transportation</th>
<th>RANK</th>
<th>PROBLEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1 = worst problem)</td>
<td></td>
<td>Emissions</td>
</tr>
<tr>
<td>(6 = least problem)</td>
<td></td>
<td>Noise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Airside Congestion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ground Access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fuel Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Costs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12) A Substantial Restructuring of the CAB during the next ten years?</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>13) Your affiliation (check one)</th>
<th>Airline</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manufacturer</td>
<td>Government</td>
</tr>
<tr>
<td></td>
<td>Airport Operator</td>
<td>Other</td>
</tr>
</tbody>
</table>