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Aviation Forecasting Methodology

A Special Workshop

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AVIATION FORECASTING METHODOLOGY

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Introduction

This special workshop on aviation forecasting methodology was held at TRB Headquarters in Washington, D.C. on April 4 and 5, 1989. It was sponsored by the Federal Aviation Administration (FAA) and organized by the Transportation Research Board.

The purpose of the workshop was to examine techniques and practices currently used by the Federal Aviation Administration and other aviation forecasters and to explore other methodological approaches. The workshop focused on the forecasting process and ways to improve the reliability and utility of forecasting results.

The workshop consisted of three sessions. Session I dealt with present methodologies used by the FAA and the aviation industry. Session II considered other types of forecasting and sought to identify trends and factors that could have important effects on the future development of aviation. Session III was devoted to a discussion of major issues and problems in forecasting, followed by a summary and conclusions.

Participation in the workshop was by invitation to those specialists who are eminent in the field of forecasting and who could contribute to advancing the understanding of techniques that could be applied to aviation. To achieve a suitable balance, invitations were extended to domestic and foreign airline representatives (5), aircraft manufacturers both domestic and foreign (5), airport operators (2), governmental and private sector specialists in non-aviation fields (7), academic and aviation consultant specialists (7), and FAA forecasting specialists (7). A list of the participants will be found at the end of this Circular.

Special recognition goes to Mr. John M. Rodgers, Director, Office of Aviation Policy and Plans, FAA, and to Eugene S. Mercer, Manager, Forecast Branch, FAA for their foresight and initiative in sponsoring the workshop; also to David Raphael (DHL Airways), Richard Mudge (Apogee Research), William Nesbit (Aviation Consulting Services), and Nawal Taneja (Ohio State University) for competently presiding over the various sessions. Particular appreciation is expressed for those who made presentations; and a special thanks goes to all those who participated and contributed to the discussions and results of the workshop.

TRB staff members Larry L. Jenney and Thomas Burnard, aviation specialists, coordinated the Workshop and Marcela Deolalikar and Lavinia H. Payson provided secretarial and administrative support.

EXECUTIVE SUMMARY

Present Methodologies

The Workshop reviewed forecasting methodologies presently used by the Federal Aviation Administration (FAA) and a sample of others used in various parts of the aviation industry (TWA, Boeing, Airbus Industrie, and the Port Authority of New York and New Jersey). Three themes ran through the discussion.

1. Financial objectives and competitive concerns are leading the industry to give greater attention to short-term forecasting methods. This is particularly true of airlines, but airports also are shortening their forecast horizons.

2. Throughout the industry there is a continuing shift to simpler forecasting models with fewer variables and requiring less detailed input data.

3. Greater use is being made of approaches that depend less on mathematical modeling and give more emphasis to scenarios, judgment, and market segmentation. Scenarios are used to test key assumptions and to explore contingencies. Judgment and "reason" have always played some part in forecasting, but they are becoming more important as subjective tests of the realism of forecast outcomes. There is growing recognition that airline management strategies are important forces shaping future aviation development.

Other Perspectives

Megatrends – monitoring local and regional media coverage of economic, social, political, and technological changes and placing them in a larger societal context -- are developed through a technique called "thematic content analysis". This involves analysis and classification of items in newspapers, popular magazines, and other periodicals and of radio and television news and commentary to identify events and behavior patterns suggestive of trends. Two emerging trends expected to have strong influence on commercial aviation in the 1990s are a) consumer protection (in terms of safety, security, and "fairness" in pricing) and b) greater public emphasis on convenience and reduced time in making travel arrangements, obtaining tickets, and gaining access to aviation services.

Demographics – population characteristics and the spatial distribution of people and jobs -- are particularly important in projecting aviation demand. The past three decades have seen steady movement of the population from the Frostbelt to the Sunbelt. Along with this, the sources of immigration have shifted from Europe to Asia and Latin America. Most of these newcomers have also settled in the South and West. During this same period the U.S. economy has been undergoing a transition from materials processing and goods production to information processing and service-oriented industries. The U.S. population is aging, and persons 65 years of age and older are expected to make up more than 20 percent of the population by early in the next century. These demographic and economic forces will change the level, character, and distribution of future air travel demand.

The economic effects of airline deregulation were also explored. The combined benefits of deregulation to travelers and airlines are estimated to be about $15 billion in 1989 dollars, with benefits to travelers making up about two-thirds of the total. The six largest airline mergers that took place since deregulation produced a net benefit to travelers of about $67 million annually. Another study showed that imposition of congestion-based landing fees at four airports (Washington National, Denver Stapleton, Chicago O'Hare, and New York LaGuardia) would reduce delays and produce a benefit of $11.5 billion for these airports but raise fares for airline passengers by $7.7 billion.

Environmental issues, chiefly global warming, were examined from the standpoint of how transportation contributes to the greenhouse effect and how aviation might be adversely affected. The predicted rise in ocean levels as a result of global warming could threaten coastal airports on low, filled-in land – for example, Boston Logan, New York LaGuardia, and San Francisco. A related concern is future energy supply. The United States and Canada account for about 30 percent of world oil demand, but they have only 4 percent of petroleum reserves. OPEC, with about two-thirds of the world's reserves, is expected to reassert control over prices sometime in the 1990s. Unless the United States takes steps to control its energy appetite and to develop new energy alternatives, the fuel costs of aviation (and all other forms of transportation) can be expected to rise sharply in the coming decade.

New technologies in aviation will include improved air traffic control and navigation aids and advanced aircraft technology. In subsonic aircraft, advanced turboprop engines, improved control of laminar flow, high-aspect wing designs, and flight control systems using power-by-wire technology will be developed. Tiltrotor development is being pursued for short-haul commuter service. Supersonic aircraft that could economically carry up to 300 passengers on routes of 5,000 to 6,500 nautical miles at speeds of Mach 2.4 to 5.0 are being studied. Estimated costs are in excess of $200 million per aircraft, assuming a fleet of 500 aircraft.

Discussion

Workshop participants identified three major factors that will determine the demand for air travel: a) population growth, b) income and the cost of air travel, and c) quality of service. Present FAA forecast methodology takes the first two factors into account, but it does not expressly consider the third. Some observers felt that, because of the importance that the public attaches to the qualitative aspects of service, this variable should be factored into future forecasts.

The issue of forecast accuracy was also discussed. In general, participants felt that excessive optimism (high forecasts) leads to more serious consequences than excessive conservatism (low forecasts). The chief dangers of high forecasts are premature investment and overbuilding.

Forecasting, though always difficult, is particularly complicated at this time. The market today contains mixed signals about the future. Some segments of travel demand seem to be maturing or even declining. Others show signs of continuing robust growth. It was noted that overall domestic air travel showed almost no increase from 1987 to 1988 and that airlines lost market share (albeit slight) to passenger rail and the private auto in 1988.

Present airline marketing activity appears to concentrate on gaining market share among frequent business travelers. Some participants thought this segment of the market might be maturing and that future air travel growth may depend on marketing efforts directed toward other segments, such as recreational travel by those of retirement age or international travel by recent immigrants returning to their country of origin to visit family and friends.

While there was agreement that the underlying, long-term trends discussed under "other perspectives" should be folded into the forecasting process, their importance depends to a large degree on the forecast horizon. One-year forecasts, such as those used by many airlines, are unlikely to be influenced by these trends in any significant way. Five- or ten-year forecasts represent a middle ground where changes in economic structure, demographic shifts, and social trends begin to show their effect on travel demand. For strategic forecasts -- those of 20 years or more made to foresee long-range investments in infrastructure or applications of new technology -- these forces must be considered in a systematic way since they may be more important than purely macroeconomic indices of national growth and well-being.

Conclusions

1. The present FAA forecast procedure appears to produce results that are satisfactory for the purposes intended -- anticipation of workload and facilities requirements ten years ahead.

2. While past FAA forecasts, particularly in the years since airline deregulation, have underestimated traffic growth, inaccurate forecasting is not a primary cause of the present shortage of capacity in the air transport system. The chief reasons are lack of funding and inability to achieve consensus on the need and timing for airport and air traffic control system expansion.

3. The FAA forecasting process can be used for a wider range of purposes than it is now -- for example, exploring contingencies, alternative scenarios, and prospective policies and programs.

4. For longer-term forecasts, FAA may wish to consider a) expanded use of demographic and employment data, b) use of megatrends to assess the role of aviation in a more comprehensive view of society, and c) predictions of fossil fuel supply and demand.

5. For its short-term models FAA may wish to explore ways to utilize variables such as airline yield, price, unit costs, and market segmentation.

6. There is a need for broader and better data on market developments and travel behavior.

7. In developing its forecasts FAA may wish to expand its program to obtain a broad consensus on critical assumptions from a cross-section of industry representatives (airlines, other airspace users, aircraft manufacturers, and airports).

PART I PRESENT AVIATION FORECASTING METHODOLOGIES

SUMMARY

David E. Raphael
DHL Airways

Methodologies:

Federal Aviation Administration. Christopher J. Mayer, FAA, reviewed current FAA forecasting methodology and relevant literature and presented an analysis of the biases and omissions in many commonly used forecasting methods. He offered alternatives to the basic forecasting equation presently used by FAA and recommended that future research be directed toward improved understanding of the structure of fares and the role of traffic concentration at major hub airports. He also advocated less use of "intuition" in the forecasting process. His remarks were well received both in terms of his quantitative discipline in analyzing methods and his insights into the evolving aviation industry. Mayer stated that using pre-deregulation data in current forecasting methods could produce under-forecasts of demand, which has been a problem in recent FAA forecasts.

Airline. Paul Biederman, TWA, drew upon his experience in commercial aviation and airline revenue forecasting at TWA. He described the realistic process used at TWA which "...includes a large dose of judgment and number massaging to any econometric output before a forecast is formalized." The accuracy of revenue forecasts for the past two years in both domestic and North Atlantic sectors attests to the utility of a process that uses both judgment and analytical methods. Biederman described the TWA process that begins with cost factors, traffic mix, and yield and results in estimates of TWA market share and forecasts of passenger miles and revenue. These are used directly at the corporate level for financial planning as well as for staffing decisions and sales goals.

Aircraft Manufacturer (U.S.). Jack Howard, Boeing, presented the key steps used in preparing Boeing's market forecasts which start with economic conditions on a global basis and end up with product forecast by type of aircraft, capacity needs, and available lift. Howard stated that it was important (a) to be explicit in the identification of key assumptions, (b) to use variations of judgmental assumptions to test their sensitivity, (c) to assess constraints, such as airport congestion, that affect demand, (d) to consider the financial health of the airlines and the manufacturing industry, and (e) to be as realistic as possible knowing that to err on the side of excessive conservatism or on the side of excessive optimism presents equal dangers. The long-term nature of Boeing's forecasts (15 to 20 years) and the significant investments necessary to support new aircraft warrant careful review by many managers within the firm.

Aircraft Manufacture (European). Didier Lenormand, Airbus Industries, presented the results of a recent study, "Short and Medium Term Requirement for Jet Aircraft in North America". Lenormand described the Airbus forecasting process which includes (a) factors affecting the pattern of aircraft orders, (b) elasticity of demand, (c) airline planning factors, and (d) the factors influencing orders for new aircraft. He described the Airbus "base case" approach, which included likely cycles of the economy and fuel prices through 2003. Lenormand also discussed an increased congestion scenario which, if it becomes reality, would result in U.S. flights constrained at no more than 60 percent above current levels. Scenarios are used within Airbus to test the sensitivity of key factors or barriers, such as congestion, and to obtain a better understanding of industry dynamics.

Airport Operator. Alice Herman and Johannes G. Augustinus discussed forecasting methodology at the Port Authority of New York and New Jersey. Herman indicated that forecasts are prepared to meet two pragmatic objectives: financial planning and facility planning. The substantial modernization under way at the three major New York - New Jersey area airports attests to the need for accuracy and realism in forecasts of airport revenue, costs, and capital programs. She also noted that both airside and landside planning depend on aviation activity forecasts. The Port Authority uses a blend of econometric and demographic approaches. Alternative scenarios have also been helpful in understanding the influence of key assumptions more clearly. Herman discussed new hubbing forecast methods as well as several new short-term forecasting approaches under study. The Port Authority is required to make long term forecasts to the year 2050.

Discussion

Three themes ran through the discussion of present methodologies.

1. Financial objectives are driving the industry to spend considerable effort on short-term forecasts and methods.

o Paul Biederman stated that 95 percent of his forecasting efforts were oriented toward the short term, since much of his revenue and cost projections went into profit and loss statements issued monthly.

o Alice Herman pointed out that large capital expenditures at the Port Authority had increased the need for accuracy in short-term forecasts.

o David Raphael stated that most DHL forecasting is focused on producing annual budgets and monthly marketing financial targets.

o Ed Greenslet cited airline management need to produce near-term profits as a factor in focusing on the short run.

o Several participants felt that conservative forecasts had become popular in the aviation industry in the past four years, due in part to the near-term orientation of aviation managers.

2. There is a continuing shift to less sophisticated forecasting models and approaches.

o Christopher Mayer recommended the use of one to three equations in modelling, and warned against the use of simultaneously solved equations due to biases that arise.

o Jack Howard stated that air traveler income and airline yield variables have proven useful in making traffic forecasts that, in turn, serve as the basis of projections of the new and replacement aircraft markets.

o Alice Herman said that they used a single equation forecast for each of several key trends such as revenue passenger miles per capita, regional share of domestic enplanements, and New York region domestic traffic forecasts.

o Marilyn Block, from the Naisbitt Group, cited the use of simple extrapolation in assessing new trends driven by consumer needs and concerns (See Part II).

o James MacKenzie, from the World Resources Institute described their environmental forecasts as straightforward extrapolations.

3. The use of scenarios, judgment, and market segmentation analysis can help deal with the considerable uncertainties of aviation forecasting.

o Jack Howard discussed the use of scenarios at Boeing to test key assumptions. Paul Biederman uses scenarios to assess the impact of economic conditions and competition. Didier Lenormand applies scenarios at Airbus to assess potential barriers to growth. John Fischer stated that he uses scenarios to assess "what if" questions at the Congressional Research Service. Gerry Pronk applies market scenarios at Fokker. Richard Mudge described the use of decision analysis techniques under conditions of uncertainty. David Raphael uses financial scenarios at DHL to assess the viability of new express cargo services.

o Judgment continues to play an important role in aviation forecasting, both in establishing reasonable input assumptions and in interpreting or adjusting forecast results. Adam Pilarski of Douglas Aircraft cited the use of judgment in developing economic and traffic forecasts for specific regions. Bruce McClelland of British Aerospace and Louis Gialloreto of Air Canada apply both "reason" and judgment, which they consider especially important in forecasting international activities. Bill Nesbit also noted the use of judgment in his aviation consulting practice, as does Paul Biederman in his revenue forecasts.

o Market segmentation and airline strategies were seen as new important directions that forecasting methods might usefully employ. Nawal Taneja called for the use of regional analysis to improve forecasting accuracy. Bill Nesbit and Christopher Mayer both recommended additional attention to understanding the structure of pricing and the effects of hubbing. Louis Gialloreto discussed the importance of understanding the effects of economic and business cycles.

FEDERAL AVIATION ADMINISTRATION METHODOLOGY

Christopher J. Mayer
Federal Aviation Administration

Introduction

The Airline Deregulation Act of 1978 substantially changed an industry that was regulated in almost all phases of operation for over fifty years. Much public discussion has centered on whether deregulation has lived up to the promises of its early proponents. Discount fares have spurred many more first-time fliers and made flights much more accessible for leisure travel. Non-restricted fares, however, have gone through the roof as airlines used their computer reservations systems and travel restrictions to segment the market for air travel. Real yield, defined as revenue per passenger mile, has actually increased since 1978. Some economists have suggested that increasing concentration at major airports, caused by the hub-and-spoke system and recent mergers, presents a formidable barrier to entry and will result in still higher fares. Early proponents and current advocates disagree, saying that airline markets are contestable (competitive).

This paper focuses on structural changes since deregulation, particularly on shifts in aggregate supply and demand and new fare structures. The research began when I was employed by the Federal Aviation Administration (FAA) to evaluate their forecasting process, which had come under significant political criticism due to its consistent underestimation of traffic growth. Although there was little evidence that political factors biased FAA forecasts, I found the FAA process had some structural problems. Also, FAA forecasters were relying less on their econometric model and more on "judgment" and "intuition" to produce their projections. They argued that the large fluctuation in air travel and fares made it difficult, or even impossible, to specify a structural or forecasting model for air travel.

The goal of this paper is to quantify a forecasting model for the airline industry. In addition, I will attempt to illustrate what demand "would have been" had deregulation never occurred in order to understand better the changes since 1978. Given the forecasting applications of this work, I will utilize macro/aggregate data. As noted later, these are not the best data to use for drawing conclusions about specific aspects of pricing. However, a model using city-pair data to create a "bottoms-up" forecast would be extremely complicated and less reliable.

Deregulation Hits the Airline Industry

From its infancy, the airline industry was heavily regulated. During the 1920s and 1930s passenger traffic was marginally profitable and was sustained mostly through large air mail and passenger subsidies. The Kelly Act of 1925, and subsequent legislation, gave the Postmaster General control of routes and effectively limited competition. (The "Big Four" airlines--United, American, TWA and Eastern-- received nearly 94 percent of the airmail contract money.[1]) In 1938 Congress passed the Civil Aeronautics Act, creating a new regulatory authority for aviation and freezing the industry structure as it was at that time.

This new regulatory authority, reorganized as the Civil Aeronautics Board (CAB) in 1940, had the authority to:

1. control entry into the industry,
2. control entry and exit on specific routes,
3. regulate fares and control subsidies to airlines,
4. approve mergers and intercarrier agreements, and
5. investigate deceptive trade practices and "unfair" competition.[2]

In using these powers, the CAB was to maintain the (possibly contradictory) goals of promoting adequate and efficient service by airlines at reasonable fares and fostering competition necessary for sound development.

During the forty years between the Civil Aeronautics Act and deregulation, the CAB maintained a tight grasp on the industry. Although the Board created a new class of airlines for local service, no new trunk carriers were approved. Of the original sixteen trunks, only eleven remained as of 1978, and the "Big Four" were still the same. Subsidies for trunks were completely eliminated by the late 1950s, although commuters continued to receive them.

Fares also retained their original structure, mostly varying by distance rather than by cost of providing service. With the introduction of long-range propeller aircraft in the late 1940s and

1950s and jet airplanes in the 1960s the relative cost of long-haul service fell substantially. Rates were reduced to reflect lower average costs, but fare formulas retained the same form, not reflecting differences in the marginal cost of service on different routes. By the 1970s passengers on long-distance flights were substantially subsidizing those on short-haul routes and denser markets were subsidizing thinner ones. Any deviations from these posted fares needed CAB approval and were often contested by other airlines. These lengthy and expensive procedures discouraged airlines from offering any substantive fare discounts.

Route entry was similarly discouraged. Obtaining the "Certificate of Public Convenience and Necessity" that was required to begin serving a city pair was very difficult. Carriers needed to show that entry would not harm any existing airlines and would be profitable. Other airlines would often contest these hearings, with many cases drawn out for years before any decision was reached. In practice, very few new certificates were approved.

The Board also restricted the type of routes an airline could serve and the aircraft it could operate. Only trunks could operate all types of aircraft and receive approval for any market. Local carriers used narrow jets and propeller airplanes and were allowed to serve only regional markets. Commuters could serve any markets, but only with airplanes under 20 seats (30 seats after 1972 and 60 seats after deregulation) while intrastate carriers were restricted to service within a given state.

Despite (or because of) this strict regulation, airlines were never particularly profitable. On lucrative markets they competed away profits with higher service levels, including increased capacity and flight frequency and better on-board service. The CAB often blocked exit from less profitable routes. To discourage competition, the CAB would disallow recovery of expenses relating to price or service wars. (In recessions, this strict regulation prevented airlines from changing prices to cover their costs.) In a growing economy when industry profits declined, the CAB intervened by giving airlines antitrust immunity to meet and agree on capacity reductions. This became a vicious circle; regulation led to further service competition causing reduced profitability and calls for stricter regulation. Even with capacity restrictions (in the form of minimum load factor requirements) and stringent fare regulation, the industry's financial condition remained poor.

By the mid 1970s, high fares and inefficient service levels caused increasing numbers of economists and politicians to call for (economic) deregulation of airlines. Observations of the unregulated California and Texas interstate markets, with fares 50 percent lower than those of national trunks on comparable routes, helped fuel the discussion. The (Senator Edward) Kennedy Oversight Hearings of 1975 began the official process toward deregulating the airline industry.

The CAB also started moving in this direction. In 1976, under Chairman Robson, it relaxed charter restrictions and approved some limited discount fares. Alfred Kahn continued this process during his tenure as chairman, allowing further fare reform and more liberal route access. By 1978 fares were falling for the first time since 1966 (in real terms), and airline operating profits were at their highest level since the mid-1960s[3]. Given these conditions, Congress easily passed the Airline Deregulation Act of 1978.

The Act provided for a slow elimination of the CAB's authority, with the Board ceasing all operations by January 1, 1985, and transferring its remaining authority to the Department of Transportation. Entry and exit regulations and route restrictions were to be slowly eliminated (the latter by January 1, 1982), opening the market for increased competition. Subsidies for service to small communities were assured under the Essential Air Service Program, but other subsidies were to be phased out over a six-year period.

Although the CAB would be around another six years, its own policy changes quickly reduced its role in the industry faster than even Congress had anticipated. Within a year after deregulation, carriers were able to enter almost any market. In the eighteen months following the Act, city-pair authorizations increased from 24,000 to over 106,000[4].

Initially carriers rapidly expanded into new markets, often without a strategy toward their overall route structure. As time passed, airlines began to consolidate their operations, forming hubs at major airports. For instance, in 1978 68 percent of all trips were taken on a single airplane. By the beginning of 1982 this figure had reached a high of 73 percent, but then it fell steadily, with single-plane service comprising only about 65 percent of all trips at the end of 1987[5]. Most of these connections are on the same airline, or a "code-sharing" partner operating in conjunction with the other carrier. (The "code-sharing" agreements are contracts whereby one carrrier's flights, usually commuter, are listed under the code of a larger, major airline. The two airlines act as one for marketing and operating purposes.) Carlton, Landes and Posner[6] show that consumers greatly prefer single-carrier connections. Although hubbing had begun on a small scale before 1978, deregulation allowed airlines to take full advantage of its revenue efficiencies including higher load factors and more frequent service between hubs and other cities.

New entrants also began to flood the market. By September, 1981, there were ten new airlines at the national level and many more commuters. In subsequent years dozens of new carriers would enter (and exit) the market, leaving the industry in a constant state of flux. Most of these new-entrants and former intrastate airlines, such as Southwest, PEOPLExpress, Air Florida and World, had significantly lower cost structures than the incumbents, often by 50 percent or more. (This included both direct operating costs as well as capital expenses.) The new carriers were mostly non-union, paid significantly lower wages, and demanded more work. They flew older airplanes and used them much more frequently than incumbents. Savings were also gained by service cutbacks, such as cutting ticket offices and eliminating food or snacks on many flights.

Competitive pressure resulted in sharp fare wars. This had started before deregulation when, in 1977, the CAB approved limited 30-day advance purchase discounts on some trans-continental flights. By 1978, the Board had reformed its fare policies, allowing airlines freedom to set fares in a "suspend-free" zone ranging from 10 percent above approved coach fares to 70 percent below. This policy led to immediate discounting as carriers attempted to fill previously unused seats. Although industry profitability initially jumped, the oil crisis halted this trend. Real fuel prices almost doubled in 1979, and fares could not keep pace. The upper fare region became a binding constraint as the CAB was too slow to raise coach fares. This inherent regulatory lag led the Board to expand its zone of flexibility in May, 1980.

Since that time, CAB fare regulation has ceased to be a factor. Real fares fell during the early 1980s (and have remained low until recently) as intense competition led to fare wars and increased discounting. The structure of fares also changed. Many new entrants offered uniformly low coach fares. Incumbents responded with increasingly complex fare structures that attempted to discount fares for price sensitive customers while keeping high regular coach fares for business travelers. As a further lure for these valued customers, they set up Frequent Flyers Programs that gave away free travel based on mileage flown. These perks, along with the new entrants' reputation for poor service, helped the major carriers keep the business travelers. (An Air Transport Association survey showed that in 1979 3 percent of all fliers took 36 percent of all trips[7].)

Attracting frequent flyers allowed the incumbent carriers to survive, even with their high costs. Discount fares became more prevalent in the 1980s, but full coach fares rose sharply despite the competition. [ATA figures show that in 1980 48 percent of all passenger miles on major carriers were discounted, at an average of 43 percent below the full fare. By 1987 91 percent of the passenger miles were flown at an average discount of 62 percent[8].] (Figure 1) Requirements such as

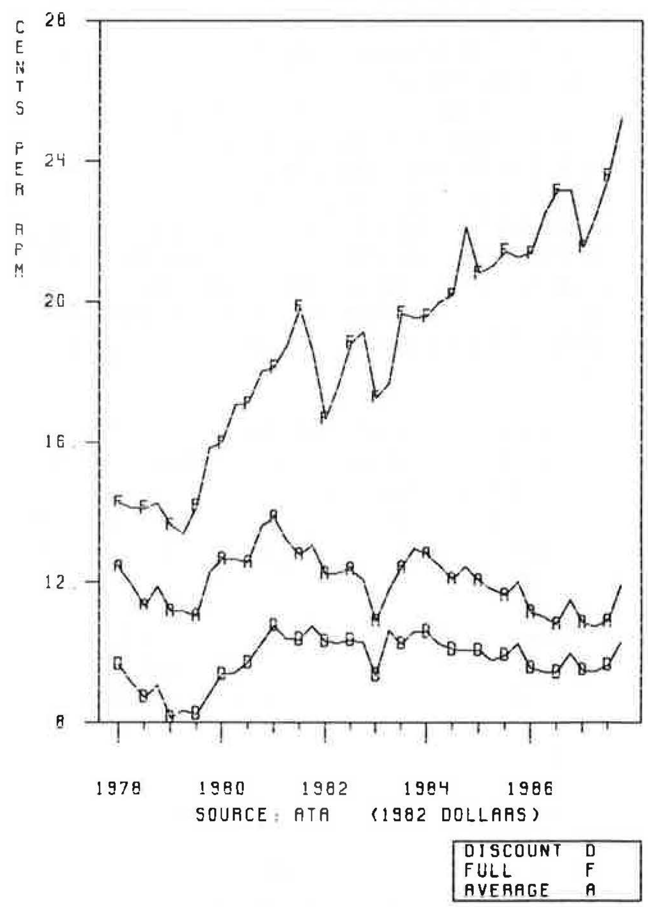

FIGURE 1. Real Yield, By Fare Type

advance purchase, Saturday night stay and limited refunds allowed airlines to price discriminate in a fashion matched by few other industries. Unable to attract lucrative business travelers that made up half of all passengers, most new entrants went bankrupt or merged with an established carrier. Between 1979 and 1987 the industry had 84 mergers or failures. The major airlines commanded 93 percent of all revenue passenger miles (RPM) in 1987, higher than even 1978 when they had 91 percent of industry RPM. USAir/Piedmont was the only new carrier in that group, but both its components were successful regional airlines before deregulation.[9]

Recent mergers have further strengthened the remaining major carriers. In 1986 and 1987 there were many large transactions, including Texas Air's purchase of Eastern Airlines and PEOPLExpress (it already owned NY Air and Continental), United's purchase of Pan Am's Pacific routes and mergers between US Air/PSA/Piedmont, Republic/Northwest, TWA/Ozark, Delta/Western and American/Air Cal. These combinations resulted in an industry with a few mega-carriers and little room for new entrants. Hubbing further strengthened the airlines' market power by giving each carrier control of its own hubs. For example, TWA has a market share over 75 percent at its hub in St. Louis, while Northwest similarly controls its hubs in Memphis, Detroit and Minneapolis. Such domination by one or two airlines has become common at most major airports. In contesting the US Air/Piedmont merger, America West suggested that,

> *"There is...consistent evidence that a market share above 30 percent at an airport without government imposed capacity constraints will be associated with higher fares than those charged on routes including only airports at which the airline is a small player."*[10]

Circumstantial evidence supports these conclusions--yields have risen significantly in 1987 and 1988 as airline concentration has increased.

<u>Evaluating FAA Forecasts</u>

Given this turbulent past, it would seem quite difficult to forecast industry traffic growth. The current FAA forecasting model utilizes econometrics as well as intuition to forecast various "workload measures". These workload measures, such as instrument operations at towered airports and aircraft-handled at Air Route Traffic Control Centers (ARTCC's), are the bottom-line requirement of the FAA. In addition, secondary measures such as load factors, RPM, enplanements, and yields are calculated and published as inputs in the process. Although the FAA forecasts look at many other sectors including commuter, general aviation, and military flights, this paper explores only the model used to forecast commercial air carrier operations. Some of the comments, however, will be applicable to other areas of the forecasting process.

In evaluating an econometric model, one must recognize that there are four potential sources of forecasting error:

1) <u>Specification Error</u>: This results if all of the assumptions implied by econometrics do not hold. For example, a particular equation might be missing an important variable. A researcher might use a logarithmic form when a linear specification was actually correct. Or the equation's coefficients or structure might vary over time (e.g., one would expect the price equation to change significantly after deregulation, when airlines were free to set their own fares).

2) <u>Conditioning Error</u>: This is a frequent source of problems. It occurs when predictions of the inputs to the forecasting model are not accurate (e.g., an unexpected rise in the price of oil, or a sudden recession).

3) <u>Sampling Error</u>: Even if a model is perfectly specified, coefficient estimates will still not be exact because they are based upon a finite sample of data. The longer the time frame, the smaller this error becomes.

4) <u>Random Error</u>: This is a shock that comes exogenously (i.e., is unrelated to any of the inputs) and temporarily changes the predicted variable. For example, a terrorist attack might have a temporary negative effect on demand for international flights.

To correct the first two types of error FAA uses a process of consultation with independent outside aviation experts to obtain their judgments and intuitive sense about potential changes in the air travel and airline industry.

The FAA model (Figure 2) begins with cost and efficiency measures that are used to predict industry yields. The yield prediction is then combined with an estimate of future GNP to forecast revenue passenger miles (RPM). RPM is converted to enplanements and used with predictions about the average load factor, aircraft size, and trip length to estimate future operations -- both instrument flight rule (IFR) and visual flight rule (VFR)--at airport control towers, air route traffic control centers (ARTCC), and other FAA facilities.

To help evaluate past performance, Table 1 lists the percentage difference between FAA one-year forecasts and actual values of selected statistics. The numbers show that forecasts of key traffic variables after deregulation have been low. The average percentage error on forecasts of total operations (not including 1981, the year of the air traffic controllers' strike), an important workload measure, is -1.9 percent. This error seems to stem, at least partially, from mistakes on key inputs. High estimates of fuel prices and yields may have caused low forecasts of RPM and enplanements. It is unclear how to view the role of "intuition" in producing this model. For example, the estimates of yields were too high, but few analysts expected the bitter fare wars that occurred in the mid 1980s. These figures do suggest, however, that there may be some systematic problems in the forecasting model that are causing low forecasts.

The FAA forecasting process, including its level of technical detail and reliance on econometrics, is probably average for the industry. Aircraft manufacturers, such as McDonnell Douglas and Boeing, have much larger staffs that use more detailed models to forecast world air traffic and cargo demand and break it down by region and airplane size. Other manufacturers have cut their forecasting staffs significantly, instead relying on their "intuition" and market knowledge to predict demand.

The airlines have also decreased the size of their forecasting departments and are looking at much shorter-term forecasts. One forecaster for a major airline estimated that he spent 50-60 percent of his time producing 30-90 day revenue and traffic forecasts and most of the remaining time on 1-2 year forecasts. He noted that management was much less concerned with a longer time frame and considered long-range predictions unreliable. Most of the airlines still produce "top down" (national) forecasts and estimate their share of the market. Some carriers, however, are moving more toward regional projections that are less reliant upon aggregate econometrics and more useful for city-pair predictions.

TABLE 1. ACCURACY OF FAA FORECASTS, PERCENT DIFFERENCE FROM ACTUAL

YEAR	IFR OP's (ARTCC)	IFR OP's (TOWER)	OP'S (TOTAL)
1976	4.032	3.158	5.376
1977	0.769	-2.970	-1.020
1978	1.471	-1.923	0.000
1979	0.714	0.935	0.000
1980	3.597	3.774	5.941
1981	8.462	5.882	0.526
1982	-7.087	-4.211	-3.333
1983	-2.256	-3.960	-4.124
1984	-2.128	-6.195	-7.339
1985	0.000	-1.695	-0.885
1986	-3.750	-2.344	-3.252
1987	-2.924	-4.348	-2.290

YEAR	GNP	FUELPR	SEATS/AC	TRIPLEN
1982	1.509	*	1.526	0.958
1983	1.788	*	-0.261	-0.546
1984	-0.627	8.578	1.175	1.516
1985	1.040	-2.107	2.632	-0.475
1986	0.728	22.992	0.196	-0.301
1987	-0.521	20.079	0.460	-1.418

YEAR	YIELD	ENPLAN	ASM	RPM	LOADS
1982	14.416	-6.195	*	-5.294	1.541
1983	9.677	-2.101	*	-2.773	-1.173
1984	-4.930	-0.223	*	1.304	5.536
1985	7.673	-3.995	*	-4.439	-2.956
1986	7.692	-5.036	-4.444	-5.299	-0.829
1987	3.835	-1.904	0.498	-3.292	-3.728

*-missing or unpublished

Some airline forecasters noted the significant information advantage they have over FAA in forecasting demand. Airlines have access to advance bookings that give a better idea of future changes. (This allowed airlines to conclude very quickly that the stock market crash would not significantly reduce air travel.) Computer systems will track frequent flyer miles to determine their effect on future traffic growth. Finally, and most importantly, the forecasters have access to future marketing strategies that will help predict areas of growth and movements in fares (i.e., they are making predictions based upon expected business actions that make it more likely that their forecasts will be accurate).

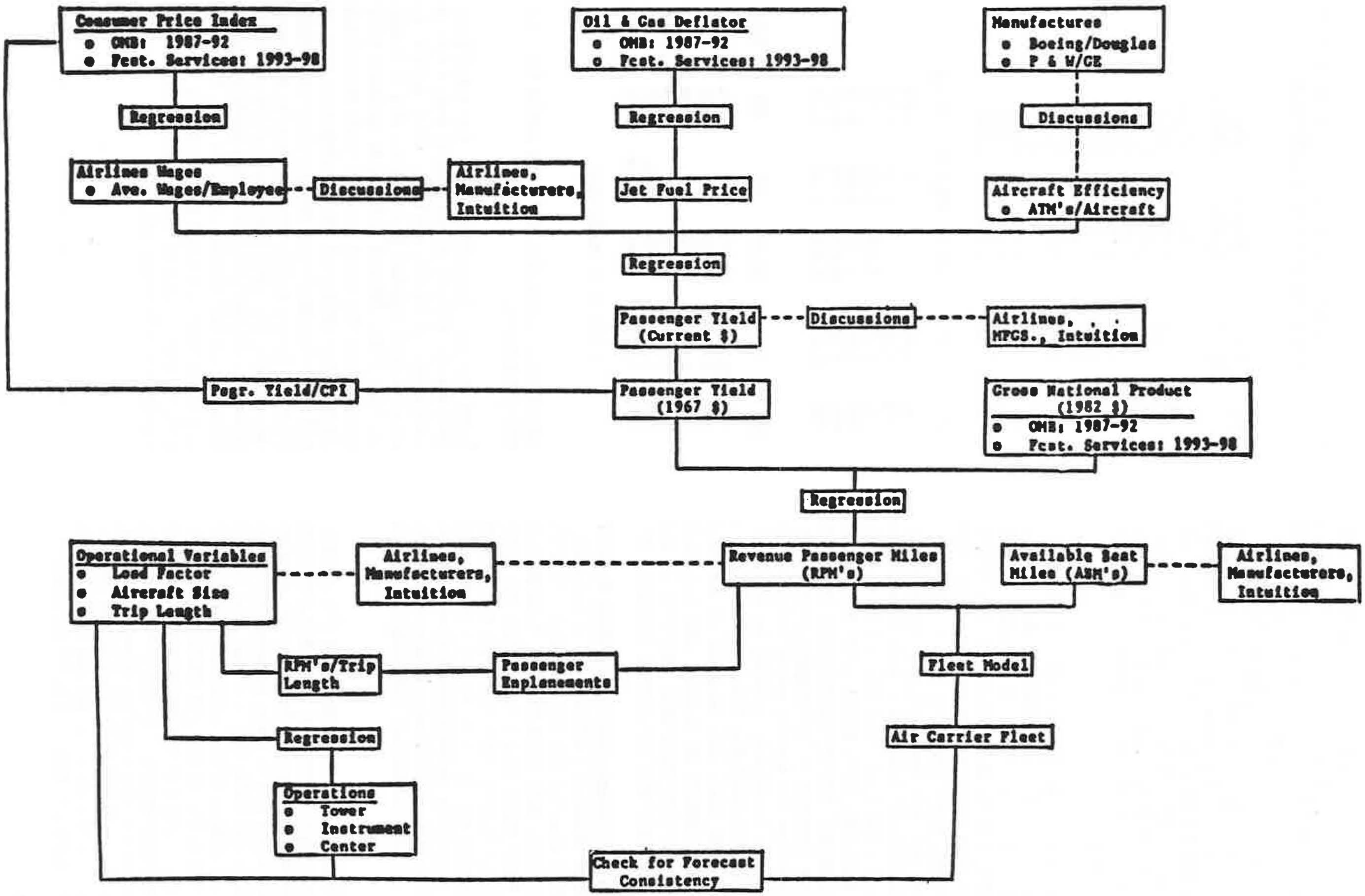

FIGURE 2. Commercial Aviation Forecasting System

Potential Improvements

One must note that it is easy to conclude that a model is missing important elements. Many econometricians are tempted to add variables to a model because the additional variables will increase the R-squared value. (i.e., the explanatory power of the regression). New variables, however, can create potential problems for forecasting both in terms of complexity and accuracy.

Data Sources. Deregulation caused significant changes in the airline industry. Fares were no longer regulated, and airlines were free to enter and exit any route they wanted, provided there were landing slots available at both endpoints. A major assumption of econometrics is that the structure of an industry remains constant (so that the coefficient estimates do not change). It is possible to test whether a specific econometric relationship remains the same over time.

For example, look at the demand equation used by the FAA to forecast RPM. Table 2 lists the results of regressing RPM on real yield (RYIELD), real GNP (RGNP), both in logs, and on quarterly dummy variables, all using quarterly data. The first regression runs from the fourth quarter of 1969 to the end of 1987. The others split that sample into two periods at the third quarter of 1979. It is quite clear that the coefficients change significantly during this period. A Chow test comparing the first regression with the other two clearly rejects (at the 1-percent level) the hypothesis that the coefficients remain the same. This suggests that using pre-deregulation data to estimate this equation will result in biased coefficients. Changes in GNP and yield have much larger numerical effects on RPM after deregulation than they had before. (This is consistent with the advent of discount fares that have made air travel much more accessible to those with lower incomes and route structures that are more responsive to demand.)

Log vs. Linear Form. Currently the FAA estimates all equations in linear form:

$$y = \alpha + \beta^* x_1 + \Gamma^* x_2 + \epsilon$$

This form implies that changes in the explanatory variables enter additively to the dependent (left-hand-side) variable. This means that a one unit change in x_1 will cause y to increase by β. In the first RPM equation in Table 2 this implies that a one thousand dollar increase in GNP results in 18.6 additional RPM. (Note: GNP is measured in billions, while RPM is denoted in millions.)

Some suggest that logarithmic form is more appropriate:

$$\log(y) = \alpha + \beta^*\log(x_1) + \Gamma^*\log(x_2) + \epsilon,$$

which is equivalent to: $y = c^* x_1^{\beta} {}^* x_2^{\Gamma} + \epsilon$

Using log form is appropriate if changes enter in a multiplicative fashion (i.e., holding elasticity constant) In this case, a one percent change in x_1 will move y by β percent.

Boeing solves this problem by estimating its demand equation using both log and linear form, arriving at a final forecast that is a weighted average of the forecasts of each equation. There is no theoretical reason to support such a system. The form that is used should depend on the particular variables in the equation and how the forecaster expects they will affect the dependent variable. In the FAA forecast model there are some equations, particularly the RPM model, that might be better specified in log form.

TABLE 2. REGRESSING RPMS ON REAL YIELD AND REAL GNP

VAR	1969:4-1987:4	1969:4-1979:3	1979:4-1987:4
CONSTANT	2.809 (1.403)	-1.450 (-2.373)	-2.010 (-2.320)
QTR1	-.006 (-1.057)	-.005 (-.540)	-.136 (-1.767)
QTR2	.061 (8.875)	.057 5.287)	.062 (7.170)
QTR3	.100 (13.609)	.117 (8.845)	.084 (10.536)
RGNP	1.212 (4.998)	1.677 (6.709)	1.869 (20.591)
RYIELD	-.719 (-7.333)	-.549 (-3.042)	-.893 (-10.365)
RHO	.987	.729	.461
R^2	.995	.984	.992

Note: All variables are in log form
Dependent Variable: Revenue Passenger Miles (RPM's)
QTR1, QTR2, QTR3 are quarterly dummy variables
All equations corrected for 1st order autocorrelation using a maximum-likelihood search procedure, RHO is shown below. t-statistics in parentheses below coefficient estimates

Simultaneous Equation Bias. Suppose we look at a simple system of two equations as follows:

1) $\text{DEMAND} = a + b^*(\text{INCOME}) + c^*(\text{PRICE}) + \epsilon_1$

2) $\text{PRICE} = \alpha + \beta^*(\text{COST}) + \Gamma^*(\text{DEMAND}) + \epsilon_2$

Regressions using ordinary least squares (OLS) assume that shock ϵ_1 is normally distributed with mean zero and unrelated to DEMAND. In this system of equations, however, that is no longer true. Let ϵ_1 be positive. This will result in an increase in DEMAND, causing PRICE to rise in equation 2. When PRICE rises it has further effects on DEMAND. The above scenario suggests that the error is related to DEMAND, violating one of the key assumptions of OLS. An increase in ϵ_1 will be attributed to PRICE, leaving equation 1 with a biased estimate of c, the PRICE coefficient.

This example is quite likely applicable to the forecasting model. Unless one assumes that yields are determined strictly by cost variables, it is probable that demand affects prices and yields. (Note that yields fell significantly during the 1982 recession, but costs remained much more stable.) Since yields also enter in the demand RPM equation, a simultaneous-equations bias is presumably present. This bias can be corrected with a technique called two-stage least squares (2SLS). In the above example, 2SLS would use an "exogenous" variable, (such as cost), called an instrument, outside the demand equation to remove the changes in price that are due to shocks in ϵ_1 This leads to consistent estimates of the parameters in the demand equation.

Enplanements vs. RPM. Enplanements, not RPM, are the final demand input in the FAA operations workload equations. A forecast of enplanements is obtained by dividing RPM by the (predicted) average trip length. This process could be simplified by estimating enplanements directly using the same equation as RPM. Both of these statistics are measures of demand. Direct estimates of enplanements would reduce one potential source of error, while the RPM equation could still be used for published predictions.

Air Traffic Delays. Delays are a particularly difficult variable to measure, let alone to use in a forecast. For example, the Department of Transportation now publishes monthly on-time reports for each major airline and fines carriers for flights that are consistently late. Airlines have responded by increasing published travel times, rather than rescheduling flights to less congested times or airports.

It is unclear how to calculate delays. Are they based on time beyond the "optimal" travel time for a route, or on deviations from the published flight schedule? Furthermore there are no reasonable time series that document delays. The FAA measure of delays only counts flights that are more than fifteen minutes late. Its accuracy has often been questioned. Air traffic controllers report delays, but large delay statistics reflect negatively on controller performance. Many in the airline industry have suggested that accurate delay figures would cause a public outcry demanding additional resources to reduce congestion. However, industry forecasters do not consider delays significant enough to include in their forecasts. One forecaster at a major airline commented that congestion just causes most travelers to allow additional travel time.

How to Handle the Hub and Spoke System. Although the FAA recognizes its significance, the forecasting model does not explicitly consider hubbing because it affects many variables. Increased number of connections cause RPM and enplanements to increase, although passengers are making the same number of trips. Yields decrease because fares are determined by the endpoints of a trip rather than routing. Recent experience suggests that longer trips, where many airlines offer connections, are often less expensive than shorter ones on less competitive routes. The price differences are not completely explained by lower costs per seat mile on longer routes. In fact, hubbing allows carriers to use larger airplanes with lower costs per seat as well as more frequent service.

Figure 3 plots the percentage of trips taken on direct flights since 1976. (i.e., flights such that the passenger never leaves the plane from origin to destination). Interestingly this figure is upside-down u-shaped, rather than being strictly downward sloping as might be expected. Deregulation brought an immediate increase in route authorizations as airlines rushed to increase their flight schedules. Interline connections, common before deregulation, became rare as carriers set fares to keep passengers on-line from origin to destination. Hubs began to operate efficiently around 1983, increasing in size ever since.

Statistics from the Origin and Destination ten-percent ticket sample might be used to correct forecasts for the effects of hubbing, although the change in the forecast might be small for a given year because hubbing moves very slowly compared to other variables. (Note: I recently

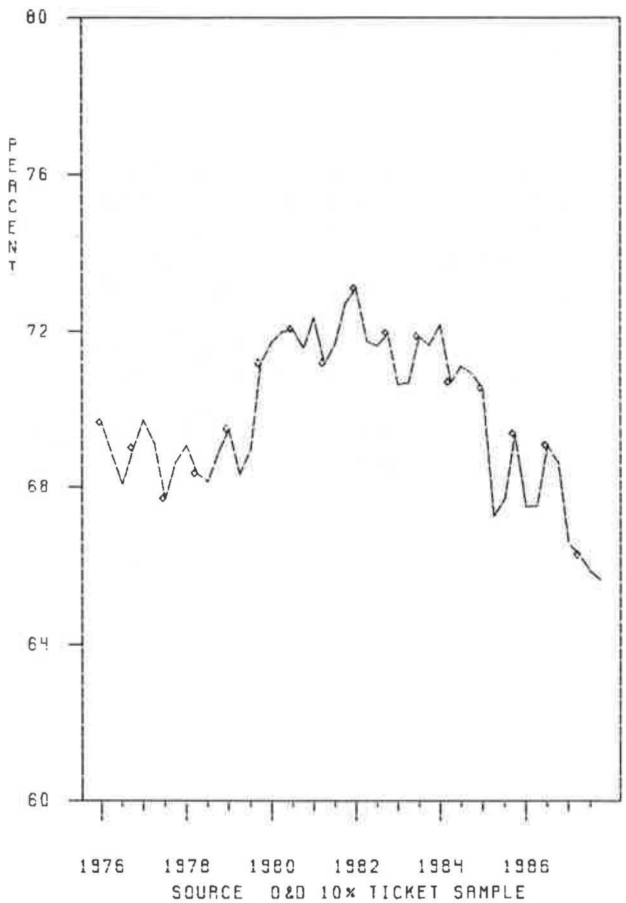

FIGURE 3. Percent of Trips, Direct Flights

discovered that the O&D sample suffered possibly major flaws in the reporting system for most of the period of deregulation. Some airlines never reported frequent flyer trips; many airlines made mistakes on routing. The routing errors, especially those that did not correctly list all connections, could seriously bias the data gathered. The extent of the damage will not be known for some time.) One useful statistic is the extra RPM or enplanements caused by connecting flights (Table 3). Later these statistics are used for supply forecasting and to calculate an average non-stop yield that is helpful for demand predictions. The estimates might also help plan manpower requirements, as hubs place greater strains on air traffic controllers by bunching flights during certain times.

TABLE 3. RPM'S/ENPLANEMENTS AND CONNECTING FLIGHTS

YEAR	TOTAL RPM's / NON STOP RPM's	TOTAL ENPLANEMENTS / TOTAL TRIPS
1977	1.043	1.36
1979	1.042	1.35
1981	1.041	1.31
1983	1.042	1.32
1985	1.045	1.35
1987	1.045	1.37

Efficiency. There are many possible measures of efficiency in the airline industry, including Available Ton Miles (ATM) per aircraft and ATM per worker are commonly used. Table 4 lists the results of regressing real cost per available seat mile (ASM) against these two efficiency measures. Not surprisingly, labor efficiency (ATM per worker) had a significant negative effect on costs, while technological improvements (ATM per

TABLE 4. - REGRESSING REAL COST PER ASM

VARIABLE	
CONSTANT	.244 (.145)
QTR1	-.003 (-.423)
QTR2	-.002 (-.352)
QTR3	-.012 (-1.893)
REAL FUEL PRICE	.167 (6.063)
AVG. REAL WAGE	.361 (2.818)
AVG. STAGE LENGTH	.051 (.194)
ATM PER WORKER	-.495 (-4.523)
ATM PER AIRCRAFT	.016 (.051)
RHO	.517
R^2	.969

Note: All variables are in log form.
Dependent Variable: Real Cost Per ASM
PERIOD: 1982:1 to 1987:4
QTR1, QTR2, QTR3 are quarterly dummy variables.
All equations corrected for 1st-order autocorrelation using a maximum-likelihood search procedure, RHO is shown below. t-statistics are shown in parentheses below coefficient estimates.

aircraft) had an insignificant coefficient. This isconsistent with industry experiences after deregulation, when airlines forced labor to accept pay cuts and changes in work rules in response to competition from low-wage, non-union entrants. below. t-statistics are shown in parentheses below coefficient estimates.

Market and Pricing Power. Most analysts will concede that airlines possess some amount of market power. In discussing monopoly or oligopoly pricing, however, one must first define the relevant market. The Department of Transportation, in approving the recent mergers, has suggested that the airline industry is "contestable". (i.e., potential competition by other major carriers will serve to limit an airline's pricing power, even if the carriers in question do not fly a particular route). Other academics and industry analysts have questioned these conclusions, noting significant barriers to entry that seem to limit competition at hubs dominated by another carrier. Studies by Levine and others have shown that frequent flyer programs, computer reservations systems, limited landing slots, long-term gate leases, cost efficiencies from hubbing, and dominance of local airport committees all serve to limit the ability of an airline to enter and undercut prices in another airline's "turf".[11] One study by Borenstein at the University of Michigan found that fares increase when an airline has a large market share at one of the two endpoints.[12] A recent Department of Justice paper rejected "perfect contestability", finding that the degree of market power depended on the number of potential competitors, as well as the number and size distribution of incumbents.[13]

Most of these studies base their conclusions on micro (city pair) data, and (or hence) their measures of market power are harder to interpret in forecasting aggregate data. For example, after reading the Borenstein study one might attempt to measure market power based on a local concentration index at the airport level. Such a statistic, called a Herfendahl index, is calculated at the airport level and plotted in Figure 4. (Note: The Herfendahl index is defined by summing the squared market share of each airline at a given airport. Airline market shares were recalculated to account for mergers and "code-sharing" agreements. For example, if two airlines each have half the enplanements at airport A then:

$$H = (50)^2 + (50)^2 = 5{,}000$$

If four airlines each have a quarter of the market then:

$$H = (25)^2 + (25)^2 + (25)^2 + (25)^2 = 2500$$

The statistic in Figure 4 is created by taking a weighted average of H at each airport, where the weight is proportional to the number of enplanements at that airport. This statistic measures the level of concentration faced by the average passenger at his departing airport. A more accurate statistic would remove enplanements that are used for connecting flights. However, that level of detail is not reported in FAA records, although it might be possible, if expensive, to calculate using O&D data.

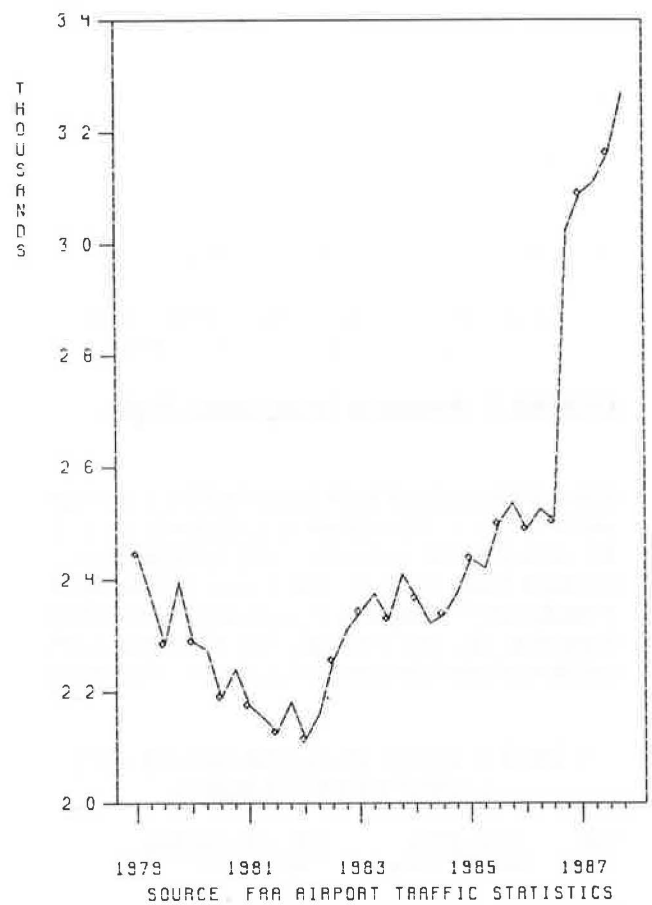

FIGURE 4. Airport Level Herfendahl

This measure, as shown in the next section, does not do a very good job of explaining price changes. This is because it is controlling for too many changes -- a problem that makes estimation harder with macro rather than city-pair data. For example, as airlines get a larger market share at the airport level, fares move in two directions. If the large market share indicates hubbing, it suggests that airlines will be flying more passengers using connecting flights with competition from other hubs. This results in lower yields on these itineraries. However, the local domination gained from these passengers allows that airline to charge higher fares for point-to-point service where they have a high market share at an endpoint. Difficulties in accounting for market power and separating it from hubbing make it difficult to get a good econometric estimate of yields.

Discount Fares Compounding the problem of estimating yields is the prevalence of discount fares that are now used in some form by over 90 percent of all travelers. (See Figure 1 for a breakdown of full and discount yields.) One might expect discount fares to spur additional traffic growth as well as dilute overall yields. This is especially true if discount fares are more prevalent on connecting flights. One might also expect discount fares to be much more responsive than full fares, to changes in market power, which seem to rise uniformly after deregulation. A model could better explain changes in demand after deregulation by accounting for changes in fare structure.

A major problem exists, however, in defining a discount fare. Full fares, as reported by the Air Transport Association (ATA), are currently used by a small and decreasing percentage of travelers. Discount fares range from those requiring a 30-day advance purchase, with a reduction of up to 75 percent off full fares, to "discounts" that can be obtained at the ticket counter the day of the flight. The quantity of discount seats available on a given flight varies, depending on expected demand, which is determined by future reservations. Airlines control the average yield on a flight by changing the quantity of various discount seats. On a given airplane there might be as many as thirty different fares charged to coach-class passengers. In this context, the ATA discount numbers are not ideal because they do not control for quantity. A better way to measure discounts, and again a more expensive method, would be to use the O&D sample and calculate aggregate 20th, 50th and 80th percentile fares.

Demographic Changes. There are several possible types of demographic movements that might affect air travel: age, income, or region. Although the demand equation accounts for GNP, one might hypothesize that the distribution of increases in GNP could matter, as families with different incomes have different propensities to fly. Regional shifts and age changes might also affect travel demand, using the same reasoning. These movements, however, are likely to be very slow, so they would be most applicable in long-term forecasts.

TABLE 5. DEMOGRAPHIC ESTIMATE OF ENPLANEMENTS YEAR 2010[1]

age group	per-capita enplanements (1986-7)	projected population (thousands)	projected enplanements (millions)
18-21	1.604655	15729	25.239
22-29	1.849117	31288	57.855
30-39	3.171652	35312	111.99
40-49	2.805058	40598	113.87
50-59	2.454716	40249	98.799
60-64	1.815891	16023	29.096
over 64	1.220244	39195	47.827
ESTIMATED ENPLANEMENTS USING AGE BREAKDOWN 2010			484.695

	per-capita enplanements	projected population	projected enplanements
all ages	2.236951	218394	488.537
ESTIMATED ENPLANMENTS USING TOTAL POP. CHANGES			488.537
PERCENT DIFFERENCE BY USING AGE BREAKDOWN			- .786

This table demonstrates that changes in the age distribution of the population should have very little effect on the 2010 forecast. In the above example, accounting for movement in the age spread of the population decreases the 2010 forecast by .786 percent, a very minor change for a forecast of more than 20 years.

The analysis assumes that all flights are taken by adults 18 years and older because their is detailed demographic data for this group in the Air Transport Association Gallup Poll. However, the percentage of the population under 18 years old is estimated to fall from the current 26.1 percent to 22.9 percent in 2010. Given this fact, and assuming the children fly less than the adult population, the impact of changing demographics should be even less than we estimate.

This analysis is only meant to isolate the effect of changing demographics and does not provide a realistic method of forecasting traffic. For example, it assumes that per-capita enplanements will remain constant at their 1986-7 average level. Our estimates for 2010 show that per-capita enplanements could double as a result of increase in real per-capita GNP and personal income per-capita income. (Note: The ATA Poll in 1987 shows that only 30 percent of the adult population flew in the last 12 months. Frequent flyers who take more than 12 round trips per year accounted for four percent of these fliers, but flew almost a third of all trips. Clearly there is much room for growth in per-capita flights as family income rises)

1/ Sources: ATA Gallup Poll, 1986 and 1987; and U.S. Bureau of the Census.

A first look at changes in travel demand due to movements in age distribution suggests that this is not a serious bias. Table 5, taken from page 12 of the *"FAA Long Range Aviation Projections, Fiscal Years 2000-2010"*, further details these conclusions. Table 6 lists the propensity to fly, by region of the country. The data imply that it is difficult to use demographics explicitly in a forecast. Changes are too slow to use in a regression with quarterly data. (A time series would be collinear with the constant.) Furthermore, forecasting solely on demographic changes does not control for other variables such as income and price, which are likely to have much larger impacts. Also, one would expect that income is heavily related to the other distributional propensities to fly. Therefore, inclusion of GNP in the demand equation captures much of the demographic movements.

TABLE 6. PROPENSITY TO FLY, BY REGION OF THE COUNTRY

EAST

YEAR	1970	1974	1979	1983	1985	1987
FLOWN BUT NOT IN LAST 12 MONTHS	27	32	39	47	44	40
1-3 TRIPS IN LAST 12 MONTHS	20	23	24	19	24	24
4-6 TRIPS IN LAST 12 MONTHS	2	3	2	3	4	4
> 12 TRIPS IN LAST 12 MONTHS	3	1	2	2	2	3
NEVER FLOWN	48	41	33	29	26	29

MIDWEST

YEAR	1970	1974	1979	1983	1985	1987
FLOWN, BUT NOT IN LAST 12 MONTHS	23	30	40	48	45	46
1-3 TRIPS IN LAST 12 MONTHS	15	18	18	14	22	22
4-6 TRIPS IN LAST 12 MONTHS	2	1	2	1	3	3
> 12 TRIPS IN LAST 12 MONTHS	2	1	2	1	1	2
NEVER FLOWN	58	50	38	36	29	27

SOUTH

YEAR	1970	1974	1979	1983	1985	1987
FLOWN, BUT NOT IN LAST 12 MONTHS	19	24	33	36	37	40
1-3 TRIPS IN LAST 12 MONTHS	14	17	16	15	16	19
4-6 TRIPS IN LAST 12 MONTHS	2	3	3	3	3	3
> 12 TRIPS IN LAST 12 MONTHS	2	1	3	1	3	2
NEVER FLOWN	63	55	45	45	41	36

WEST

YEAR	1970	1974	1979	1983	1985	1987
FLOWN, BUT NOT IN LAST 12 MONTHS	37	41	42	46	47	44
1-3 TRIPS IN LAST 12 MONTHS	26	27	32	27	30	32
4-6 TRIPS IN LAST 12 MONTHS	2	3	3	4	4	5
> 12 TRIPS IN LAST MONTHS	2	2	4	2	2	4
NEVER FLOWN	33	27	19	21	17	15

SOURCE: Air Transport Association/Gallup Air Travel Survey

The Regulated Airline Industry

In order to understand the changes brought by deregulation, one must first look at the industry as it existed prior to 1978. At that time fares werecompletely controlled by the Civil Aeronautics Board (CAB), using the Domestic Price Fare Index (DPFI), a fare formula of the form:

$$FARE = x_1 + x_2*(MILES<500) + x_3*(MILES,501\text{-}1500) + x_4*(MILES>1500)$$

The coefficients x_1-x_4 were mostly fixed in their proportions and inflated based upon the aggregate industry rate of return. With the introduction of long-range propeller aircraft, and later jets, the cost per seat mile of long flights fell dramatically, but the fare formula did not fully compensate forthis. On longer or denser routes where fares were "too-high", airlines competed away profits with larger aircraft and greater flight frequency. The industry rarely made the regulated rate of return.

In calculating the rate of return for the DPFI, the CAB used its own accounting system. Airlines reported their costs, revenue and traffic every six months. Adjustments were then made based upon CAB requirements and were calculated on averages. For example, after 1971 the CAB set a minimum load factor for the industry. Also, airplanes were required to fly, on average, a certain number of hours per day and have a minimum number of seats. (Note: All of these requirements were established to discourage "ruinous" competition based on excessive service.) Any carrier that did not meet the regulations would have its "allowable" expenses and capital depreciation reduced, increasing its "official" rate of return. Adjustments were also made for "night coach" service (80 percent of full coach fare) and "K-class" tickets (90 percent). Children and military travelers were treated separately, as were the discount fares that were approved beginning in the mid 1970s. Because the CAB used averages, it calculated "approved" yields based upon average stage length, rather than the distribution of flights. Given the non-linear fare formula, this would further bias the DPFI process. With all of these changes, "official" yields were often 15-20 percent below those predicted by the DPFI.

The "official" yields were then used to calculate CAB recognized rates of return. If these were too low, then the CAB would raise the coefficients in the fare formula by a constant percentage. Fare increases were based upon cost increases, but assumed traffic would remain constant. A former CAB employee commented that the CAB did not include future cost increases in the DPFI until 1977. However, regression analysis did not suggest the two-quarter lag that would result if past costs were used to calculate fare increases. (Note: In a recession with diminishing traffic, airlines were severely hurt because they could not adjust fares, which were based upon traffic from the previous six months. The fare inflexibility also hurt carriers coming out of a recession.)

Table 7 lists the results of regressing yield on cost per ASM as reported by the airlines (LCOST), load factor (LLOADS) and a dummy variable (DPRE1971) representing all quarters before 1971, the year CAB began requiring a minimum load factor. I also tried adding average aircraft size and average stage length, but these were major cost components and were collinear with LCOST. In addition, a former CAB employee noted that very few adjustments were caused by airlines not meeting these requirements. Log form was used because changes to yields were based on percentage changes in cost and load factor.

TABLE 7. REGRESSING YIELD ON COST PER ASM

VARIABLE	OLS	2SLS
CONSTANT	.597 (3.724)	.696 (4.071)
QTR1	-.015 (-2.149)	-.018 (-1.547)
QTR2	.023 (2.269)	.014 (1.009)
QTR3	.020 (1.489)	.006 (.325)
DPRE1971	-.036 (-1.889)	-.046 (-3.386)
COST	.697 (11.049)	.681 (14.114)
LOADS	-.494 (-4.244)	-.385 (-2.452)
RHO	.665	****
R^2	.984	****

Note: All variables are in log form
Dependent Variable: Yield
PERIOD: 1969:4 to 1977:4
OLS equation corrected for AR1 process
t-statistics are shown in parentheses below coefficient estimates.

The results were quite good. The elasticity of price with respect to cost was .69, which is reasonable considering that cost is measured per seat-mile, while yields are calculated only for occupied seats. Also, holding cost constant, one would expect increases in the load factor to decrease the allowed yields. Quarterly dummy variables all had expected signs. It seemed possible, however, that the yield variable in the OLS equation might be simultaneously determined with load factor, biasing the coefficient estimates. [Load factor = (total RPM)/(total ASM)]

To investigate, I ran 2SLS using real GNP as an instrument for load factor. This was enough to run a Hausman test of the null hypothesis (Ho:) that the OLS estimates are unbiased. (The Hausman test compares the coefficients and standard errors of the OLS and 2SLS estimates. If there is no simultaneous equations bias, the coefficients in both equations should be close, with lower standard errors in the OLS equation. If simultaneous equations bias is a problem, the OLS coefficients will be biased.) The statistic m = 1.096 $\approx X^2_1$ does not allow rejection of the null hypothesis (i.e., one cannot reject that the OLS and 2SLS coefficient estimates are the same). Although this is not evidence to accept Ho:, further thought suggests that simultaneity should not be a problem. The CAB fare formula was fixed in a given period and did not respond to shocks in demand. Only if airlines had freedom to discount, or to change the composition of discounts, could they adjust price to movements in demand.

Demand, pre-1978, was also easy to understand. The results of regressing RPM's on real GNP (RGNP) and real yield (RYIELD) are shown in Table 6 and appear quite reasonable. Demand has a price elasticity of -.36 and an income elasticity of 1.64. Studies have shown that changes in aggregate supply, either greater flight frequency or larger aircraft, have little effect on demand. (Individual airlines might offer more numerous flights on a route, however, because the carrier can attract a disproportionate share of its rivals' passengers.) Again, the possibility of a simultaneous equations bias exists and Table 8 lists the results of 2SLS, with real cost per ASM and a dummy for quarters before 1971 serving as an instrument for real yield. A Hausman test of the hypothesis that OLS estimates are unbiased gives m = .0759 $\approx X^2_1$ As in the yield equation, we cannot reject the unbiasedness of OLS coefficients.

TABLE 8. RESULTS OF 2SLS

VARIABLE	OLS	2SLS
CONSTANT	-1.555 (-.937)	-2.273 (-.822)
QTR1	-.010 (-1.002)	-.012 (-.924)
QTR2	.060 (5.326)	.060 (4.654)
QTR3	.122 (10.415)	.126 (7.452)
RGNP	1.629 (9.263)	1.698 (6.087)
RYIELD	-.373 (-3.093)	-.309 (-1.422)
RHO	.393	****
R^2	.980	****

Note: All variables are in log form.
Dependent Variable: Revenue Passenger Miles (RPM)
PERIOD: 1969:4 to 1977:4
OLS equation corrected for AR1 process.
t-statistics are shown in parentheses below coefficient estimates.

Effects of Deregulation

The model of the airline industry developed in the previous section gives an interesting opportunity to ask, "What if deregulation never occurred?" In order to answer that question, it is necessary to get estimates of the model's inputs; but these estimates must be exogenous to the airline industry. In particular, it is not accurate to use data for load factor and cost per ASM after 1978 when these variables have been profoundly affected by deregulation.

To obtain a projection for expenses after 1978, I used a cost breakdown based on 1977 CAB figures: Fuel represented 22 percent of operating expenses, non-fuel costs, including depreciation, wages, advertising, etc..., were the remaining 78 percent. To estimate cost changes, the fuel component was indexed using the oil and gas deflator and the non-fuel portion according to the Consumer Price Index. Cost per ASM after 1977 was determined by adding these two components. There are several problems with this measure, mostly relating to the technological change that might have taken place without deregulation. Airlines were still likely to upgrade to larger, more fuel-efficient aircraft. The recession of 1982 would likely have accelerated this process;

previous recessions under regulation caused retirements of older, less efficient aircraft to reduce capacity as well as seat-mile costs. Retirements would have been further encouraged with the new load factor standards, because expenses relating to excess capacity would have been disallowed. A newer fleet of larger aircraft would have resulted in lower fuel and non-fuel costs than I estimate. Any decrease in costs, however, could easily have been eaten up by higher labor costs. Unions in a regulated environment such as airlines or trucking have shown great ability to grab a portion of windfall profits.[14]

Overall, any bias would probably be in the upward direction. Real costs were steady, or even declining, throughout the 1970s. This cost measure increases slightly in real terms. Figure 5 plots the movement in my cost measure (PREDCOST) versus actual costs (COST), both measured in nominal terms. Note that actual costs move substantially below predicted costs after 1982 when new, low-cost airlines entered the market. Recently this difference has started to narrow as airlines have begun to compete using costly items such as frequent-flyer programs and higher quality service rather than just fighting for the lowest price.

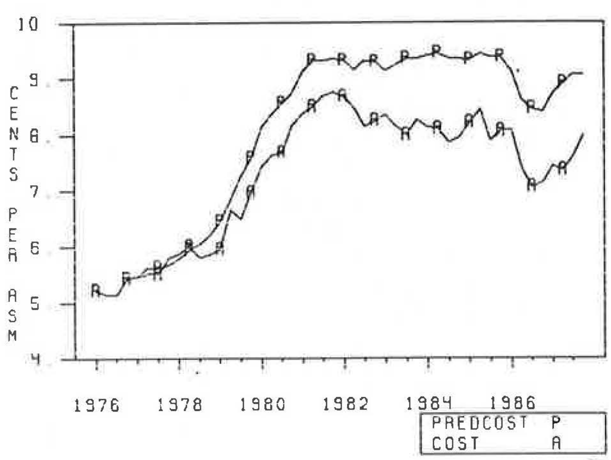

FIGURE 5. Predicted vs. Actual Costs

The load factor would also be difficult to predict. I use a constant 60 percent load factor after 1978, which was the announced CAB standard. In the 1970s airlines showed a great ability to meet CAB load factor requirements. If they exceeded these restrictions, they received higher actual rates of return because the additional passengers and revenue did not affect the yield formula. In practice, however, higher load factors were usually competed away by increased flight frequency.

Substituting these two measures in the previously derived yield equation gives an estimate of what yields would have been if deregulation had not occurred. Figure 6 plots predicted "regulated" yields (PRYIELD) versus actual yields (YIELD). Surprisingly, actual yields are much higher for most of the 1980s. This is even more startling because the cost estimates used for predicted yields may even be too high. One reason might involve the high load factor I imposed, a standard not in effect at the end of regulation. Choosing a lower load factor increases the predicted yields, but it still leaves them below observed yields for most of the 1980s. Another plausible explanation involves the use of discounts to attract traffic. Airlines were able to raise prices for those passengers who had a higher willingness to pay (i.e., business travelers) and give lower fares to leisure travelers[15].

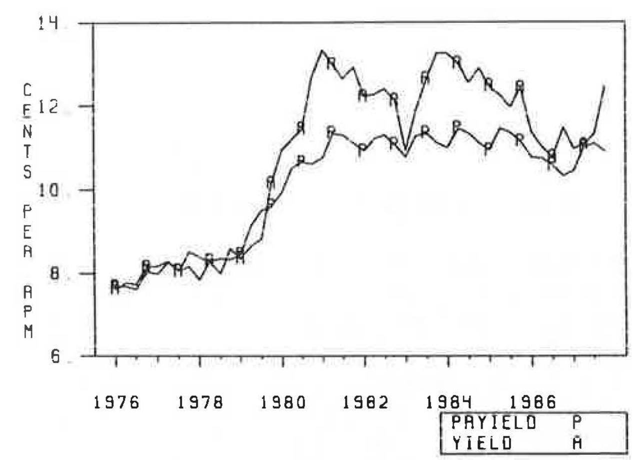

FIGURE 6. Predicted vs. Actual Yield

Combining the predicted yields, converted to real terms, with actual RGNP, which is assumed independent of deregulation, allows a forecast of RPM under regulated conditions. Such a prediction (PREDRPM) is compared to actual RPM (ACTRPM) in Figure 7. Even though this forecast uses predicted yields that might be too low and hence overstate what demand would have been under regulation, deregulation has allowed tremendous increases in passenger miles. By the end of 1987 under regulation there would have been 61.3 billion RPM (60.4 if we assume a 55 percent load factor standard), almost a 25 percent decrease from the 75.8 billion RPM that were

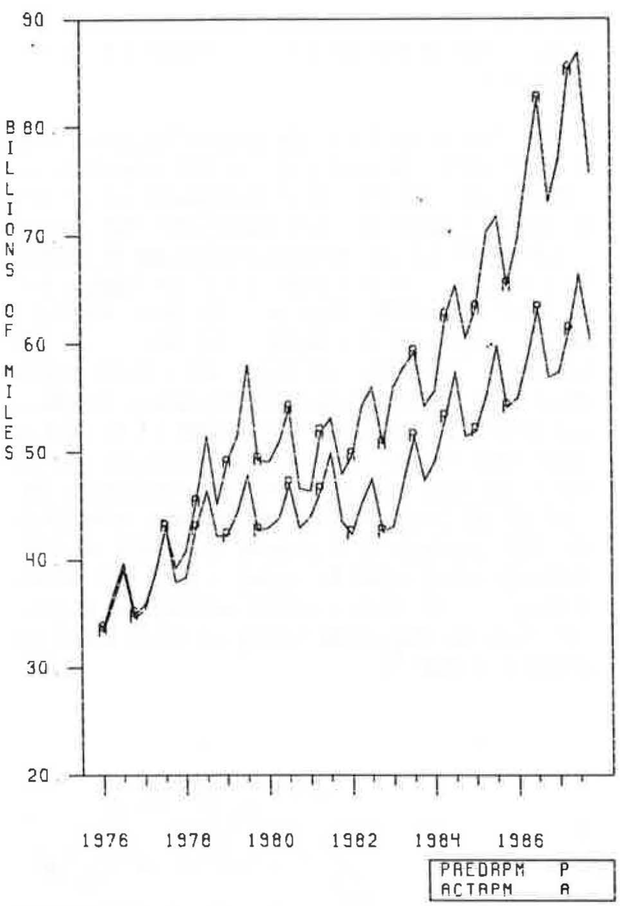

FIGURE 7. Predicted vs. Actual RPM

actually flown. The advent of the hub-and-spoke system has contributed to that rise, but estimatesfrom O&D data suggest this effect is less than five percent. The major part of the increase is probably due to the change in the routes that are now flown and the freedom to set fares according to demand. Figure 2 showed the structural break in the demand equation due to deregulation. After 1979, the income elasticity of demand was substantially higher than previously estimated. Price elasticity was also more negative. Airlines were free to set their route structures based upon demand and use hubs, which geometrically increase the potential travel options. In fact, Morrison and Winston[15] found the greatest gains from deregulation came from increased flight frequency and better service.

Explaining the Deregulated Airline Industry

Several factors explain the changes that occurred after 1978. Here I will develop a set of structural equations that govern the current industry and are useful for forecasting.

I specify a disequilibrium model where there is always aggregate excess supply, although local markets may come closer to clearing[16]. Because supply never equals demand (i.e., airlines never fill all of their seats), price moves as a function of both supply and demand. The following (general) model was used. (For simplicity, quarterly dummies and the constant are omitted).

1) $DEMAND = a_1(FARE) + a_2(DISCOUNT\ FARE) + a_3(RGNP) + \epsilon_1$

2) $ASM'S = b_1(YIELD) + b_2(RPMS) + b_3(COST\ VAR'S) + b_4(CONCENTRATION) + \epsilon_2$

3) $FARE = c_1(ASM'S) + c_2(TRIPS) + c_3(RCOST) + c_4(CONCENTRATION) + c_5(TRIP\ LENGTH) + \epsilon_3$

For equation 1, I tested several specific measures of demand, including ENPLAN (enplanements), NSENPLAN, RPM and TRIPS, where:

TRIPS= NON-STOP RPM (Extra RPM to/from a hub were removed.)

NSENPLAN= NON-STOP ENPLANEMENTS (Extra enplanements were removed.)

For price, both FARE and RYIELD were used, with FARE=REVENUE/NON-STOP RPM (Yield, adjusted for hubbing.)

Supply shocks are allowed to enter demand only through price. This follows the industry view that aggregate changes in supply have little effect on demand. Also, in equation 3 demand and price are assumed to affect ASM only in expectation. (i.e., airlines publish their schedules well in advance and make commitments based on those schedules, implying that supply is predetermined and there is no simultaneous equations bias). All money-related variables are in real terms ($1982-4), and all variables are measured in logs.

To account for changing route structure, some demand-related variables that utilized passenger miles were modified for changes in hubbing. All of the hubbing corrections were made based on O&D data, which I recently discovered may be biased. If anything the bias is downwards, i.e., these variables do not account for the full extent of hubs, rather than overcorrecting for them. In analyzing the ATA discount data I assumed that all full-fare flights were non-stop. Consequently all connections were assumed taken by discount travelers. (Assuming that both types of travelers connected in the same percentage did not change the results.)

First I estimated the demand model, shown in Tables 9, 10, and 11 using ENPLAN, NSENPLAN and TRIPS, respectively, as measures of demand. (There were similar results using RPM.) Because changes in travel distance affect non-stop RPM's, the TRIPS equations also included a variable for average trip length (TRIPLEN):

TRIPLEN= NON-STOP RPM'S/NON-STOP ENPLANEMENTS

In all three equations, I compared OLS results to 2SLS, with ASM, CONCEN (the airport concentration index), DNS (percent of single plane trips), and RCOST (real cost per ASM) as instruments for FARE and TRIPLEN. The results of a Hausman test are given in the tables and provide some evidence that OLS estimates are biased. In the TRIPS equation (Table 9) the coefficient of TRIPLEN (.85) is significant and close to 1. This suggests that estimating NSENPLAN is equivalent to estimating TRIPS and accounting for average trip length.

In addition to the conclusion of simultaneity, the coefficients suggest further differences since

TABLE 9. ENPLAN

VAR	OLS	2SLS	2SLS
CONSTANT	-4.397 (-.998)	-6.705 (-1.316)	-4.971 (-.756)
QTR1	-.024 (-1.598)	-.034 (-2.029)	-.006 (-.226)
QTR2	.051 (3.703)	.043 (2.885)	.065 (2.667)
QTR3	.060 (2.286)	.041 (1.411)	.073 (1.691)
RGNP	1.747 (17.319)	1.694 (21.169)	1.752 (16.031)
TRIPLEN	.460 (.768)	.850 (1.263)	.429 (.475)
FARE	-.831 (-4.926)	-.807 (-3.941)	-1.225 (-3.143)
DISCFARE	****	****	.753 (1.438)
R^2	.992	****	****

Dependent Variable: TRIPS1
Period: 1981:1 to 1987:3
t-statistics are shown in parentheses below coefficient estimates.

NOTE: A Hausman test of equations 1 and 2 gives m = 4.151 ≈ X^2_2 (significant at an 87 percent confidence interval), which provides some evidence that OLS estimates are biased.

TABLE 10. NSENPLAN

VAR	OLS	2SLS	2SLS
CONSTANT	-1.827 (-2.674)	-1.300 (-1.726)	-1.858 (-1.565)
QTR1	-.034 (-3.358)	-.036 (-3.467)	-.032 (-2.441)
QTR2	.051 (5.069)	.049 (4.720)	.052 (4.276)
QTR3	.042 (4.117)	.040 (3.794)	.042 (3.509)
RGNP	1.854 (26.932)	1.810 (24.391)	1.839 (19.987)
RYIELD	-.799 (-11.730)	-.867 (-11.052)	-1.008 (-4.300)
RDISCYLD	****	****	.290 (.647)
R^2	.991	****	****

Dependent Variable: ENPLAN
Period: 1981:1 to 1987:3
t-statistics are shown in parentheses below coefficient estimates.

NOTE: A Hausman test of equations 1 and 2 gives m= 5.761 ≈ X^2_1 (significant at a 98 percent confidence interval), which provides strong evidence that OLS estimates are biased.

TABLE 11. TRIPS

VAR	OLS	2SLS	2SLS
CONSTANT	-1.256 (-1.728)	-.914 (-1.157)	-2.306 (-1.835)
QTR1	-.036 (-3.307)	-.037 (-3.383)	-.021 (-1.477)
QTR2	.042 (3.912)	.041 (3.728)	.055 (3.961)
QTR3	.037 (3.416)	.035 (3.241)	.048 (3.427)
RGNP	1.722 (23.379)	1.693 (21.621)	1.764 (17.718)
FARE	-.723 (-10.086)	-.766 (-9.439)	.874 (-3.337)
DISCFARE	****	****	.470 (1.005)
R2	.989	****	****

Dependent Variable: NSENPLAN
Period: 1981:1 to 1987:3
t-statistics are shown in parentheses below coefficient estimates.

NOTE: A Hausman test of equations 1 and 2 gives m = 1.904 ≈ X^2_1 (significant at an 83 percent confidence interval), which provides limited evidence that OLS estimates are biased.

regulation. The elasticities of demand with respect to both price and income are much greater (in absolute value) than in earlier years. The third column lists 2SLS estimates adding the average discount fare (DISCFARE) or yield (RDISCYLD) to account for the increased dispersion of fares. As noted earlier, the percentage of travelers using the ATA-measured discount fares does not remain constant over time, so it is not surprising that the results of this equation are less than satisfying. The coefficient for the discount fare (or yield) is never significantly different from zero, and the coefficient for average fare (or yield) is not realistic.

Equation 2, estimating ASM, should be considered only as a short-run predictor. Any long-term model must explain the role of capital accumulation in determining supply. For example, the cost of capital is not even mentioned in the above model. (Most major airlines have committed to major purchases of new aircraft without any indications of retiring older models. Older aircraft, however, will face severe and expensive restrictions because of increased governmental attention to safety and noise pollution.) Capital costs will also play a major role in the future as more airlines lease their aircraft, some with short-notice cancellation clauses. (Last year a leasing company placed the largest single order of aircraft in history.)

The results of equation 3, listed in Table 12, are quite satisfactory. (Both log and linear results are listed.) Most of the variation in ASM is explained by changes in variable costs (fuel prices - FUEL and average wages - WAGE), efficiency (available ton miles per worker - ATMPLAB), demand (RPM) and price (YIELD). Not surprisingly, the coefficient for the airport concentration index (CONCEN) was negative, but insignificant. Changes in concentration can result from increased hubbing, which would raise ASM, or increased market power, moving supply in the opposite direction. Also note that expected increases in demand, holding price and cost constant, are met by higher supply and higher load factors (i.e., the demand elasticity of ASM is less than 1).

Estimating fares, however, turned out much more difficult than anticipated. There are several possible formulations:

A) Estimate the equation as it stands.

B) Set $c_3 = 0$, letting costs enter through changes in ASM.

C) Set $c_1 = 0$, assuming aggregate supply does not affect price.

TABLE 12. RESULTS OF EQUATION THREE

VARIABLE	LOG	LINEAR
CONSTANT	6.136 (2.832)	53309.6 (1.669)
QTR1	.006 (.041)	97.691 (.061)
QTR2	-.058 (-3.291)	-5820.59 (-3.067)
QTR3	-.045 (-2.629)	-4297.74 (-2.241)
RPM (MILLIONS)	.793 (6.457)	1.180 (5.587)
RYIELD (CENTS)	.255 (1.529)	1572.60 (1.005)
FUEL (CENTS)	-.097 (-2.151)	-210.021 (-3.067)
WAGE (DOLLARS)	-.549 (-2.695)	-5.380 (-2.613)
ATMPLAB	.366 (2.290)	928.12 (2.381)
CONCEN	-.030 (-.349)	-1.197 (-.337)
R^2	.988	.987
DURBIN-WATSON	2.129	2.043

Dependent Variable: AVAILABLE SEAT MILES (ASM IN MILLIONS)
Period: 1982:1 to 1987:3
t-statistics are shown in parentheses below coefficient estimates.

(All systems were 2SLS with RGNP serving as an instrument for TRIPS.) None of these setups was clearly successful. The results of B and C are in the first two columns of Table 13. (Empirical testing showed that A was clearly incorrect.) Equation B had reasonable coefficient estimates, but the coefficients of ASM and TRIPS were not significant. Equation C is certainly not the correct specification. Results were similar for different log and linear specifications. Other failed strategies included using instrumental variables to correct ASM for changes in hubbing, treating TRIPLEN as endogenous, and removing TRIPLEN from the equation. Equation B suggests that airlines first choose a schedule based on cost and expected demand and then set fares based on realized demand and other airlines' supply, but not cost changes.

Although this story may seem reasonable at first glance, price setting seems more complicated than B would indicate. It is very hard to separate the effects of hubbing, discounts, concentration, cost, demand, and supply using aggregate data. Computer reservations systems have allowed airlines to use very sophisticated procedures to set fares. The average fare may have little meaning because prices are adjusted on a flight-by-flight basis. Price wars often occur in some regions, but never happen on every route.

TABLE 13. REDUCED FORM ESTIMATE

VAR	EQN B	EQN C	REDUCED FORM
CONSTANT	38.214 (2.661)	22.880 (7.909)	17.129 (3.419)
QTR1	.084 (1.958)	.059 (2.863)	.027 (1.001)
QTR2	.005 (.081)	.059 (2.805)	.036 (1.718)
QTR3	.161 (2.921)	.149 (4.969)	.116 (3.484)
ASM	-1.367 (-1.116)	**** ****	-.885 (-2.689)
TRIPS	1.125 (.930)	-.096 (-.918)	****
TRIPLEN	-5.172 (-2.423)	-3.238 (-6.218)	-2.278 (-3.334)
CONCEN	.409 (1.742)	.290 (2.441)	.252 (2.104)
COST	**** ****	.274 (1.303)	-.228 (-.767)
HUBS	****	****	-4.508 (-.885)
RGNP	****	****	1.169 (2.287)
R^2	****	****	.920

Dependent Variable: FARE
Period: 1981:1 to 1987:3
t-statistics are shown in parentheses below coefficient estimates.

The results (Table 13) seem very dependent on the functional form, suggesting that I have not yet specified the correct model. If this is the case, then the solution for the FAA forecasting process is to use the reduced form to obtain consistent forecasts, although the coefficients will have no structural meaning. In a simultaneous equations system, the reduced form regresses each endogenous variable (demand and price) on all exogenous and predetermined variables. An estimate of the reduced form for FARE is listed in the third column of Table 13. Further research is necessary to obtain a structural equation for fares or yields.

Conclusion

This paper confirms the results of many papers on the airline industry -- profound changes have occurred since deregulation, and consumers seem to be the large beneficiaries. RPM is 25 percent greater than if regulation had continued after 1978. Following Morrison and Winston and others, much of this growth seems to have occurred because the industry is more responsive to demand. Demand elasticities with respect to both price and income are larger (in absolute value), and we are able to reject with some confidence the unbiasedness of the OLS estimator after 1978, when previously that was not possible. Demand seems now to be simultaneously determined with price.

This paper should have many applications to the FAA forecasting process. The most significant result is that using pre-deregulation data to forecast demand causes biased coefficient estimates. This bias would result in under-forecasts of demand, a problem in recent FAA forecasts. Other biases might come from problems with simultaneous equations. Accounting for hubbing will remain difficult until all problems with the O&D data set are solved. Demand regressions (Tables 8, 9 and 10) show similar results regardless of whether they are corrected for hubbing. The advantage of using a formal correction is that it provides a systematic method for adjusting forecasts based on changes in hubbing. Problems in defining discount made it difficult to account directly for the changing distribution of fares. The ATA discount data were not useful in that regard. Future work might focus on using 20th and 80th percentile fares as better measures of discounting.

A structural fare/yield equation was less successful in resolving problems. The default is to use the reduced form to forecast yields/fares. This is similar to the current FAA procedure, except that using more variables, especially GNP, will provide a more efficient and accurate forecast.

A new equation is suggested to forecast short-run changes in ASM. FAA might develop an iterative approach to forecast ASM, demand, and fares, using forecasts of ASM to refine the predictions of demand and fares.

Future research should focus on the structure of fares, using percentile breakdowns as a start. Such a study might also better explore the role of concentration and other competitive measures in determining fares. The airport concentration index seemed to come up positive in most of the price equations, but this result cannot be confirmed until getting a properly specified model.

Given the results of this paper, it is clearer why FAA forecasters have had less confidence in their model since deregulation. This is not to suggest that "professional judgment" (or "intuition") does not have a proper role. Judgment allows the forecaster to correct for changes that are not included in the model. (e.g., triple frequent flyer miles, strikes, safety restrictions, terrorism, etc.) However, as one airline executive commented, the government should beware using too much "intuition" in its forecasts. Observers may allege that "professional judgment" is really politically motivated. This paper should help in developing a forecasting process that is more accurate and less vulnerable to political criticism.

FOOTNOTES

1) David, P. (1934), p. 167.

2) Bailey, Graham and Kaplan (1983), p. 7.

3) ibid., p. 33

4) ibid., p. 78

5) O&D 10-percent Ticket Sample Data, 1977-1987 (Table 12).

6) Carlton, Landes, and Posner, (1980), p. 65-73.

7) Air Transport Association 1987 Air Travel Survey, p.13.

8) Air Transport Association Annual Report, 1982-1988.

9) Federal Aviation Forecasts, (1987) pp. 35, 179-181.

10) Borenstein Testimony, DOT Docket 44719, AWA-T-2, p. 10.

11) Morrison and Winston, (1986), Bailey, Graham and Kaplan, (1985).

12) Borenstein, (1987), p.13.

13) Hurdle, et. al., (1988).

14) Rose, N., (1987).

15) The results, however, conflict with those published by Morrison and Winston (1986, p.14). They calculate a fare deflator of 1.93 between 1977 and 1983. (Their deflator is calculated in the opposite way from mine. Morrison and Winston use 1980-81 data to estimate a fare equation, where fare is defined by revenue per enplanement, and then substitute 1977 and 1983 data to get the "deregulated" fares for the years that are used in their index.) In contrast a deflator based on actual yields is 1.38. Using the 55 percent and 60 percent load factor data I get a deflators of 1.42 and 1.36, respectively. Why the difference? Morrison and Winston's fare equation contained several, but not all, cost components, so the cost measures that they used, especially fuel prices and wages, made up a correspondingly larger share of yields.

    Calculating the index in 1980-1 with high fuel prices and wages (new entrants were not yet in the industry) magnified the difference between 1977 and 1983. (This is especially true because the limited CAB fare regulation was still binding during parts of 1980.) Also, the structure of the airline industry, especially with regard to fare setting, was not yet settled during the early 1980s.

16) I also considered using a switching regression for the fare equation because the industry seems to suffer from periods of cut-throat pricing. Price wars, however, seem to be a regional rather than a national phenomenon (e.g., when PEOPLExpress entered the industry, airlines would fight only on routes that PEOPLExpress served.) A switching model would be much more useful in a study using time series, city-pair data.

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AIRLINE METHODOLOGY - REVENUE FORECASTING AT TWA

Paul Biederman
Trans World Airlines

Purpose of the Forecast

Let me begin by saying that since the change of ownership in 1986, TWA has been remade in terms of management style and financial performance. As many of you know, our operating earnings last year were nearly triple the amount of our strongest year before Mr. Icahn took control, and executive accountability is strictly enforced. The sole criterion of one's longevity in my position at TWA is reasonable accuracy as well as an ability to provide good advice on trends in the current marketplace. Obviously, the fact that I am here this morning means that I have done tolerably well during the past three years.

Regarding forecasting accuracy, my 1986 projections were way off mark but for good reasons: 1) terrorism which destroyed U.S. - origin North Atlantic traffic and 2) our flight attendant strike which further depressed results over a four-month period. Luckily, for me, our leader acknowledged that these failures were aberrations.

As the Table 1 indicates, our forecast variances were +1.1 percent in 1987 and zero in 1988, results which obviously owe a great deal to luck. The traffic and average price pieces were less precise; but since the movements of one tend to counter movements in the other, the overall results were highly satisfactory.

TABLE 1. TWA PASSENGER REVENUE - ACTUAL VS. FORECAST
($ millions)

	1987			1988		
	FCST*	Actual	% Change	FCST*	Actual	% Change
Domestic	$2272	$2294	+1.3%	$2409	$2406	(0.1)%
N. Atlantic	1108	1124	+1.4%	1290	1294	+0.3
System	$3380	$3418	+1.1%	$3699	$3700	0.0%

* Produced November of prior year and revised the following May.

The point I wish to emphasize here, beyond self-congratulation, is that, for us at least, the forecast is not just an intellectual exercise but a serious guideline; and so becoming a slave to one methodology or another just will not do. Consequently, at TWA, we always inject a large dose of judgment and number massaging into any econometric output before a forecast is formalized. Inviting comments from informed individuals and showing the forecast scenario around the company can be valuable in terms of discovering overlooked factors.

Rigid versus Flexible Methodology

Before our change of ownership in 1986, the annual revenue forecasting exercise tended to be a political football, meaning that we would employ a rather rigid methodology (that I will describe shortly) to determine a revenue projection and then wait to see what profit and loss resulted. Because TWA was a high-cost carrier, the outcome was usually a substantial operating loss. Since cost control was never paid more than lip service under the old management, this in turn meant that the revenue forecast had to be arbitrarily increased, whether it made sense or not, in order to make sure that the plan showed a profit. Inevitably the blame for the all-but-sure revenue shortfalls and operating losses during the forecast period would be rationalized away as aberrations, unseen forces, etc. Needless to say, TWA's financial performance was nearly always sub-par under this system.

Happily, since the change in ownership, the operating line now is very healthy. Moreover, since cost control is a serious ongoing concern at TWA, almost any reasonable revenue projection (assuming an expanding economy) will yield an operating profit. Hence, the former need to force the revenue higher at the end of the forecasting process is now absent. To further illustrate the change in the planning mentality, Mr. Icahn insisted that we have been too optimistic on the revenue side in 1989 but accepted the forecast anyway. However, through the first quarter, we are running 2 percent ahead of the target, traceable to stronger-than-anticipated domestic prices and the Eastern strike windfall which more than offset some transatlantic terrorism damage.

Top-Down versus Bottom-Up Methodology

Although we produce long-term forecasts, largely for equipment planning, 95 percent of my forecasting work is short-term, meaning one year or less. Also, our domestic and transatlantic divisions are projected separately. We use a top-down and industry-share approach as opposed to a markets-aggregation or bottom-up process. The reasons we opted for the top-down were two-fold: 1) We could monitor accuracy more quickly, establish causality for the variances, and embark on corrective action where possible. Even if we were highly accurate with the markets approach, we would still not be able to differentiate overall market strength or weakness from competitive strength or weakness because of the approximately nine-month lag in receiving the industry origin-destination tapes from DOT. 2) Individually treating the 400+ markets that TWA serves was too time-consuming, given the sharp reduction in staffing in which two people essentially do the work that eight did pre-1978. Let me reemphasize the first point. The major advantage of the top-down forecasting technique has to do with establishing a monitoring framework. For example, under this methodology we are able very quickly to single out industry size, TWA share, or price in explaining forecast misses. When we seek a remedy for a revenue shortfall, a shrinking industry will evoke a different marketing or pricing response than a smaller traffic share. With a market-aggregation or bottom-up approach, you would not be able to pinpoint causality nearly as quickly because of the long lag in DOT origin-destination reporting. On the other hand, macro-industry data is usually available within a week at the close of a month.

TWA's Methodology

Now let me briefly outline our methodology. (See Figure 1.) We begin with annual industry traffic forecasts in which multiple regression and auto-regressive models are used. The former incorporates real gross national product, industry yield, and time as explanatory variables in the domestic model and real U.S. gross national product with real TWA average prices (as a proxy for the industry) for the North Atlantic. Over the years, we have also experimented with business/pleasure models domestically and U.S.- and European-originating models for the North Atlantic. The auto-regressive or trend model incorporates the latest monthly traffic data and is useful provided economic and pricing conditions are stable throughout the forecast period. Before arriving at an assumption regarding the price variable, we consult our pricing people as to the prospective competitive and cost environment and trends in traffic mix by fare type. Macro-economic inputs more often than not conform to those of a consensus of economists. After obtaining the mechanical output of the models, we analyze the results for reasonableness. Here we are essentially dealing with confidence in the models and qualitative exogenous factors.

Last week I re-ran our industry traffic models for 1988 with actual values for the explanatory variables. The result -- a domestic industry variance of 0.2 percent but a 4 percent North Atlantic miss. The latter was probably caused by applying U.S. rather than European economic variables. European origin traffic has grown by over 80 percent since 1985 when the dollar weakness began. Once our industry forecasts are selected, we move to estimate TWA's traffic share by first projecting a share of industry capacity and then determining our "share gap". In forecasting industry capacity, we rely on equipment delivery and retirement information, trends in utilization, and advance schedules. The "share gap" represents the difference between the capacity and traffic shares and may be the equivalent of competitive position, i.e., a positive share gap means that your traffic share exceeds your share of capacity. Applying a derived traffic share to industry size supplies TWA traffic volumes. Finally, we attach a TWA price (yield), which is a by-product of our industry price assumption estimated earlier as a regression input, to obtain TWA passenger revenue. The annual figures are subsequently broken down into months according to seasonal relationships. It is at this point that others around the company scrutinize the monthly forecasts. If, for instance, the net annual sum of the new collective wisdom exceeds what I have presented, I may be encouraged to raise the forecast. The final step is the Chairmen's review. Once approved, the Controller's department will publish a financial plan which combines our revenue projection with their expense forecasts to reveal the annual and monthly profit and loss targets. This process is repeated again in May as an update. In 1988, we were running a little ahead of plan during the first half so we raised the forecast a touch,which we failed to meet. The net result for the year, however, was the zero variance that I noted earlier. I also have responsibility for station boardings (we serve 86 domestic and 32 international cities) which are used for staffing purposes as well as sales quotas which we use to measure the performance of our city sales managers. Both measures are derived from the monthly macro-traffic and revenue distributions by mechanical and judgmental means.

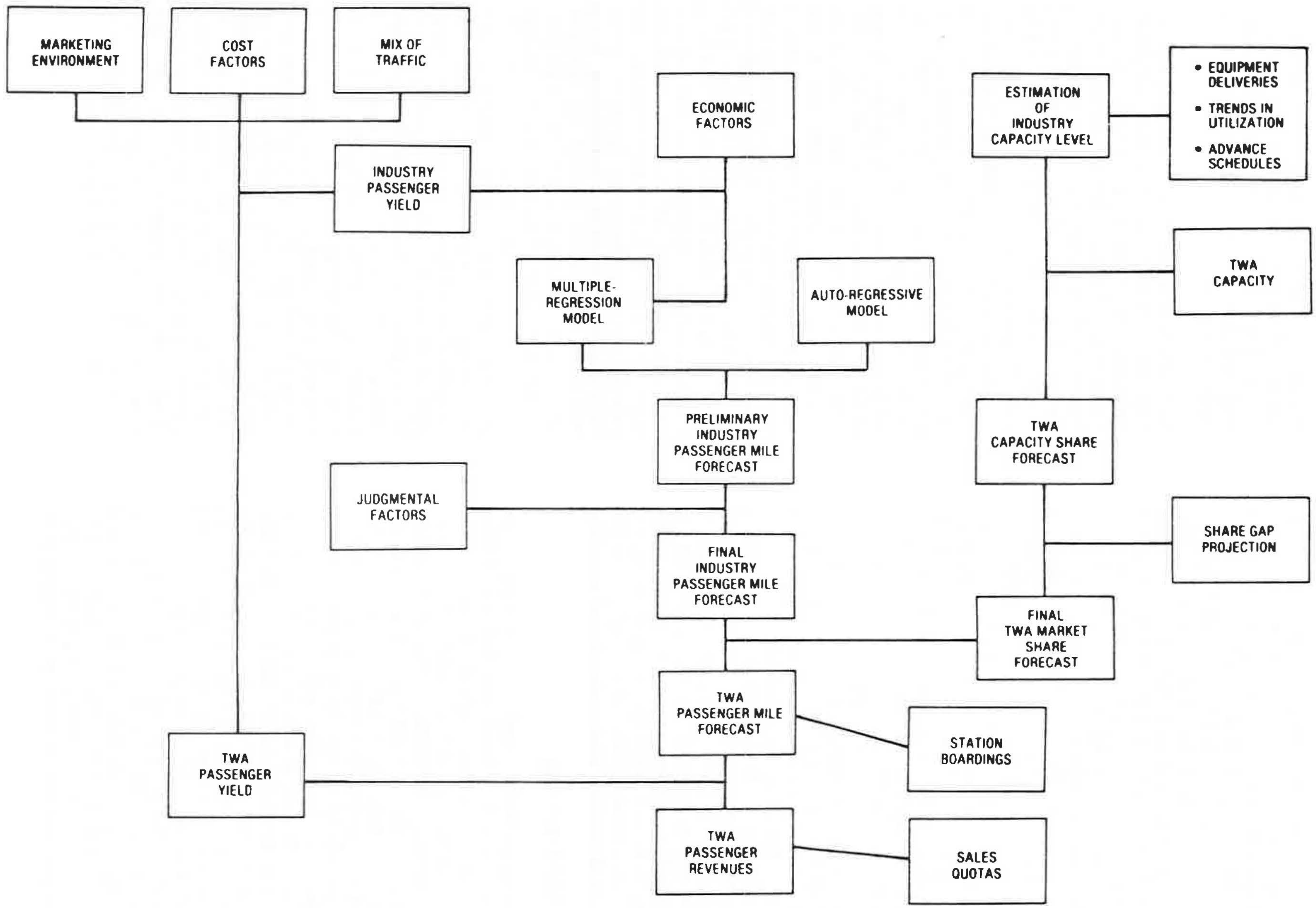


FIGURE 1. TWA Revenue Forecast Development

Conclusion

I would conclude my remarks by saying that our current forecasting approach is highly eclectic or non-doctrinaire but that our forecast process does not end with a set of projections. Rather it becomes a working management tool that can locate areas of strength or weakness and encourage marketing and pricing initiatives.

U.S. AIRCRAFT MANUFACTURERS METHODOLOGY

Jack Howard
Boeing Commercial Airlines

Air Travel Growth and Airplane Replacement Rate Drives Forecast.

The demand for commercial airplanes is dependent on two drivers -- air travel growth and replacement of the current fleet.

Air Travel Growth The Boeing forecast for air travel growth is driven by two parameters -- airline yields and disposable income (GNP is used as a surrogate) -- as can be seen in Figure 1. First, Gross National Product is projected to grow at an average rate of 3 percent per year worldwide. No attempt is made to project cycles in the long term. However, recognition of the U.S. Federal Reserve Bank's announced intent to drive down the U.S. economic growth rate to 2.0 - 2.5 percent in the short term, an economic slowdown bottoming out at 2 percent is included in the forecast. This economic forecast defines the growth in air traveler income.

Next, an assessment of airline operating costs is made. These operating costs are projected to decrease at a rate of 2.1 percent per year. These reductions are driven by a 1.7 percent per year

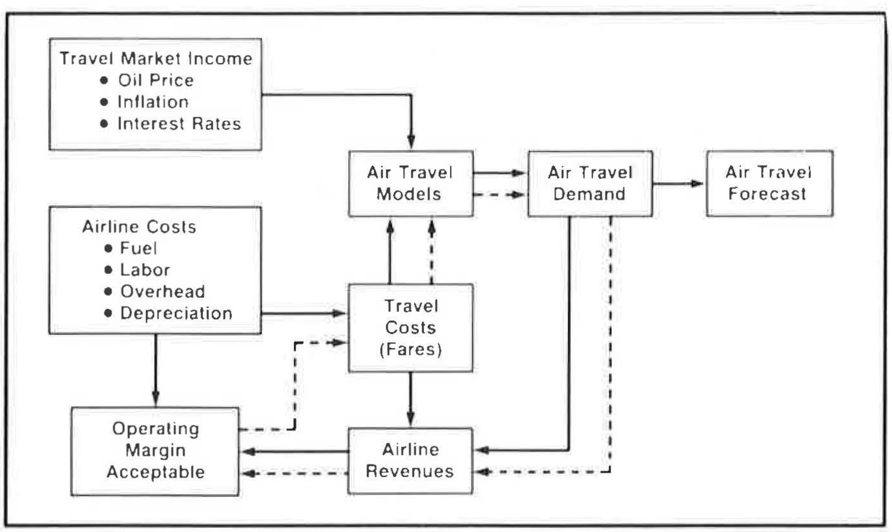


FIGURE 1. Air Travel Demand

reduction in unit labor costs and a 2.5 percent per year reduction in unit fuel costs. In both labor and fuel cost, forecasted decreases are significantly less than that attained in recent history.

The airline traffic forecast is derived from an iteration model that, given the economic and airline cost forecasts, establishes an airline traffic and yield that satisfies an input airline financial return target. (Figure 1) The result of this model is a 5.4 percent annual growth in revenue passenger miles, worldwide, through 2005.

Replacement of Aging Aircraft As indicated in Figure 2, the above revenue passenger mile forecast along with projections of load factor, utilization and departures, defines the future airline fleet requirements. That fleet requirement minus the current fleet defines the growth demand for new airplanes which accounts for 70 percent of new airplane demand in the current Boeing forecast. The remaining 30 percent, is of course, for replacement of aging airplanes which are currently assumed to retire at 28 years of age. The result of the forecast is a world fleet of 12,000 airplanes by the end of 2005 compared to 7,800 airplanes at the end of 1988. In order to provide for this fleet growth and replacement, airlines will require 8,400 airplane deliveries through 2005.

Conclusion

In conclusion, the above describes the forecast methodology and baseline forecast currently used for long-range planning at Boeing Commercial Airplanes. However, the scenario described therein is just that, a baseline. Since no one is a perfect prognosticator, it is therefore essential to test the plan derived from the baseline forecast against alternative scenarios in order to confirm the effectiveness of the plan for all reasonably possible environments.

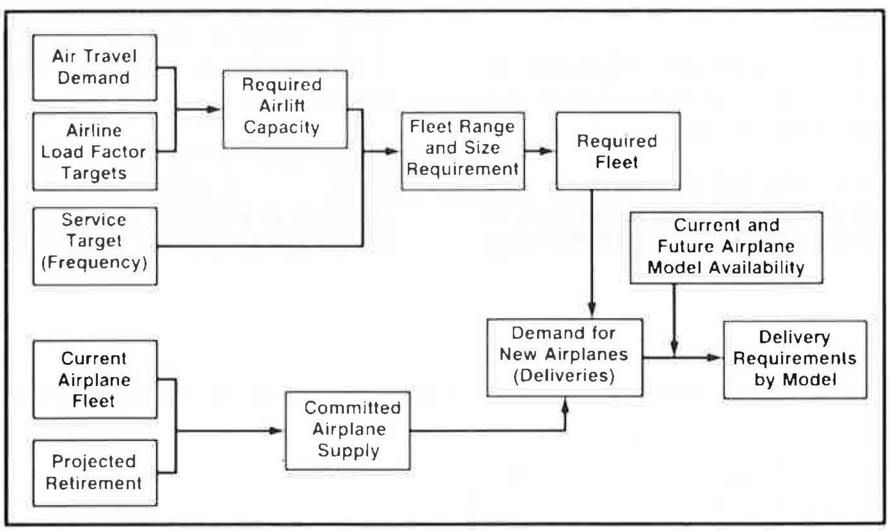


FIGURE 2. Demand For Airplanes

EUROPEAN AIRCRAFT MANUFACTURERS' METHODOLOGY

Didier Lenormand
Airbus Industries

Introduction

Forecasting is a method for evaluating risk. Forecasting methods must be tailored to the sort of risk you want to evaluate. They must be in line with the information required.

Simplified megatrend methods may be suitable for long-term risks, but short- and medium- term risk will need more adjustability to take into account the cyclical structure of all economic phenomena.

Cycles are the result of the combination of many positive and negative factors. Short- and medium-term models must have great ability to reflect a changing environment. They must be adaptive so as to remain realistic as conditions change. In addition, short- and medium-term models must be able to anticipate economic upturns and downturns. They must also be able to simulate these changes and to be used as a "what if" tool.

The Airbus Model

This is what I would now like to demonstrate by discussing the Airbus Industrie Macroeconomic Approach to Medium-Term Requirements for Jet Aircraft in North America.

Forecasting has either a long-term or a short-term horizon. On the long-term side, forecasting is used in most corporate planning for investment analysis and new product evaluation. In Airbus Industries, for instance, among other concerns we have built up a method to estimate the overall long-term delivery flows by main aircraft types to the year 2010. The megatrends we use for this purpose are:

- economic growth : + 3 percent
- fuel price: ≈ inflation rates
- slight decline of real fares
- traffic growth: + 5.5 percent annually
- capacity requirement: + 4 percent annually

For the shorter term -- 3 to 10 years -- we forecast to minimize risks related to day-to-day management such as market opportunity, threats to our activities due to political uncertainties, market opportunity, and positive or negative influences of the cyclical economy. These risks are well known to the aviation industry.

Airbus Industrie, as an aircraft manufacturer, seeks to limit this sort of risk and to have a method to anticipate cyclical influences on such elements as production mix (NB VV WB), production rates by aircraft type, etc.

Many methods exist for short- and medium-term forecasting, but to properly take into account the relevant cycles requires a model with several well chosen variables. These should be combined in a system dynamic approach, where the different variables are put into proper relation to the whole model.

We have started to use a model that takes into account the following external variables:

- economic inputs: GDP, fuel price, inflation, financial rates;
- industry operating characteristics: average flight length, aircraft utilization, average aircraft life;
- airline cost planning: DOC trends, operating margins, fare rates;
- air system limitations: airport and air traffic congestion, noise regulation;
- supply constraints: aircraft delivery delays;
- aircraft availability and competitiveness: effect and availability of new technologies;
- other: up to 50 external variables set at their 1987 values.

From this initial set of inputs we have worked out the basic relationships in the model to get the initial drivers which will allow further calculation of the number of new aircraft required.

These drivers are:

- demand in RPK in total and by market segments – correlated to GDP, fuel price, fares, and frequencies;

- o orders and deliveries of new aircraft -- with deliveries derived from orders, backlog, and production limits;
- o airline operating performance -- number of flights, load factors, number of passengers carried;
- o airline financial performance -- cost and revenue;
- o fleet composition -- number of aircraft by size and category for the region.

System dynamic approach is illustrated in Figure 1. Let us look at an increase in demand (which is in fact a long-term historical trend). It increases the load factor, which in turn increases airline revenues. Increase in demand reduces unit cost, which is a condition to reduce fares and further stimulate demand. Last but not least, higher demand and greater revenues stimulate aircraft orders.

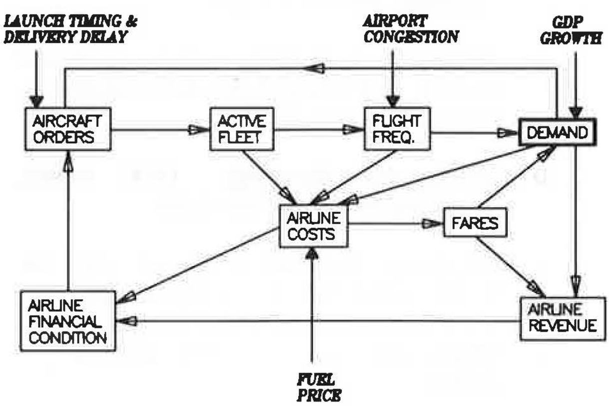


FIGURE 1. Factors Affecting the Pattern of Orders

At this point the dynamic may reverse itself because of negative external factors such as delivery delays or increase in fuel prices. These have a direct effect on cost, which results in raising fares, reducing demand and thereby reducing airline load factors and revenues. By the time the new aircraft are delivered the airline may be in a down-turn cycle which might be exacerbated by the new extra capacity. This is a simplified view of the way the system dynamics works.

We have already seen that traffic growth (RPK) is the main driver of the model. From an airline fleet planning standpoint, this demand must be transformed into a given number of aircraft (See Figure 2).

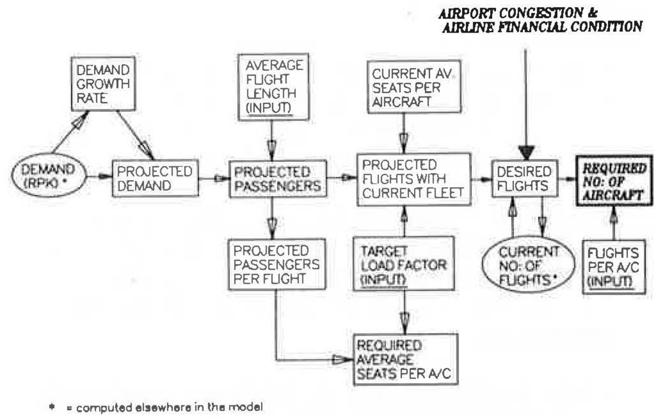


FIGURE 2. Airline Planning

Present demand is projected into the future according to a given growth rate. The projected demand is transformed into a projected number of passengers by dividing by the average flight length. The projected flights with the current fleet result from projected passengers times a target load factor and an average number of seats per aircraft.

Projected flights (trips) with the current fleet along with current flight and airport constraints (limiting slots) gives the desired number of flights, which in turn gives the required number of aircraft by applying a given number of flights per aircraft.

Obtaining the required number of aircraft to meet a given demand is a major forecasting step in determining the actual number of aircraft to be ordered. To achieve this, the following must be taken into account: (1) the fleet retirement policy (noise, age, leasing contract) and (2) additional aircraft to accommodate traffic growth. Combining these two gives the total number of aircraft required.

Having reviewed the main steps in this forecasting process, let us now look at how well the model fits reality (Figure 3).

Domestic Demand: These two curves take into account the cyclical phenomenon of air transport in 1979 (the first year of deregulation) and in 1981 (the second oil crisis).

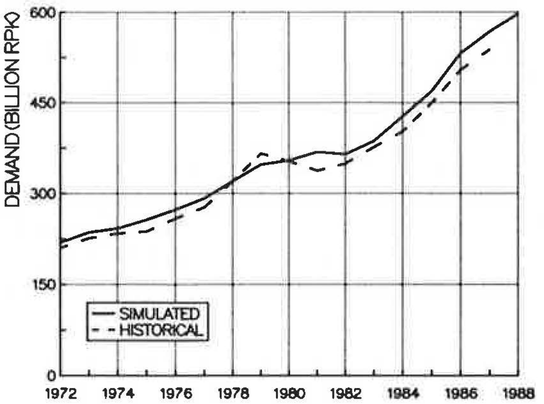


FIGURE 3. Domestic Demand - Model vs History

In terms of aircraft deliveries, the same level of accuracy applies. (See Figure 4.) These two curves emphasize the close correspondence between simulated and historical data.

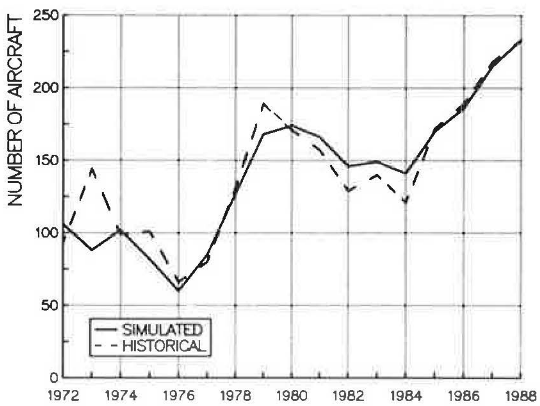


FIGURE 4. Deliveries - Model vs History

A more complex task is predicting total orders in relation to airline operating margins. Figure 5 shows the aircraft ordering pattern when the financial position of airlines is good. They anticipate the ordering of additional capacity by one year.

To go one step further, I would like to stress how useful this sort of modeling can be for the short and medium term and even the longer term forecasting by running a "what if" case.

First let us take a reference case. It is the most probable scenario, and we call it the base case. We use assumptions about the economy, airlines, and the operating environment as shown in Figure 6.

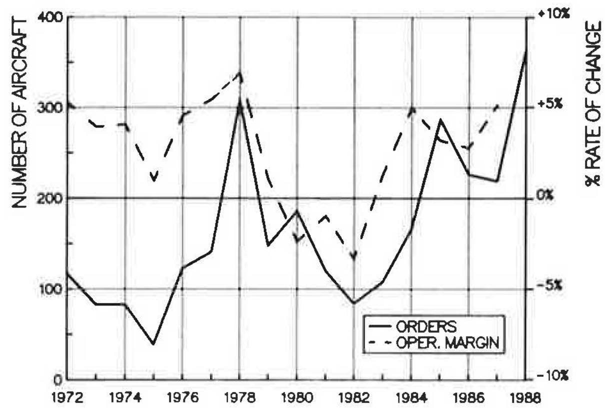


FIGURE 5. Total Orders vs Airline Operating Machines

Figure 7 illustrates the growth of the main driver of the system -- the demand, for domestic (+ 5% percent per year) and for international (+ 5.6 percent per year) hauls.

Input Assumption	History (1970 - 1988)	Forecast (1988 - 2003)
Economy	Cyclical around:	Cyclical around:
Real GDP Growth	+2.6% p.a.	+3.0% p.a.
Fuel Price Growth	2 Surges in 1974 and 1980	+1.8% p.a.
Interest Rate	+9.7% p.a.	+8.0% p.a.
Inflation Rate	+6.4% p.a.	+4.8% p.a.
Airlines		
Average Flight Length	Doms +10%, Inat +40% Overall	Doms +5%, Inat +10% Overall
Average Flights per A/C	Doms -33%, Inat +1% Overall	No change
Environment		
Airways and Airport Restrictions on Flights	None	None
Number of Routes	Doms +23%, Inat +12% Overall	Doms +5%, Inat +10% Overall

FIGURE 6. Base Case: Inputs and Assumptions

This base case demand will fuel the airline revenues illustrated in Figure 8 in terms of the operating margin; and that, in turn, will stimulate fleet growth -- expressed here in terms of total orders.

The airline ordering patterns are turned into yearly deliveries of narrow-body and wide-body aircraft to the year 2003.

The model also permits us to do "what if" simulations. For instance, if we constrain flight growth to only 60 percent of the current level for domestic markets (instead of some 200 percent in the base case), the number of flights will decrease by 700,000 by 2003. (See Figure 9.)

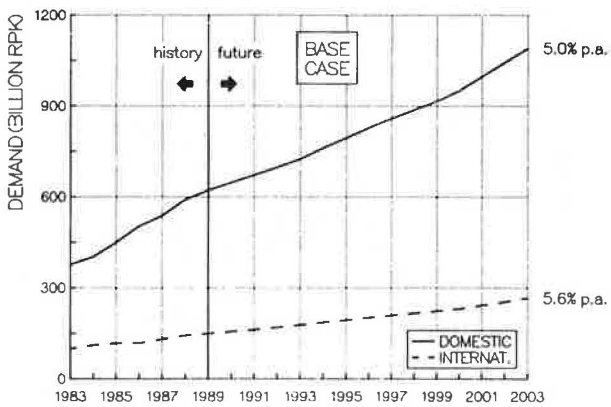


FIGURE 7. Domestic and International Demand

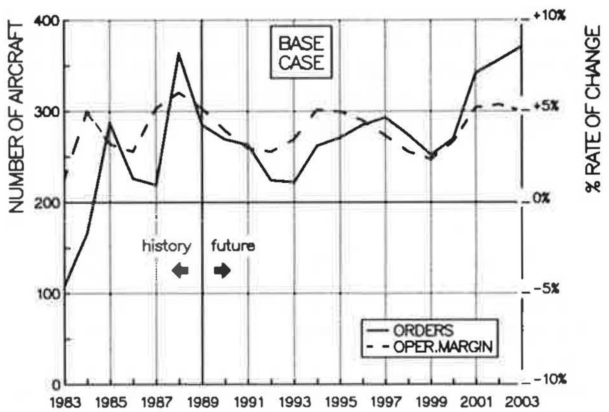


FIGURE 8. Total Orders vs Airline Operating Margin

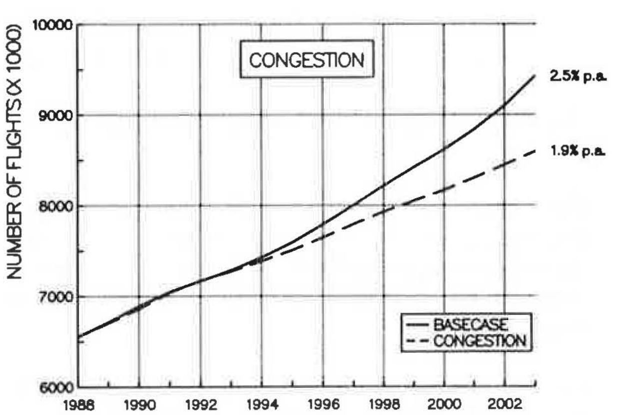


FIGURE 9. Domestic Flights

The delivery of narrow-body aircraft is most affected by this limitation, particularly from 1995 onward (25 percent less delivery over the period). (See Figure 10.) As growth in flights becomes increasingly restricted, more and more capacity is required to meet a growing demand. The average domestic aircraft size grows from 140 to 200 seats and the wide body come to the rescue (+ 13 percent over the base case). (See Figure 11.)

To sum up the effect of the higher constraint on flights, total deliveries for the U. S. domestic market are reduced by 12 percent or 500 aircraft. The effect of air congestion will be noticeable only from the second third of the period onward

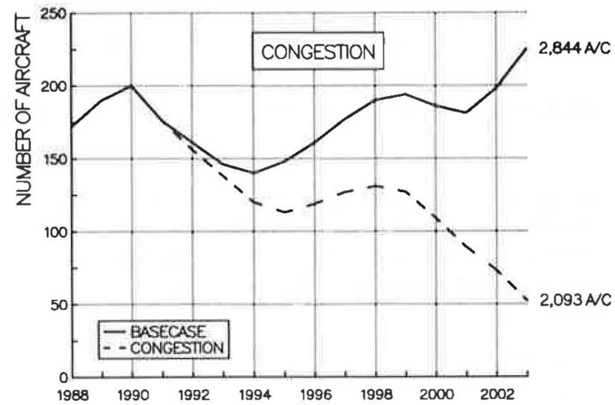


FIGURE 10. Deliveries for Narrow Bodies

North American market

	Forecast period	1989 to 1993	1994 to 1998	1999 to 2003
Base Case	Narrow bodies	873	816	984
	Wide bodies	582	478	451
	Total deliveries	1,455	1,294	1,435
Congestion Scenario	Narrow bodies	860	610	450
	Wide bodies	570	513	660
	Total deliveries	1,430	1,123	1,110

FIGURE 11. Delivery Summary (1989 - 2003)

since the orders for the early 1990s are already fixed. It will be most severe near the end of the forecast period, when the tension to get extra slots will rise it to its maximum.

To conclude, we have a tool that helps to build possible scenarios, and to simulate "what if" cases for the short- and medium-term future. However, you will notice how a medium term decision on aircraft ordering can affect the longer-term outlook.

AIRPORT OPERATOR METHODOLOGY

Alice Herman, Port Authority
of New York and New Jersey

Objectives of Airport Traffic Forecasting

The objectives of airport traffic forecasting are to provide criteria for financial planning and facility planning. For financial planning we are concerned primarily with revenue forecasting, operations and maintenance cost projections, and capital programs. Looking at facility needs, traffic forecasts provide planning criteria for both airside and landside capacity requirements, ranging from FAA terminal area control and ground control systems, runways and taxiways, aircraft gates and parking spaces, to terminal passenger handling facilities, ground access systems, and cargo handling facilities.

Financial Planning Financial planning relies upon the forecast in assessing sources of revenue that depend upon traffic volumes. These include concession revenues, automobile parking revenues, fuel sales, and flight fees. Operations and maintenance cost projections that relate somewhat to traffic volumes include staffing, contractor services, and materials. For capital programs the forecast plays an important role in decisions about the kinds of investments to be made, both dollars and functional requirements, as well as determining reasonable cost recovery plans.

Facility Planning Facility planning requires a close look at annual and monthly traffic levels, as well as daily and seasonal peak load activity levels. Airport traffic is looked at as a number of discrete elements -- domestic passengers, international passengers, parked cars, aircraft movements and seats, cargo tonnage, fuel volumes loaded. For aircraft movement projections to be useful we need to consider them by aircraft type and time of day or season as criteria for traffic control systems, runway, and taxiway planning and by airline for the planning of aircraft gates at passenger terminals. Passenger, vehicle, and cargo flows are projected by the time of day and by terminal as criteria for appropriate facility planning. These criteria may be summarized as follows:

FORECAST ELEMENTS FOR FACILITY PLANNING CRITERIA

1. Airside Capacity Planning Criteria

a. Aircraft movements		
by aircraft type	}	traffic control
	}	systems
by time of day	}	runways/taxiways
(by season)	}	
by airline	}	aircraft gates

2. Landside Capacity Planning Criteria

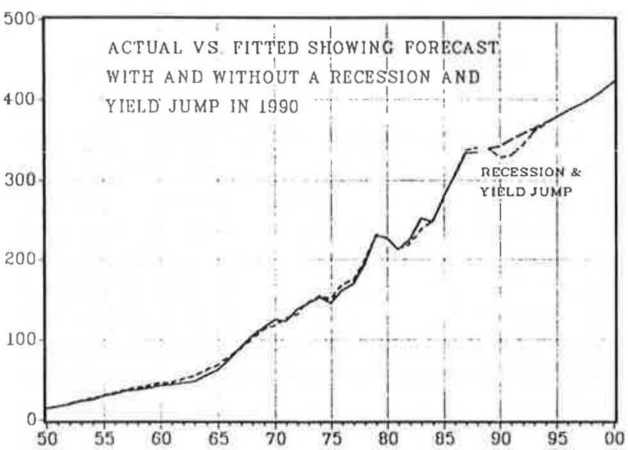
a. Passenger flows	}	passenger handling
by time of day	}	facilities
by terminal	}	(ticketing, check-in,
		baggage, concessions)
b. Vehicles flows	}	terminal curb space
by time of day	}	on and off airport
by terminal	}	roadways
c. Cargo flows	}	cargo handling
	}	facilities
Trucking activity	}	trucking facilities

Truck activity has dramatically increased at the New York and New Jersey airports. We are now considering ways to determine the amount of air cargo that travels by road feeder service and methods for projecting the volume of this activity in the future as planning criteria for on-airport cargo and trucking facilities. In preparation for this TRB workshop we had been asked to think specifically about forecasting issues that call for judgment and intuition. Gradual recognition that a substantial amount of air cargo was continuing to move on air waybills but traveling by truck rather than air is probably one of our best recent examples of intuition and judgment leading to further investigation that is now affecting our forecast methodology.

Passenger Forecasting

Let me now focus on our domestic passenger forecasting methodology. Traditionally we develop market demand forecasts using an econometric top-down approach beginning with forecasting national traffic. The rationale for this approach is that approximately 50 percent of our airport users are non-area residents. After developing the national forecast we then develop regional share forecasts. Independent of this approach we are also working on a bottom-up forecast, through which we first look at regional economic factors in order to surface any influences that might be disproportionately important to our region and not show up as readily on a nationwide basis. In addition to the econometric approach we consider demographics very important, especially for forecasting traffic further out than 10 years. Elements that we are interested in incorporating into our forecasting efforts are national demographic trends such as age and income, travel participation rates and trends, and both inter- and intra-regional demographic shifts. The most recent addition to our forecasting tools has been a networking model developed to assess the potential impact of various hubbing strategies. The model considers both origin and destination and transfer traffic flows, choices in aircraft type, as well as airline operating costs and profit maximization.

The U.S. domestic passenger forecast is defined in revenue passenger miles per capita, as shown on Figure 1.

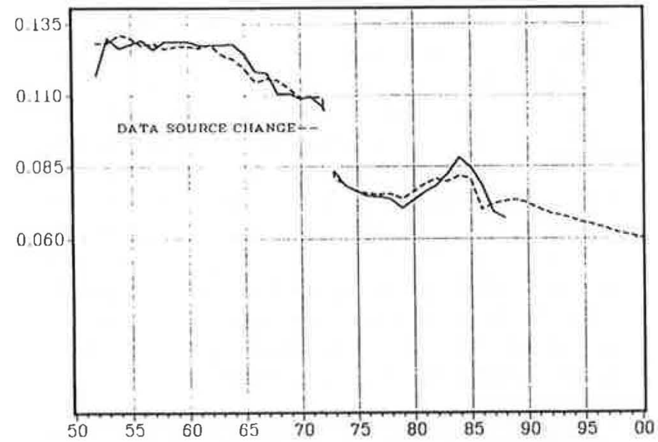


RPM's per capita = F(INCOME, AVERAGE YIELD, TREND LINE)

FIGURE 1. Domestic RPM Per Capita

We are increasingly interested in considering alternative scenarios as part of our forecasting process. In a recent domestic passenger forecast we show one example of this, projecting the effect that a recession and yield jump might have. It is important to make the point that we do not consider alternative scenarios substitutes for specific forecast numbers. Instead they are important additional decision-making tools in this environment of constantly changing aviation players and strategies.

Figure 2 shows the New York region's share of U.S. domestic enplanements, which is presently approximately 6.5 percent. In deriving the regional share from the nationwide domestic passenger forecast, income and yields are again the main indicators. Once we develop a regional passenger traffic forecast, those volumes need to be distributed among three airports. To do so we use a model that takes into account intra-regional demographic trends and relative ease of airport access measured in both time and dollars.



Regional Share = F (Regional Share, Ratio Region/USA)
TRAFFIC INCOME YIELDS

FIGURE 2. New York Region Share of U.S. Domestic Enplanements

Forecasting Aircraft Movements

Forecasting the aircraft movements requires estimates of fleet mix and available seating capacity, projected load factors, and average passenger load per movement. Small narrow-body, large narrow-body, small wide-body and large wide-body aircraft are separately identified. There is a significant difference in average seats per aircraft between domestic and international flights. The significance of these projections becomes apparent in a situation such as we currently face at Newark International Airport, which has been overwhelmingly domestic but is now receiving a surge of attention from international carriers. The fleet mix that this potential activity would bring with it has important implications for airport facility needs.

Importance of Forecasts in Facility Planning

Traditionally the most important use of our air traffic forecasts has been as a planning tool for future facilities. A 10-year forecast has proven over the years to be a very good indicator of the traffic levels to be accommodated a decade in the future. The challenge that we now face is to increase our focus on short-term projections, one to two years. For example, because we are in the beginning stages of a $5.5 billion redevelopment program at all three New York area airports, construction staging over the next several years is an important capital investment issue for the Port Authority. Projected traffic levels that need to be accommodated during this period is a key piece of the decision-making process.

Finally, the dynamic nature of airline market strategies increasingly requires econometric modeling to be supplemented by careful tracking and analysis of the current market, as well as development and consideration of alternative scenarios. This need is particularly important to the New York/New Jersey region in light of the recent history of People Express and the current uncertain activity levels of important NY/NJ airport users such as Eastern and Pan Am.

To monitor the market in the kind of detail that we need, we segment the air passenger market into business versus pleasure travelers, domestic versus international, and various age segments. For air cargo we look at bulk cargo versus small package and all-freighter activity versus cargo carried in the bellies of passenger aircraft and in combos. Through a combination of econometric modeling, demographics, market analysis, and development of alternative scenarios, traffic forecasting retains its role as an important tool for airport facility and financial planning.

PART II OTHER PERSPECTIVES

SUMMARY

Richard Mudge
Apogee Research Inc.

This summary focuses on the major themes raised by the speakers from outside the airline industry. Much of the discussion involved social, economic, and technological trends that could result in structural changes in the way we use the aviation system -- that is, changes that could greatly reduce the usefulness of forecast models using historical trends. While many of these topics and ideas might be vital to understanding long-term forces in demand and supply of aviation, they are not easily incorporated into traditional forecasting approaches. The subjects presented were:

- changes in social values and life styles -- Marilyn Block, The Naisbitt Group;
- demographic and industrial shifts in where people live and how they work across different parts of the country and within given metropolitan regions -- John Kasarda, University of North Carolina;
- recent shifts in the economic structure of the aviation industry -- Steven Morrison, The Brookings Institution;
- economic risk assessment techniques as a systematic way to address uncertainty in long-term forecasts -- Richard Mudge, Apogee Research;
- Evolving long-term, worldwide trends in the environment and energy fields -- James MacKenzie, World Resources Institute; and
- technological developments that could revolutionize how aviation services are provided -- John White, National Aeronautics and Space Administration.

The key theme developed by most speakers was the need to see the public as customers. In other words, it is important to incorporate more elements of market research into forecasting since consumer attitudes affect almost every aspect of demand forecasts for aviation services and how these services will be supplied.

For example, airlines and aircraft manufacturers already incorporate some of these forces into their forecasting efforts -- manufacturers on a long-term scale and airlines on a generally much shorter time horizon.

Social trends and values are hard to identify with any certainty until they have become well established. Data to predict these changes are necessarily soft in nature and subject to individual interpretation. Further, even if identified correctly, it may not be clear how to incorporate their implications into traditional forecasting models. Development of alternative scenarios may be one approach that could ultimately lead to parameter changes. For example:

1. The trend toward public concern with environmental problems implies (a) greater unrest concerning aircraft noise, which in turn, could impose (b) increased capacity constraints for many busy airports, leading to (c) the need for larger aircraft and requiring (d) new airport terminals with somewhat different configurations.
2. Capacity constraints could also limit market entry, thus (a) leading to higher airline fares with (b) greater profits for airlines and perhaps larger revenues for airports but (c) reduced air travel as well.
3. Similarly, airlines might be forced to convert to Stage 3 aircraft more rapidly, a step that would also (a) increase financial pressures on the industry as existing aircraft are retired earlier than planned, leading to (b) higher fares, and (c) reduced travel.

As a result of such a series of hypotheses, it might be wise to incorporate larger aircraft sizes and higher fares into a series of alternative long-term forecasts.

Demographic changes -- including the size, age, and family structure of the population -- affect the overall magnitude of demand for air travel and its geographic distribution. New geographic structures of metropolitan regions (the decreased importance of central cities as job centers, for example) will also affect the quality and cost of airport access, with implications for airports serving the metropolitan area. Shifts in industrial structure -- perhaps toward greater internationalization of service industries -- will change the need for air travel. Some of these shifts might be examined through micro-scale studies of shifts of industrial and demographic structure within certain regions that may be ahead of national trends.

Environmental and energy trends -- the greenhouse effect and rising sea levels, for example -- could have far reaching influences on life styles as well as on demographic and industrial bases. In general, however, their direct effect on aviation appears relatively limited, as they may result in higher fuel prices.

Technological change has always been a key characteristic of the aviation industry. While the scale of some of the changes now under development is striking, the financial and organizational role played by the government may make it easier to predict the speed with which they will occur.

Probabilistic techniques (such as economic risk assessment) offer one approach to incorporating these socio-economic and technological changes into existing forecasting techniques. By recognizing uncertainty, and analyzing these techniques it may be possible to incorporate uncertainty directly and explicitly in the modeling process.

The extent to which these long-term forces are folded into aviation forecasts depends to a large degree on the time frame for the forecast. One-year forecasts, such as those used by many airlines, are probably less in need of greater sophistication. Five- or ten-year forecasts represent a middle ground where there is a need to recognize changes in economic and industrial structures of the industry and to extrapolate current demographic and social trends. If, however, strategic forecasts -- those of twenty years or more -- are to be of use in airport planning or long-term public investment decisions (such as the next NAS Plan) ways must be found to consider these forces in a systematic way.

MEGATRENDS: THE NAISBITT GROUP FORECASTING PROCESS

Marilyn R. Block
The Naisbitt Group

With enormous amounts of information available today, the opportunity cost of ignorance is incalculable. Changes in economic, social, political, and technological areas occurring now will have a dramatic effect on our future. By closely monitoring local events through newspapers, trade journals, and other sources, and then placing these events into a larger social context, The Naisbitt Group is able to forecast trends that are likely to affect companies.

Research Methodology

The Naisbitt Group obtains information about the economic, social, political, and technological environment, and its effect on a variety of institutions, through a research methodology called thematic content analysis. This approach examines the present in order to comprehend and manage the plannable future.

Content analysis is a method of studying and analyzing communications in a systematic, objective, and quantitative manner to measure variables. It is a method of both observation and measurement. Instead of observing people's behavior directly, asking them to respond to scales, or interviewing them, the content analyst takes the communications that people have produced and asks questions of the communications. Content analysis generally is used to determine the relative emphasis or frequency of such phenomena as propaganda, trends, styles, and changes in content.

Content analysis is not new -- it first was used during World War II. At that time, the American intelligence community was searching for a way to discover what was occurring inside enemy nations. With the help of Paul Lazersfeld and Harold Lasswell, now well-known communications theorists, intelligence experts decided to analyze the content of German newspapers.

The newspapers proved to be the best source of information about conditions within Germany. Although information about the country's supplies, production, transportation, and food situation remained secret, the strain on Germany's people, industry, and economy was well documented.

In time, it was possible to determine whether conditions were improving or deteriorating in Germany by carefully tracking local stories about factory openings and closings, production targets, train arrivals and departures, and so forth. Military casualties were estimated by adding up the number of individuals listed in obituaries. Impressed by the accuracy of information, intelligence agents began analyzing the content of newspapers in Japan.

Thematic Content Analysis. There are several ways to evaluate the objects of content analysis. The first and most common of these corresponds to nominal measurement: count the number of items in a defined category after assigning each item to its proper category.

A second form of evaluation is ranking, or ordinal measurement. If one is working with fewer than 30 objects, they can be ranked according to a specified criterion.

A third form of evaluation is rating. Objects are deemed superior, equal, or inferior to other objects on the basis of some objective standard.

More complex, but more meaningful than these methods, is thematic content analysis. This involves more than merely identification of the object. It requires placing the object within the larger context of society. The Naisbitt Group seeks to identify trends as they emerge, before they reach widespread public consciousness. Thus, nominal and ordinal measurement are inappropriate techniques, since one would anticipate very few examples of an emerging trend. More telling is the identification of issues in different geographic areas that in and of themselves easily could be overlooked but, when viewed as part of a national context, suggest trends.

The topic of education offers an example of the value of thematic content analysis in comparison to the other three methods. The proportion of articles in newspapers pertaining to education has remained constant at approximately 14 percent over the past decade. However, the issues within education have changed dramatically. A nominal or ordinal approach would have missed such critical trends as privatization of education, business-education relationships, teacher competence, and declining achievement.

Thematic content analysis serves as an empirical method for studying emerging trends and facilitates the use of quantitative techniques for correct inferences from the data.

Secondary Data Analysis. Once a trend has been identified through thematic content analysis, secondary data analysis ensures accurate inferences about cause and probable future effect. Secondary analysis refers to the re-analysis, for a new purpose, of data originally gathered by another researcher. Archival data are well-suited for measures of incidence and frequency because these data are not specifically produced for comparison and inference. The outstanding advantage of physical evidence data is freedom from reactive measurement effects; that is, there is no intrusion by a researcher into the various settings to be described which might produce biased information.

Monitoring Social Change. Thematic content analysis is an effective technique for monitoring social change because, simply stated, a newspaper is a closed system. For economic reasons, the amount of space devoted to news in a newspaper -- the "news hole" -- does not change significantly over time. When something new is introduced, something else must be omitted. Newspapers operate on the principle of forced choice within a closed system -- you cannot add unless you subtract.

This forced-choice situation causes the news hole to serve as a mechanical representation of social priorities. By keeping track of the changing content of the news hole, The Naisbitt Group measures the importance of competing issues.

Why are we so confident that thematic content analysis is an accurate forecaster of social change? Because we have proven it time and time again.

Over the years, we have observed a variety of social issues emerge, expand, and then decline. In the early 1970s, for example, the news hole in American papers devoted an increasing amount of space to environmental concerns. What was reduced in the closed system to accommodate the intrusion of environmental concerns? News about civil rights yielded as environment gained. By 1973, the closed system showed a crossover and, for the first time, the environment became a more important preoccupation than civil rights.

These research methods -- thematic content analysis and secondary data analysis -- enable The Naisbitt Group to place seemingly unrelated events in the context of evolving issues, to delineate appropriate responses to these issues, and to give organizations a basis upon which to make sound decisions.

The Naisbitt Group Data Base

The Naisbitt Group analyzes the content of a diverse mix of printed materials, including local newspapers, trade journals, government papers, and reports. Each week, The Naisbitt Group monitors several hundred local newspapers. These papers represent America's largest cities and smallest towns, industrial regions and agricultural areas, areas of decline and areas of growth. This geographic and economic diversity enables rapid identification of local, state, regional, and national trends.

A smaller but no less critical component of the thematic content analysis data base is trade journals. New developments often appear in specialized publications before exposure in newspapers.

These data sources represent the critical point in the normative cycle of awareness and acceptance of issues and events at which media coverage and public awareness begin to increase and forecasting error begins to decrease. This cycle entails:

Idea creation. Information appears in specialized periodicals and fringe publications. Public awareness is very low, and the likelihood of error in projecting future impact is high.

Elite reports and industry journals. Trade journals, research reports, and specialized newsletters begin to provide information.

Local news. Broadcast and print news begin to cover the issue.

Popular magazines. Coverage by news magazines provides information to a broad segment of the population.

Government awareness. As public awareness about an issue grows, local, state, and federal governments often react to demands for action. At this point, public awareness is very high and the likelihood of errors in projecting future impact has been reduced substantially.

Policy enactment. New policies to deal with the issue in question often occur following government awareness.

The Analysis Process

Trends have two significant elements: events and behavior. If an event occurs that does not alter the way in which individuals behave, it does not presage a trend. If, however, an event results in some kind of behavioral change, it may represent an emerging trend. For example, in 1983, the U.S. government restricted the amount of money it provides hospitals to cover medical services for the elderly. Hospital administrators responded by refusing to take Medicare assignments. This in turn caused many elderly to forgo necessary care because they could not afford it on their own. The event, reduction in federal Medicare support, changed behavior in a way that could lead to a new trend -- increased medical problems among the elderly.

When a similar event occurs in an area unrelated to the first event, and resulting behavior also is similar, this provides additional evidence that a trend is developing.

Critical Thinking

The trend analyst's primary responsibility in reading newspaper articles is to identify events and behavior that create patterns suggestive of trends. This is a difficult task because the amount of information available is increasing exponentially -- estimates suggest that it doubles every two to three years. More than 15,000 scientific and technical articles are published daily worldwide. As delivery technologies improve, the speed with which new information reaches us accelerates. With information reaching us sooner and in greater volume, separating that which is useful from that which is irrelevant becomes an increasingly valuable skill.

Eight questions should be asked in evaluating information received via print and broadcast media:

- **How credible is the source of information?** Too often, we do not look past the conveyor of news to the original source of information. If a newspaper reports that the number of families living in poverty has declined, we accept that information because we respect the newspaper. It is important to consider where the newspaper got its information. If the report indicates that a state agency said the number had declined, it is important to consider how that agency conducts its research and whether it has proven reliable in the past. Often, a news story will credit a "Western analyst" or "university professor" -- the critical thinker will question whether such a source is credible.

- **Is an event or behavior described?** Frequently, information used in formulating decisions is speculative -- it describes state-of-mind or threats of future action. Reliance on this kind of information is harmful because it elicits actions on the basis of an emotional response to a projected scenario instead of an unemotional response to data.

- **Within what context has the event or behavior occurred?** Information presented out of context can be misleading and result in flawed decisions. The plight of the American farmer is illustrative. During late 1985, when the U.S. Congress was working on the farm policy bill, a number of newspapers published stories about family farms experiencing severe financial difficulty. The obvious response would have been concern that Congress was not doing enough to help this sector of the economy. What many of the news stories failed to report, however, was that large corporate farms and small boutique farms were doing very well. The proportion of farms in trouble was relatively small.

- **What is the historical context?** Historical development is important when it demonstrates relativity. To return to our example of the family farm, many reports indicated that thousands of farms had failed in 1984 and 1985. Without reference to the hundreds of thousands of farms that failed in the 1950s and 1960s, it is impossible to assess the severity of present circumstances.

- **Is anything about the event surprising or unusual?** Many news stories present information that is taken for granted even though the event is new. For example, if the evening news reports a cave-in at a coal mine, we are unlikely to consider this an unusual occurrence. Experience has taught us that cave-ins are a hazard associated with coal mining, and we have heard similar news reports over the years. Anything about an event that surprises us, however, provides new information that can be used to advantage.

- **What is likely to happen next as a result of the event or behavior?** Every event affects some sector of society. A change in birth rates will affect manufacturers of baby food. A forest fire may affect the lumber industry, which, in turn, has implications for home builders. Events should not be viewed as single occurrences. In the information economy, the executive able to project beyond the event to possible outcomes is less likely to be taken by surprise. Similarly, it is important to avoid the "domino-theory" trap. Events and their outcomes do not progress in straight lines, but rather grow like spider webs. An event can trigger reactions along a number of spokes and around several concentric circles. The recent plunge in oil prices, for example, not only sent shock waves through the oil industry, but had an impact on worldwide securities markets and manufacturing costs. The effects of lower oil prices on many different industries are both independent and interrelated.

- **How important is this event?** Whether we realize it or not, we constantly evaluate the relative importance of events. A news bulletin about freeway traffic is important if we travel the route in question and inconsequential if it is on the other side of town. Critical thinking involves the ability to ascertain the relative importance of events so that we neither overreact to the unimportant nor minimize significant events. Important pieces of information often are missed because they do not have imminent effect. Consider a banker who reads a newspaper article about increased use of technology and decreased labor in American industry. Although seemingly unrelated to banking, there are some important implications. The banker who is able to think critically will immediately consider that capital needs are changing -- capital requirements for people, plants, and equipment will decrease and capital needs for technology to update production will increase. Moreover, the timespan within which capital is required will decrease. Technology is outdated far more rapidly than a physical plant, so industry leaders will be seeking capital far more frequently than in the past. This in turn suggests that short-term instruments will be required.

- **What should you look for as indicators that something is going to happen?** Once you have projected what is likely to happen, it is necessary to identify those things that will indicate whether the projected outcome is probable. Shortly after the explosion at the nuclear power plant in Chernobyl, news reports suggested that the event might be advantageous to American farmers, because the incident had occurred in the heart of Soviet farmland. Indicators that Soviet agriculture was in jeopardy included warnings to avoid drinking water and fresh produce, an Eastern bloc ban on Soviet food, radiation in fresh milk, and so forth. These events do not guarantee success for American farmers -- to assume that they do is to fall into the domino-theory trap. What they do suggest is a Soviet need for agriculture imports. The spider web analogy provides a broader context within which other competitors play a role. Canada or Argentina might benefit more than the United States.

These eight questions, applied to print and television news, enable trend analysts to develop a critical sensitivity to the quality of everyday information. Critical thinking skills reduce the amount of useful information that is ignored and decrease the tendency to rely on confusing, irrelevant information.

Trends and Forces that will Affect Aviation

Two trends will strongly influence commercial aviation during the 1990s -- consumer protection and time and convenience.

Consumer Protection. The consumer protection issue encompasses both safety and fairness. Although safety always has been a concern, public perception about culpability has undergone a shift in recent years. Public reaction to acts of terrorism directed toward U.S. carriers (e.g., Pan Am 103) and the number of incidents linked to aging aircraft represents the emergence of a growing demand for accountability. Consumers will continue to favor deregulation as it relates to competition, but they will demand regulation that addresses safety.

There is an emerging demand by consumers for "fairness." This is easily illustrated by queuing behavior -- consumers hate to wait in line but they prefer to spend more time in a serpentine line (viewed as socially just) than in a "skip and slip" line -- that is, a situation in which several lines operate simultaneously such that a person who enters a line later may actually get served first because his line moved faster.

In the coming decade, fairness will move beyond queuing to pricing. Today, air fares are like automobiles -- no one has to pay the sticker price. Consumers do not understand the basis on which air fares are determined. We will have a new pricing system within the coming decade.

Time and Convenience. Convenience will be a critical factor. Airlines increasingly are viewed as commodities. Ease of use will be the primary differentiating factor.

One area in which convenience will be vastly improved is ticketing. Within the next ten years, satellite ticketing printers (STP) will become as pervasive as fax machines. As increasing numbers of corporate offices print tickets, the need for a travel agent will decline. The reservation system is the distribution system for commercial aviation -- whoever controls it controls the business. STP will be the distribution system of choice in the 1990s.

DEMOGRAPHICS - THE SPATIAL REDISTRIBUTION OF PEOPLE AND JOBS

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Although my topic was listed only as demographics, I will talk about demographics and employment and how they might possibly interact affecting demand for aviation both in terms of passenger travel and air freight. Demographics, I believe, are particularly useful when one wants to assess long-term projections, conduct bottom-up types of analyses and forecasts, market forecasts, as well as to look at processes for improving the forecasts for individual hubs such was described by Alice Herman of the Port Authority of New York and New Jersey. Even if one starts with a national aggregate forecast, the question that seems to arise immediately from this top-down procedure is how best to break it down to regions, States, metropolitan areas, or, individual hubs.

Redistribution of Demand

Today I am going to talk about some of the basic trends that I think will shape redistribution of demand for enplanements and air freight over the next decade. I am going to present some figures on forecasts from various public and private agencies, from the regional level right down to the Metropolitan Statistical Area (MSA) level. I have included an addendum to the tables that describes methodologies underlying the forecasts derived from private and public agencies such as Bureau of Economic Affairs (BEA), Wharton Econometrics, Bureau of the Census, and the National Planning Association. (For additional details you may refer to the Appendix to this paper to obtain appropriate baseline information used by demographers used at these various agencies).

If one looks at patterns and shifts taking place, one sees that over the last two or three decades there has been a dramatic change in the location of population and jobs in individual metropolitan areas, city-suburban shifts, and more macro cross-regional Frostbelt-Sunbelt shifts. In interpreting these data I believe that we have to separate the megatrends from the short-term cycles.

In the Table 1 you can see the net inter-regional migration flows. This represents flows of people between census regions for five-year periods beginning with 1955 to 1960, up through the last date we have data available, which is the Current Population Survey of 1988.

You can see the dramatic shift to the West in the 1950s and 1960s. There are many reasons why the West demographic explosion in the west, California particularly, after World War II. Most deal with its expanding economic base. Over three million people alone moved to California between 1945 and 1960. During this period, the South also turned around from a net exporter of people to a demographic magnet. You can see by 1955 to 1960, in and out migration in the South had pretty much evened out, although the South was still sending more people to the West. These, incidentally, are net figures. Everyone knows there is no such person as a net migrant, the difference in in-movers and out-movers in each region so what this says is that between 1955 and 1960, 380,000 more Southerners moved to the West than Westerners moved to the South. During the following 25 years the South became a demographic magnet, attracting people from all other regions. By the 1980 to 1985 period, for every one person moving to the West, three were moving to the South in terms of net migration exchange.

The Midwest continued to send people to other regions except the Northeast. During the 1980 and 1985 period, dominated by the 1980 to 1982 recession, there was a hemorrhage of midwestern migrants. Notice how this loss really slowed down with the Midwest's economic recovery. Many of these states had cyclically sensitive industries that 1988 responded quite well after 1982 to the economic recovery and, as they stabilized, their outmigration slowed. Thus, the Midwest went from losing 1.5 million people in the net between 1980 and 1985 to a loss of just 183,000 between 1985 and 1988.
Such is not the case in the Northeast. Their net out-migration continued at a rapid pace. The last three years, 817,000 in the net, compared to a 1,022,000 loss between 1980 and 1985. So these are the internal shifts taking place and generally you can see, looking at the totals, not only the Frostbelt-Sunbelt moves but also increasingly over the last 30 years, a shift in terms of internal flows from the West to the South.

Impact of Immigration. All I have discussed so far is internal flows. If you look at movers from abroad who are mostly immigrants, although there are some expatriates here, you see that two basic changes have taken place in immigration. (Table 2.) One, since the 1950s there has been a substantial increase in the number of movers from

TABLE 1. NET INTERREGIONAL MIGRATION FLOWS, 1955 TO 1988

Regional Migration Exchanges	Net Migration in Thousands					
	1955-60[1]	1965-70[2]	1970-75[3]	1975-80[4]	1980-85[4]	1985-88
South: Net Exchange With						
Northeast	+314	+438	+964	+945	+737	+588
Midwest	+122	+275	+790	+813	+1,100	+104
West	-380	-56	+75	+176	+60	+ 41
Total Other Regions	+56	+657	+1,829	+1,935	+1,897	+732
West: Net Exchange With						
Northeast	+285	+224	+311	+518	+234	+118
Midwest	+760	+415	+472	+634	+475	+190
South	+380	+56	-75	-176	-60	- 41
Total Other Regions	+1,425	+695	+708	+976	+649	+267
Midwest: Net Exchange With						
Northeast	+40	+53	+67	+146	+50	+111
South	-122	-275	-790	-813	-1,100	-104
West	-760	-415	-472	-634	-475	-190
Total Other Regions	-842	-637	-1,195	-1,302	-1,525	-183
Northeast: Net Exchange With						
Midwest	-40	-53	-67	-146	-50	-111
South	-314	-438	-964	-945	-737	-588
West	-285	-224	-311	-518	-234	-118
Total Other Regions	-639	-715	-1,342	-1,609	-1,022	-817

[1] U.S. Census of Population, Vol 1, U.S. Summary 1960: Table 237

[2] U.S. Census of Population, 1970 Vol 1, U.S. Summary: Table 274

[3] Mobility of the Population of the U.S.: March 1970 to March 1975, Series P-20, No. 285 in Current Population Reports

[4] Current Population Survey machine-readable files, 1980, 1985, 1986, 1987, 1988

abroad. Secondly, comparing the figures from 1955 to 1960 right across to 1985 to 1988, the net gain in immigrants has been picked up almost entirely in the South and the West, with the West really pulling ahead as the nation's magnet for immigrants. If you look back at 1955 to 1960 you can see the Northeast was the modal immigration region. This reflected the fact that until the late 1960s, the bulk of the immigrants were orginating from nations that were geographically to the east and north of the United States, primarily Europe.

TABLE 2. MOVERS FROM ABROAD BY REGION, IN 1955 TO 1988

Region	1955-1960[1]	1965-70[2]	1970-75[3]	1975-80[4]	1980-85[4]	1985-88[4]
Northeast	592	821	903	834	832	672
Midwest	361	440	638	590	457	509
South	505	740	1,082	1,164	1,180	1,001
West	545	697	980	1,475	1,387	1,340

[1] 1960 Census of Population, Vol. 1, U.S. Summary Table 237.

[2] 1970 Census of Population, Vol. 1, U.S. Summary Table 274.

[3] Mobility of the Population of the U.S.: March 1970 to March 1975 Series P-20, No. 285 in Current Population Reports.

[4] Current Population Survey Machine-Readable Files, 1980, 1985, 1986, 1987, 1988

This does not include illegals; these are census figures. The Census and Current Population Survey might pick up a few illegals, but I doubt most respond to the census questionnaire. If anything, my guess is that illegals would inflate further the West and the South in terms of their immigration dominance.

You can see that when people were moving from nations in Europe, the closest port of entry would be New York City and points in the Northeast. As sending nations shifted to Asia, South America, and the Pacific Islands, the closest ports of entry became San Francisco, Los Angeles, Houston, and Miami. Between the early 1970s and 1984, one million Asian and Hispanic immigrants settled in Los Angeles County alone. Clearly, Los Angeles has become the nation's leading growth node for immigrants.

One other point. Notice that between 1980 and 1985, the West attracted 649,000 people from other regions of the country. It grew twice as fast from immigration, 1,387,000, so that the demographic driving force for the West is no longer people moving from other regions of the country, but people moving to the West from abroad, primarily from Asia and South America. This might also go against conventional wisdom. We think of "Go West Young Man," but a lot of it is "Go East", -- immigrants coming from Asia. Those living in California surely recognize this. A lot of immigration is by air, increasingly so. Many of the immigrants today have the resources to afford international air travel for return trips to see family and friends. Places like Los Angeles, with a million immigrants in 14 years, are going to feel this immigrant impact on air travel.

But when you combine the flows of internal shifts, with immigration, you can see that the South and the West during the last eight years, that is (1980 to 1988) captured approximately 90 percent of the nation's population increase. (Table 3) In fact, three States alone, California, Florida, and Texas captured half of the increase. California grew by 4,500,000, Florida by 2,600,000, Texas by 2,500,000, which together account for 51 percent of the total nation's population growth. Projections we will see in a moment indicate that these trends will continue.

Projecting Aviation Demand

In projecting demands for aviation, I tend to look at business travel and economic development as being the key factors. When one wants to predict these, one has to go beyond the economic data and look at other changes such as labor force characteristics. We can see already certain parts of the country are facing a serious labor force squeeze which is driving up wages and preventing businesses from adding employees. These businesses are moving elsewhere to look for employees.

Table 4 gives a population projection for the 10-year period 1990 to 2000 for those aged 18 to 44 in each State. I chose 18 to 44 year olds as an indication of the growth of the new labor force entrants, which I consider critical to employment growth and further business expansion. You can see the number of States towards the bottom of the table that are going to take a beating. They are ranked on the left in terms of net changes, this is absolute numbers and on the right in terms of percent change. So, on a percent-change basis,

TABLE 3. POPULATION CHANGES IN U.S. REGIONS AND STATES, 1980 -1988

Area	1980[1]	1988[2]	Change 1980-1988 Net	Change 1980-1988 Percent
United States	226,546	245,807	19,261	8.5
Northeast	49,135	50,611	1,476	3.0
Midwest	58,866	59,894	1,028	1.7
South	75,372	84,878	9,506	12.6
West	43,172	50,424	7,252	16.8
Alabama	3,894	4,127	233	6.0
Alaska	402	513	111	27.6
Arizona	2,717	3,466	749	27.6
Arkansas	2,286	2,422	136	5.9
California	23,668	28,168	4,500	19.0
Colorado	2,890	3,290	400	13.8
Connecticut	3,108	3,241	133	4.3
Delaware	594	660	66	11.1
Dist. of Columbia	638	620	-18	-2.8
Florida	9,747	12,377	2,630	27.0
Georgia	5,463	6,401	938	17.2
Hawaii	965	1,093	128	13.3
Idaho	944	999	55	5.8
Illinois	11,427	11,511	84	0.7
Indiana	5,490	5,575	85	1.5
Iowa	2,914	2,834	-80	-2.7
Kansas	2,364	2,487	123	5.2
Kentucky	3,660	3,721	61	1.7
Louisiana	4,206	4,420	214	5.1
Maine	1,125	1,206	81	7.2
Maryland	4,217	4,644	427	10.1
Massachusetts	5,737	5,871	134	2.3
Michigan	9,262	9,300	38	0.4
Minnesota	4,076	4,306	230	5.6
Mississippi	2,521	2,627	106	4.2
Missouri	4,917	5,139	222	4.5
Montana	787	804	17	2.2
Nebraska	1,570	1,601	31	2.0
Nevada	801	1,060	259	32.3
New Hampshire	921	1,097	176	19.1
New Jersey	7,365	7,720	355	4.8
New Mexico	1,303	1,510	207	15.9
New York	17,558	17,898	340	1.9
North Carolina	5,880	6,526	646	11.0
North Dakota	653	663	10	1.5
Ohio	10,798	10,872	74	0.7
Oklahoma	3,026	3,263	237	7.8
Oregon	2,633	2,741	108	4.1
Pennsylvia	11,865	12,027	162	1.4
Rhode Island	947	995	48	5.1
South Carolina	3,121	3,493	372	11.9
South Dakota	691	715	24	3.5
Tennessee	4,591	4,919	328	7.1
Texas	14,226	16,780	2,554	18.0
Utah	1,461	1,691	230	15.7
Vermont	512	556	44	8.6
Virginia	5,347	5,996	649	12.1
Washington	4,132	4,619	487	11.8
West Virginia	1,950	1,884	-66	-3.4
Wisconsin	4,706	4,858	152	3.2
Wyoming	470	471	1	0.2

SOUCRES: 1. Current Population Reports, Population Estimates and Projections, Series P-25, no. 1017, 1988.
2. Dept. of Commerce, News, CB88-205, released Dec.30, 1988; 1988 Interim method estimates.

Hawaii is ranked number one with a 62,000 increase in those 18 to 44, but that is an 11.9 percent increase because the base is much smaller. The left is the where the States are ranked by absolute increase, California dominates with 714,000 projected growth. If you look at the States down towards the bottom, they are actually going to be facing dramatic declines of new labor force entrants over the next 10 or 15 years. Pennsylvania, for example, is actually going to lose only about 300,000 people overall, but lose 500,000 people in the 18 to 44 year age range.

TABLE 4. THE STATES RANKED BY NET CHANGE AND PERCENT CHANGE FOR THE POPULATION Aged 18-44, 1990-2000

Ranked by Net Change				Ranked by Percent Change			
	STATE	Net Chng (1000s)	% Chng		STATE	Net Chng (1000s)	% Chng
1	California	714	5.5	1	Hawaii	62	11.9
2	Florida	441	9.0	2	Alaska	33	11.3
3	Texas	440	5.6	3	Arizona	175	11.1
4	Georgia	329	11.0	4	Georgia	329	11.0
5	Arizona	175	11.1	5	New Mexico	75	10.7
6	North Carolina	84	2.9	6	Nevada	47	9.5
7	New Mexico	75	10.7	7	Florida	441	9.0
8	Hawaii	62	11.9	8	Utah	44	6.1
9	Virginia	55	1.9	9	Texas	440	5.6
10	Nevada	47	9.5	10	California	714	5.5
11	Utah	44	6.1	11	New Hampshire	24	4.6
12	Maryland	39	1.8	12	North Carolina	84	2.9
13	Alaska	33	11.3	13	Virginia	55	1.9
14	New Hampshire	24	4.6	14	Maryland	39	1.8
15	South Carolina	22	1.4	15	Delaware	5	1.7
16	Mississippi	6	0.5	16	South Carolina	22	1.4
17	Delaware	5	1.7	17	Mississippi	6	0.5
18	D. C.	0	0.0	18	D. C.	0	0.0
19	Rhode Island	-11	-2.5	19	New Jersey	-17	-0.5
20	Vermont	-13	-5.1	20	Colorado	-15	-0.9
21	Colorado	-15	-0.9	21	Alabama	-42	-2.4
22	South Dakota	-16	-5.7	22	Rhode Island	-11	-2.5
23	New Jersey	-17	-0.5	23	Tennessee	-56	-2.6
24	Maine	-23	-4.4	24	Arkansas	-37	-3.9
25	Idaho	-26	-6.2	25	Connecticut	-56	-4.0
26	Wyoming	-30	-12.9	26	Missouri	-95	-4.4
27	North Dakota	-32	-11.5	27	Maine	-23	-4.4
28	Montana	-34	-10.1	28	Massachusetts	-129	-4.9
29	Arkansas	-37	-3.9	29	Washington	-105	-5.0
30	Alabama	-42	-2.4	30	New York	-384	-5.1
31	Tennessee	-56	-2.6	31	Vermont	-13	-5.1
32	Connecticut	-56	-4.0	32	Oklahoma	-73	-5.3
33	Nebraska	-66	-10.1	33	South Dakota	-16	-5.7
34	Kansas	-69	-6.6	34	Idaho	-26	-6.2
35	Oklahoma	-73	-5.3	35	Minnesota	-118	-6.3
36	Missouri	-95	-4.4	36	Kansas	-69	-6.6
37	Washington	-105	-5.0	37	Illinois	-377	-7.6
38	Oregon	-106	-8.7	38	Louisiana	-154	-8.0
39	Minnesota	-118	-6.3	39	Oregon	-106	-8.7
40	West Virginia	-121	-15.8	40	Michigan	-357	-8.8
41	Massachusetts	-129	-4.9	41	Kentucky	-141	-8.8
42	Kentucky	-141	-8.8	42	Indiana	-215	-9.1
43	Louisiana	-154	-8.0	43	Ohio	-428	-9.4
44	Iowa	-180	-16.1	44	Wisconsin	-200	-9.9
45	Wisconsin	-200	-9.9	45	Nebraska	-66	-10.1
46	Indiana	-215	-9.1	46	Montana	-34	-10.1
47	Michigan	-357	-8.8	47	Pensylvania	-537	-11.1
48	Illinois	-377	-7.6	48	North Dakota	-32	-11.5
49	New York	-384	-5.1	49	Wyoming	-30	-12.9
50	Ohio	-428	-9.4	50	West Virginia	-121	-15.8
51	Pennsylvania	-537	-11.1	51	Iowa	-180	-16.1

Source: U.S. Census, Projections of the Population of States by Age, Sex & Race: 1988-2010 Current Population Reports P-25 #1017, 1988.

When we look at the Massachusetts miracle of unemployment decline, much of that was demographically driven. Their labor force did not grow. They added jobs only at a national average rate, but their very slow labor force growth pushed down their unemployment rate.

In Table 5, you can see the overall projections for State population growth. Again, the nation will be dominated in the next 10 to 12 years by the growth of California, Florida and Texas. I think Texas is a good example of separating cycles from trends. Houston's economy is booming right now. They added 36,000 jobs in the last eight months, over 50,000 jobs in the last 14 months. Talking to real estate investor members of the Urban Land Institute, Houston is considered to be a hot spot for investment when just a couple of years ago it

TABLE 5. THE STATES RANKED BY NET CHANGE AND PERCENT CHANGE IN POPULATION 1987-2000

	State	Net Chng (1000s)	% Chng		State	Net Chng (1000s)	% Chng
1	California	5969	21.7	1	Arizona	1186	34.6
2	Florida	3453	28.9	2	Nevada	310	31.2
3	Texas	3274	19.3	3	New Mexico	450	29.6
4	Georgia	1713	27.4	4	Florida	3453	28.9
5	Arizona	1186	34.6	5	Georgia	1713	27.4
6	North Carolina	1061	16.5	6	Alaska	143	26.3
7	Virginia	994	16.9	7	New Hampshire	275	26.0
8	New Jersey	859	11.2	8	Hawaii	264	24.4
9	Maryland	742	16.4	9	California	5969	21.7
10	Colorado	505	15.3	10	Texas	3274	19.3
11	South Carolina	486	14.2	11	Utah	297	17.5
12	Washington	477	10.6	12	Virginia	994	16.9
13	New Mexico	450	29.6	13	North Carolina	1061	16.5
14	Tennessee	418	8.6	14	Maryland	742	16.4
15	Alabama	324	7.9	15	Colorado	505	15.3
16	Nevada	310	31.2	16	Delaware	93	14.5
17	Utah	297	17.5	17	South Carolina	486	14.2
18	Missouri	283	5.5	18	New Jersey	859	11.2
19	New Hampshire	275	26.0	19	Washington	477	10.6
20	Hawaii	264	24.4	20	Mississippi	234	8.9
21	Massachusetts	249	4.3	21	Tennessee	418	8.6
22	Minnesota	247	5.8	22	Vermont	44	8.0
23	Mississippi	234	8.9	23	Alabama	324	7.9
24	Connecticut	233	7.3	24	Maine	87	7.3
25	New York	227	1.3	25	Connecticut	233	7.3
26	Oregon	161	5.9	26	Rhode Island	67	6.8
27	Alaska	143	26.3	27	Arkansas	143	6.0
28	Arkansas	143	6.0	28	Oregon	161	5.9
29	Delaware	93	14.5	29	Minnesota	247	5.8
30	Maine	87	7.3	30	Missouri	283	5.5
31	Oklahoma	81	2.5	31	Massachusetts	249	4.3
32	Rhode Island	67	6.8	32	Idaho	41	4.1
33	Kansas	60	2.4	33	Oklahoma	81	2.5
34	Michigan	59	0.6	34	Kansas	60	2.4
35	Vermont	44	8.0	35	D. C.	13	2.1
36	Idaho	41	4.1	36	New York	227	1.3
37	D. C.	13	2.1	37	South Dakota	7	1.0
38	Louisiana	12	0.3	38	Michigan	59	0.6
39	Illinois	11	0.1	39	Louisiana	12	0.3
40	South Dakota	7	1.0	40	Illinois	11	0.1
41	Kentucky	0	0.0	41	Kentucky	0	0.0
42	Wisconsin	-7	-0.1	42	Wisconsin	-7	-0.1
43	Indiana	-16	-0.3	43	Indiana	-16	-0.3
44	Wyoming	-17	-3.4	44	Ohio	-138	-1.3
45	Montana	-20	-2.5	45	Nebraska	-39	-2.4
46	Nebraska	-39	-2.4	46	Montana	-20	-2.5
47	North Dakota	-45	-6.7	47	Pennsylvania	-371	-3.1
48	Ohio	-138	-1.3	48	Wyoming	-17	-3.4
49	West Virginia	-180	-9.5	49	North Dakota	-45	-6.7
50	Iowa	-277	-9.8	50	West Virginia	-180	-9.5
51	Pennsylvania	-371	-3.1	51	Iowa	-277	-9.8

Source: U.S. Bureau of Census, Current Population Reports "Population Estimates and Projection, Series P-25, no.1017, 1988.

was a sure loser, and before that a boom area. So you have to separate the cycles from the trends. In projecting air travel demand in the early 21st century, one wants to look at the longer-term trends, not the short term cycles. Taking any one of these short-term cyclical boom or bust periods and extrapolating could get you into big trouble. You can see when States are ranked in terms of net change and percent change in employment, Texas is second. The National Planning Association projections, the BEA projections, and the Bureau of Labor Statistics projections closely correspond. As a matter of fact, the National Planning Association derives its projections here, as you can see in the Appendix, from the Bureau of Economic Analysis figures, so the growth nodes will, in terms of employment, continue to be California, Texas and Florida, with Georgia and Virginia following close behind.

TABLE 6. THE STATES RANKED BY NET CHANGE IN EMPLOYMENT 1987-2000

	State	Net Chng (1000s)	% Chng		State	Net Chng (1000s)	% Chng
1	California	3556.3	24.1	1	Nevada	200.1	34.0
2	Texas	2000.8	24.4	2	Arizona	515.8	32.0
3	Florida	1807.3	30.1	3	Florida	1807.3	30.1
4	Georgia	691.6	20.4	4	Alaska	85.7	29.0
5	Virginia	654.3	19.8	5	Colorado	515.4	28.0
6	New Jersey	648.9	15.2	6	New Hampshire	169.6	27.6
7	New York	626.4	6.6	7	Utah	207.3	26.7
8	North Carolina	592.3	16.6	8	Texas	2000.8	24.4
9	Massachusetts	529.5	14.8	9	New Mexico	165.1	24.4
10	Arizona	515.8	32.0	10	California	3556.3	24.1
11	Colorado	515.4	28.0	11	Wyoming	61.8	23.6
12	Washington	513.0	21.7	12	Washington	513.0	21.7
13	Pennsylvania	481.8	8.1	13	Georgia	691.6	20.4
14	Illinois	450.7	7.6	14	Virginia	654.3	19.8
15	Ohio	436.2	8.0	15	Idaho	95.1	19.5
16	Minnesota	419.7	17.2	16	Hawaii	119.2	19.3
17	Maryland	397.3	16.5	17	Oregon	268.0	18.7
18	Michigan	379.9	8.9	18	Vermont	55.0	17.7
19	Tennessee	358.5	14.0	19	South Carolina	314.7	17.6
20	Wisconsin	343.8	13.2	20	Minnesota	419.7	17.2
21	Missouri	328.6	11.8	21	Oklahoma	275.6	16.9
22	Louisiana	318.9	16.4	22	Maine	109.5	16.9
23	South Carolina	314.7	17.6	23	North Carolina	592.3	16.6
24	Connecticut	296.7	15.2	24	Maryland	397.3	16.5
25	Oklahoma	275.6	16.9	25	Louisiana	318.9	16.4
26	Oregon	268.0	18.7	26	New Jersey	648.9	15.2
27	Indiana	263.2	9.2	27	Connecticut	296.7	15.2
28	Alabama	241.8	12.6	28	Montana	60.2	14.9
29	Kentucky	209.6	11.8	29	Massachusetts	529.5	14.8
30	Utah	207.3	26.7	30	Arkansas	165.0	14.4
31	Nevada	200.1	34.0	31	Tennessee	358.5	14.0
32	Kansas	192.0	13.7	32	Kansas	192.0	13.7
33	New Hampshire	169.6	27.6	33	Wisconsin	343.8	13.2
34	New Mexico	165.1	24.4	34	Rhode Island	70.6	13.1
35	Arkansas	165.0	14.4	35	Alabama	241.8	12.6
36	Iowa	121.7	7.8	36	North Dakota	44.1	12.2
37	Hawaii	119.2	19.3	37	Kentucky	209.6	11.8
38	Maine	109.5	16.9	38	Missouri	328.6	11.8
39	Mississippi	106.3	9.1	39	Nebraska	105.5	11.4
40	Nebraska	105.5	11.4	40	South Dakota	37.9	10.2
41	Idaho	95.1	19.5	41	Delaware	35.2	9.6
42	Alaska	85.7	29.0	42	Indiana	263.2	9.2
43	Rhode Island	70.6	13.1	43	Mississippi	106.3	9.1
44	West Virginia	64.0	8.5	44	Michigan	379.9	8.9
45	Wyoming	61.8	23.6	45	West Virginia	64.0	8.5
46	Montana	60.2	14.9	46	Pennsylvania	481.8	8.1
47	Vermont	55.0	17.7	47	Ohio	436.2	8.0
48	North Dakota	44.1	12.2	48	Iowa	121.7	7.8
49	South Dakota	37.9	10.2	49	Illinois	450.7	7.6
50	Delaware	35.2	9.6	50	New York	626.4	6.6
51	D. C.	26.5	3.6	51	D. C.	26.5	3.6

Source: National Planning Assoc., Regional Projection Series, R-87-1, 1988.

Tables 6, 7 and 8 describe population and employment projections by labor market area and by metropolitan area. They speak for themselves. I also present projections for single-unit housing construction, (Table 9) multi-unit (Table 10) and non-residential (Table 11) construction and some other factors for your consideration.

Effect on Air Transportation

What does this all mean? Well, I thought I heard Paul Biederman say that airline travel is not likely to grow very fast. Aggregate air passenger forecasts are based on a number of variables -- GNP, CPI, fuel prices. I would like to comment on such factors for a moment because we found

TABLE 7. THE TOP 50 METROPOLITAN AREAS RANKED BY NET CHANGE AND PERCENT CHANGE IN POPULATION, 1987-2000

Metropolitan Area	Population Change 1987-2000 Net Chng (1000s)	Percent Change
1 Los Angeles-Long Beach CA	874.8	10.4
2 Houston TX	752.1	23.0
3 Riverside-San Bernardino CA	643.3	30.9
4 Atlanta GA	547.3	20.8
5 Dallas TX	546.8	22.5
6 Phoenix AZ	527.4	26.8
7 Anaheim-Santa Ana CA	498.9	22.3
8 San Diego CA	494.7	21.8
9 Washington D.C.	488.7	13.5
10 Tampa-St Petersburg FL	419.4	21.3
11 Denver CO	370.9	22.5
12 Fort Lauerdale-Hollywood FL	302.2	25.6
13 Minneapolis-St. Paul MN-WI	300.9	13.0
14 Oakland CA	298.5	15.1
15 Fort Worth-Arlington TX	293.3	23.1
16 San Jose CA	283.5	19.7
17 West Palm Beach-Boca Raton FL	273.2	34.7
18 Sacremento CA	271.9	20.5
19 Boston-Lawrence-Salem MA	267.6	7.2
20 Orlando FL	262.4	28.2
21 Seattle WA	241.8	13.6
22 Miami-Hialeah FL	235.9	13.1
23 Philadelphia PA-NJ	190.2	3.9
24 Salt Lake City-Ogden UT	184.8	17.6
25 San Antonio TX	184.4	14.4
26 Austin TX	179.1	24.3
27 Oxnard-Ventura CA	164.7	26.0
28 Baltimore MD	164.6	7.1
29 San Francisco CA	161.8	10.0
30 Las Vegas NV	156.3	26.3
31 Tucson AZ	145.0	23.4
32 Monmouth-Ocean NJ	143.7	15.2
33 Norfolk-Virginia Beach VA	141.4	10.6
34 Portland OR	133.0	11.4
35 Nassau-Suffolk NY	132.5	5.0
36 Raleigh-Durham NC	126.1	18.9
37 Fort Meyers FL	124.5	42.4
38 Charlotte-Gastonia NC-SC	121.0	11.2
39 Tulsa OK	120.0	16.4
40 Vallejo-Fairfield CA	118.4	29.1
41 Oklahoma City OK	113.7	11.7
42 Santa Rose-Petaluma CA	113.3	31.7
43 New Orleans LA	109.8	8.3
44 Jacksonville FL	105.4	12.1
45 Baton Rouge LA	105.2	19.2
46 Columbus OH	104.1	7.9
47 Nashville TN	102.8	10.9
48 Kansas City MO-KS	98.4	6.4
49 Fort Pierce FL	97.2	44.9
50 Albuquerque NM	95.0	19.7

Metropolitan Area	Population Change 1987-2000 Net Chng (1000s)	Percent Change
1 Naples FL	68.6	53.3
2 Fort Pierce FL	97.2	44.9
3 Fort Meyers FL	124.5	42.4
4 Ocala FL	67.6	37.7
5 Olympia WA	54.7	35.9
6 Bryan-College Station TX	43.7	35.3
7 West Palm Beach-Boca Raton FL	273.2	34.7
8 Santa Cruz CA	78.1	34.3
9 Fort Collins-Loveland CO	56.9	31.9
10 Santa Rose-Petaluma CA	113.3	31.7
11 Riverside-San Bernardino CA	643.3	30.9
12 Vallejo-Fairfield CA	118.4	29.1
13 Bremeton WA	50.4	28.9
14 Sarasota FL	73.4	28.6
15 Orlando FL	262.4	28.2
16 Phoenix AZ	527.4	26.8
17 Portsmouth-Dover NH	87.6	26.8
18 Las Vegas NV	156.3	26.3
19 Oxnard-Ventura CA	164.7	26.0
20 Fort Lauerdale-Hollywood FL	302.2	25.6
21 Reno NV	60.1	25.6
22 Brazoria TX	47.7	24.9
23 Daytona Beach FL	82.3	24.8
24 Anchorage AK	57.5	24.8
25 Austin TX	179.1	24.3
26 Provo-Orem UT	57.8	23.7
27 Bradenton FL	42.7	23.4
28 Tucson AZ	145.0	23.4
29 Fort Worth-Arlington TX	293.3	23.1
30 Houston TX	752.1	23.0
31 Chico CA	39.5	23.0
32 Dallas TX	546.8	22.5
33 Denver CO	370.9	22.5
34 Anaheim-Santa Ana CA	498.9	22.3
35 McAllen-Edinburg TX	82.7	22.3
36 Lafayette LA	48.7	22.2
37 Boise City ID	43.2	22.2
38 Midland TX	24.8	22.1
39 Vancover WA	47.9	22.1
40 San Diego CA	494.7	21.8
41 Manchester-Nashua MH	70.1	21.7
42 Panama City FL	27.1	21.6
43 Santa Fe NM	23.2	21.5
44 Boulder-Longmont CO	46.4	21.4
45 Laredo TX	26.1	21.4
46 Tampa-St Petersburg FL	419.4	21.3
47 Fort Walton Beach FL	30.9	21.3
48 Salinas-Seaside CA	73.7	21.1
49 Richland-Kennewick WA	32.4	21.1
50 Atlanta GA	547.3	20.8

Source: National Planning Association, Regional Economic Projections, Series 87-R-1, 1988.

that, at least in terms of the territorial shifts of population, they did not predict very well.

For example, when the real energy prices went up, it was thought that people would come back to the cities. When prices went up in the mid- to late-1970s, we had one of our greatest period of population deconcentration. We had the non-metropolitan revival. People moved even further away from their urban jobs. We saw figures on airline trends that bucked the CPI; and during the 1980-82 recession, certain hubs -- Phoenix for example -- boomed, as did the Texas airports. When we look at exogenous factors, we need to get into industry-specific propensities, getting back to the idea of structural change in the economy. As

TABLE 8. THE TOP 50 METROPOLITAN AREAS RANKED BY NET CHANGE AND PERCENT CHANGE IN EMPLOYMENT, 1987-2000

Metropolitan Area	Employment Change 1987-2000 Net Chng (1000s)	Percent Change	Metropolitan Area	Employment Change 1987-2000 Net Chng (1000s)	Percent Change
1 Los Angeles-Long Beach CA	723.6	15.1	1 Naples FL	36.2	54.4
2 Anaheim-Santa Ana CA	616.4	45.7	2 Fort Meyers FL	71.1	52.0
3 Washington D.C.	522.5	21.4	3 Fort Pierce FL	46.3	49.4
4 Houston TX	515.1	30.7	4 Anaheim-Santa Ana CA	616.4	45.7
5 Dallas TX	471.6	31.1	5 West Palm Beach-Boca Raton FL	171.5	42.3
6 Atlanta GA	452.2	28.1	6 Bradenton FL	36.2	41.8
7 Boston-Lawrence-Salem MA	396.1	15.9	7 Boulder-Longmont CO	54.0	39.2
8 San Diego CA	351.3	29.4	8 Orlando FL	215.2	39.1
9 San Jose CA	348.8	35.9	9 Ocala FL	27.7	38.2
10 Phoenix AZ	347.5	34.3	10 Fort Lauerdale-Hollywood FL	216.2	37.5
11 Denver CO	291.0	29.0	11 Santa Rosa-Petaluma CA	64.7	37.4
12 Minneapolis-St. Paul MN-WI	290.5	19.9	12 San Jose CA	348.8	35.9
13 Tampa-St Petersburg FL	286.4	30.0	13 Sarasota FL	46.3	35.0
14 Seattle WA	278.2	25.4	14 Bryan-College Station TX	20.6	34.5
15 Chicago IL	261.4	7.6	15 Las Vegas NV	113.0	34.5
16 Nassau-Suffolk NY	258.7	18.5	16 Santa Cruz CA	35.3	34.4
17 Philadelphia PA-NJ	256.3	10.0	17 Phoenix AZ	347.5	34.3
18 Fort Lauerdale-Hollywood FL	216.2	37.5	18 Oxnard-Ventura CA	92.4	34.1
19 Orlando FL	215.2	39.1	19 Fort Collins-Loveland CO	27.8	33.5
20 San Francisco CA	214.7	18.2	20 Portsmouth-Dover NH	56.1	33.3
21 Riverside-San Bernardino CA	198.1	26.3	21 Reno NV	51.8	32.5
22 Oakland CA	195.9	19.4	22 Austin TX	133.2	32.2
23 Sacremento CA	193.4	28.7	23 Tucson AZ	90.8	31.9
24 Miami-Hialeah FL	188.0	18.5	24 Midland TX	19.5	31.4
25 Baltimore MD	180.1	13.8	25 McAllen-Edinburg TX	35.1	31.2
26 West Palm Beach-Boca Raton FL	171.5	42.3	26 Lafayette LA	34.3	31.2
27 Fort Worth-Arlington TX	168.6	28.2	27 Dallas TX	471.6	31.1
28 St. Louis MO-IL	151.2	11.3	28 Gainesville FL	33.6	31.0
29 Detroit MI	149.0	7.2	29 Houston TX	515.1	30.7
30 San Antonio TX	143.9	23.5	30 Boise City ID	34.9	30.6
31 Middlesex-Somerset NJ	143.8	25.2	31 Tampa-St Petersburg FL	286.4	30.0
32 Salt Lake City-Ogden UT	137.1	26.0	32 Fort Walton Beach FL	22.8	29.7
33 Austin TX	133.2	32.2	33 Brazoria TX	20.9	29.4
34 Portland OR	130.5	19.1	34 San Diego CA	351.3	29.4
35 Norfolk-Virginia Beach VA	130.0	17.0	35 Albuquerque NM	79.6	29.3
36 Charlotte-Gastonia NC-SC	127.5	19.2	36 Panama City FL	19.1	29.2
37 Columbus OH	126.8	16.6	37 Atlantic City NJ	62.1	29.2
38 Raleigh-Durham NC	122.4	28.1	38 Denver CO	291.0	29.0
39 Nashville TN	119.2	21.0	39 Anchorage AK	39.7	28.7
40 Hartford-New Britain CT	118.1	16.5	40 Sacremento CA	193.4	28.7
41 Kansas City MO-KS	115.7	13.2	41 Olympia WA	18.4	28.4
42 Las Vegas NV	113.0	34.5	42 Santa Fe NM	17.6	28.3
43 Oklahoma City OK	108.5	19.9	43 Fort Worth-Arlington TX	168.6	28.2
44 Newark NJ	105.6	9.5	44 Tallahassee FL	34.7	28.2
45 Monmouth-Ocean NJ	105.2	25.7	45 Atlanta GA	452.2	28.1
46 New Orleans LA	104.0	16.3	46 Colorado Springs CO	57.7	28.1
47 Indianapolis IN	96.6	13.3	47 Redding CA	15.8	28.1
48 Jacksonville FL	93.5	19.9	48 Raleigh-Durham NC	122.4	28.1
49 Greensboro-Winston Salem NC	93.3	16.7	49 Chico CA	19.1	27.8
50 Milwaukee WI	92.5	11.3	50 Manchester-Nashua NH	57.6	27.5

Source: National Planning Association, Regional Economic Projections Series, 87-R-1, 1988.

we move from a goods-processing to an information-processing society, with the types of businesses changing, business travel is, in all likelihood, going to increase. If we can get industry-specific propensities to fly, and then calculate the forecasts in employment in specific industries I think we are going to get a better sense of what we might expect from a business travel standpoint in different areas of the country.

We have to look at other industry factors as well such as acquisitions and mergers and what they mean from the standpoint of spatial distribution of units. When you have one single-site company buying other companies located at different sites but controlled from the corporate headquarters, what is that going to mean in terms of linking and controlling these various multiple dispersed-site locations for air travel?

TABLE 9. THE TOP 50 METROPOLITAN AREAS RANKED BY PROJECTED 1997 SINGLE UNIT HOUSING CONSTRUCTION STARTS (in thousands)

	Metropolitan Area	1987 (1000s)	1997 (1000s)	1987-1997 Net Change	1987-1997 Percent Change
1	Dallas-Ft. Worth TX	22.1	30.5	8.4	38.0
2	Atlanta GA	30.6	30.3	-0.3	-1.0
3	Riverside-San Bernardino CA	29.2	26.6	-2.6	-8.9
4	Washington D.C.	28.7	21.6	-7.1	-24.7
5	Philadelphia PA-NJ	24.3	19.1	-5.2	-21.4
6	Phoenix AZ	17.3	17.5	0.2	1.2
7	Orlando FL	14.8	16.5	1.7	11.5
8	Tampa-St Petersburg FL	13.2	16.1	2.9	22.0
9	Chicago IL	19.6	15.1	-4.5	-23.0
10	Boston-Lawrence-Salem MA	13.6	14.6	1.0	7.4
11	West Palm Beach-Boca Raton FL	13.1	14.2	1.1	8.4
12	Minneapolis-St. Paul MN-WI	17.7	13.9	-3.8	-21.5
13	St. Louis MO-IL	11.9	12.7	0.8	6.7
14	Los Angeles-Long Beach CA	16.2	12.5	-3.7	-22.8
15	San Francisco-Oakland CA	15.3	11.9	-3.4	-22.2
16	Baltimore MD	17.4	11.9	-5.5	-31.6
17	Nassau-Suffolk NY	10.4	11.7	1.3	12.5
18	Houston TX	5.8	11.4	5.6	96.6
19	Norfolk-Virginia Beach VA	11.4	10.5	-0.9	-7.9
20	Jacksonville FL	9.5	10.2	0.7	7.4
21	San Diego CA	14.9	10.1	-4.8	-32.2
22	Raleigh-Durham NC	8.7	9.6	0.9	10.3
23	Charlotte-Gastonia NC-SC	8.1	9.5	1.4	17.3
24	Monmouth-Ocean NJ	12.5	9.3	-3.2	-25.6
25	Kansas City MO-KS	8.9	9.1	0.2	2.2
26	Richmond-Petersburg VA	9.4	8.9	-0.5	-5.3
27	Indianapolis IN	8.4	8.9	0.5	6.0
28	Nashville TN	9.7	8.8	-0.9	-9.3
29	Detroit MI	11.5	8.7	-2.8	-24.3
30	Greensboro-Winston Salem NC	7.5	8.6	1.1	14.7
31	Sacremento CA	10.6	8.6	-2.0	-18.9
32	Fort Lauerdale-Hollywood FL	7.5	8.3	0.8	10.7
33	Portland OR	6.0	7.4	1.4	23.3
34	Columbus OH	9.1	7.2	-1.9	-20.9
35	Hartford-New Britain CT	8.4	7.2	-1.2	-14.3
36	Las Vegas NV	7.8	7.2	-0.6	-7.7
37	Miami-Hialeah FL	8.2	6.9	-1.3	-15.9
38	Daytona Beach FL	5.9	6.8	0.9	15.3
39	Memphis TN-AR-MS	7.1	6.6	-0.5	-7.0
40	Melbourne-Titusville FL	5.4	6.5	1.1	20.4
41	Seattle-Everett WA	9.3	6.2	-3.1	-33.3
42	Cincinnati OH-KY-IN	8.5	6.2	-2.3	-27.1
43	Denver-Boulder CO	6.6	5.8	-0.8	-12.1
44	Fort Meyers FL	5.0	5.8	0.8	16.0
45	Albany-Schenectady-Troy NY	5.0	5.1	0.1	2.0
46	Oklahoma City OK	2.8	5.0	2.2	78.6
47	Tucson AZ	5.1	5.0	-0.1	-2.0
48	Middlesex-Somerset NJ	8.3	4.8	-3.5	-42.2
49	New York NY	5.7	4.6	-1.1	-19.3
50	Rochester NY	5.4	4.5	-0.9	-16.7

Source: Real Estate and Construction Service Long-term MSA Tables, Wharton Econometric Forecasting Associates, Spring 1988.

Air Freight

What do just-in-time manufacturing processes mean? These new processes of inventory control add to the growing importance of air freight. We can see already that parts of Southeast Asia are booming in air freight shipments, which are growing faster than container sea shipping. North Africa now is beginning to take off in terms of its air freight shipments. I do not have time to go into the details, but I really believe that air freight is going to take on an increased importance and that airports are certainly going to be as important as railroads were to our economy and cities in the past. I understand that Ross Perot, Jr. is building an air-freight-only facility on the periphery of Fort Worth. I will not be surprised to see more of them in the future with the economic vitality of the area being driven by air freight. Just think of types of multiplier effects we are going to have in

TABLE 10. THE TOP 50 METROPOLITAN AREAS RANKED BY PROJECTED 1997, MULTI-UNIT HOUSING CONSTRUCTION STARTS.

Metropolitan Area	1987 (1000s)	1997 (1000s)	1987-1997 Net Change	1987-1997 Percent Change
1 Los Angeles-Long Beach CA	47.2	38.8	-8.4	-17.8
2 Dallas-Ft. Worth TX	3.3	21.5	18.2	551.5
3 Atlanta GA	17.0	15.8	-1.2	-7.1
4 Houston TX	0.0	13.1	13.1	(X)
5 San Diego CA	19.0	12.9	-6.1	-32.1
6 Riverside-San Bernardino CA	15.1	12.3	-2.8	-18.5
7 Phoenix AZ	10.2	12.2	2.0	19.6
8 Nashville TN	2.3	12.0	9.7	421.7
9 Chicago IL	15.5	10.4	-5.1	-32.9
10 Detroit MI	18.8	10.3	-8.5	-45.2
11 Seattle-Everett WA	18.7	10.1	-8.6	-46.0
12 Anaheim-Santa Ana CA	14.7	9.4	-5.3	-36.1
13 Kansas City MO-KS	10.2	9.3	-0.9	-8.8
14 West Palm Beach-Boca Raton FL	13.3	9.2	-4.1	-30.8
15 Minneapolis-St. Paul MN-WI	10.6	9.1	-1.5	-14.2
16 Las Vegas NV	8.4	8.5	0.1	1.2
17 Fort Lauerdale-Hollywood FL	12.2	7.9	-4.3	-35.2
18 St. Louis MO-IL	9.2	5.9	-3.3	-35.9
19 Boston-Lawrence-Salem MA	10.0	5.9	-4.1	-41.0
20 Miami-Hialeah FL	10.0	5.5	-4.5	-45.0
21 New York NY	5.7	5.3	-0.4	-7.0
22 Sacramento CA	5.9	4.7	-1.2	-20.3
23 San Antonio TX	1.0	3.9	2.9	290.0
24 Norfolk-Virginia Beach VA	2.8	3.5	0.7	25.0
25 Columbus OH	3.8	3.5	-0.3	-7.9
26 Denver-Boulder CO	5.3	3.5	-1.8	-34.0
27 Baltimore MD	4.9	3.2	-1.7	-34.7
28 Austin TX	0.8	2.9	2.1	262.5
29 Portland OR	2.4	2.7	0.3	12.5
30 Tampa-St Petersburg FL	6.5	2.7	-3.8	-58.5
31 Charlotte-Gastonia NC-SC	3.8	2.7	-1.1	-28.9
32 Tucson AZ	1.5	2.7	1.2	80.0
33 San Francisco-Oakland CA	5.4	2.6	-2.8	-51.9
34 Salt Lake City-Ogden UT	0.9	2.3	1.4	155.6
35 Indianapolis IN	3.0	2.1	-0.9	-30.0
36 Washington D.C.	7.3	2.1	-5.2	-71.2
37 Raleigh-Durham NC	1.6	2.0	0.4	25.0
38 El Paso TX	0.2	1.9	1.7	850.0
39 Providence-Pawtucket RI	1.9	1.5	-0.4	-21.1
40 Philadelphia PA-NJ	4.5	1.5	-3.0	-66.7
41 Atlantic City NJ	2.9	1.5	-1.4	-48.3
42 Richmond-Petersburg VA	1.2	1.4	0.2	16.7
43 New Haven-Waterbury CT	2.7	1.4	-1.3	-48.1
44 Middlesex-Somerset NJ	2.2	1.4	-0.8	-36.4
45 McAllen-Edinburg TX	0.0	1.3	1.3	(X)
46 Greensboro-Winston Salem NC	1.5	1.3	-0.2	-13.3
47 Jacksonville FL	2.7	1.3	-1.4	-51.9
48 Bergen-Passaic NJ	2.4	1.2	-1.2	-50.0
49 Orlando FL	3.3	1.2	-2.1	-63.6
50 Grand Rapids MI	1.6	1.2	-0.4	-25.0

Note: (X) indicates that percent change could not be calculated.
Source: Real Estate and Construction Service Long-term MSA Tables, Wharton Econometric Forecasting Associates, Spring 1988.

warehousing and just-in-time manufacturing facilities around such facilities.

In addition, we have to look at foreign trade deficits and what all those U. S. dollars that are building up in Japan mean. I believe that in the next 10 years, you are going to see that Japanese teenagers and young people coming into the U.S. will continue to increase. They have all these dollars that have to be spent, and a lot of them are going to be spent travelling here.

What is the effect of age distribution and shifts in the age distribution that Alice Herman mentioned earlier? Oftentimes, we look at airlines and airports as endogenous factors. They could be activistic. They can, themselves, play a role through innovative marketing and service and create growth opportunities that otherwise would not exist. Where are the foreign investors located? What does this mean for future air travel demand? Are they changing? To date they have been concentrated in the Northeast and in

TABLE 11. TOP 50 METROPOLITAN AREAS RANKED BY PROJECTED 1997 VALUE OF NONRESIDENTIAL CONSTRUCTION PUT IN PLACE IN 1982 DOLLARS.

Metropolitan Area	1987 (in millions $)	1997	1987-1997 Net Change	Percent Change
1 Los Angeles-Long Beach CA	3203.4	2630.3	-573.1	-17.9
2 Atlanta GA	1787.2	2078.1	290.9	16.3
3 Washington D.C.	2221.0	2021.5	-199.5	-9.0
4 Chicago IL	1913.7	1840.0	-73.7	-3.9
5 Detroit MI	1805.6	1517.5	-288.1	-16.0
6 Seattle-Everett WA	717.4	1114.0	396.6	55.3
7 Dallas-Ft. Worth TX	1791.1	1086.1	-705.0	-39.4
8 Philadelphia PA-NJ	1167.7	1076.6	-91.1	-7.8
9 New York NY	1406.9	1046.7	-360.2	-25.6
10 San Diego CA	797.3	1025.8	228.5	28.7
11 Riverside-San Bernardino CA	1031.5	879.8	-151.7	-14.7
12 Boston-Lawrence-Salem MA	1263.9	867.4	-396.5	-31.4
13 Minneapolis-St. Paul MN-WI	1088.6	827.3	-261.3	-24.0
14 Anaheim-Santa Ana CA	1265.0	821.4	-443.6	-35.1
15 San Jose CA	551.9	720.4	168.5	30.5
16 Greensboro-Winston Salem NC	346.5	699.6	353.1	101.9
17 Tampa-St Petersburg FL	978.2	688.1	-290.1	-29.7
18 Baltimore MD	738.6	676.2	-62.4	-8.4
19 Phoenix AZ	1237.3	672.2	-565.1	-45.7
20 Jacksonville FL	402.5	652.2	249.7	62.0
21 St. Louis MO-IL	719.8	643.1	-76.7	-10.7
22 Indianapolis IN	676.5	641.5	-35.0	-5.2
23 Middlesex-Somerset NJ	760.5	579.9	-180.6	-23.7
24 Orlando FL	781.6	561.1	-220.5	-28.2
25 Columbus OH	543.1	526.6	-16.5	-3.0
26 Raleigh-Durham NC	446.1	521.1	75.0	16.8
27 Houston TX	663.2	515.2	-148.0	-22.3
28 Cleveland OH	604.6	485.2	-119.4	-19.7
29 West Palm Beach-Boca Raton FL	444.8	480.9	36.1	8.1
30 Newark NJ	442.4	457.5	15.1	3.4
31 Miami-Hialeah FL	532.8	443.6	-89.2	-16.7
32 Kansas City MO-KS	597.7	438.0	-159.7	-26.7
33 Norfolk-Virginia Beach VA	576.0	426.4	-149.6	-26.0
34 Cincinnati OH-KY-IN	443.9	425.4	-18.5	-4.2
35 Portland OR	252.0	412.5	160.5	63.7
36 Nashville TN	582.7	412.0	-170.7	-29.3
37 New Haven-Waterbury CT	371.0	385.9	14.9	4.0
38 Charlotte-Gastonia NC-SC	433.8	385.9	-47.9	-11.0
39 Nassau-Suffolk NY	548.8	385.0	-163.8	-29.8
40 Sacremento CA	539.3	373.7	-165.6	-30.7
41 Monmouth-Ocean NJ	294.4	370.9	76.5	26.0
42 Birmingham AL	284.1	370.5	86.4	30.4
43 Pittsburg PA	488.7	343.3	-145.4	-29.8
44 Memphis TN-AR-MS	533.7	340.8	-192.9	-36.1
45 Milwaukee WI	393.3	334.8	-58.5	-14.9
46 Louisville KY	345.9	331.0	-14.9	-4.3
47 Fort Lauerdale-Hollywood FL	582.6	325.4	-257.2	-44.1
48 Richmond-Petersburg VA	282.7	320.9	38.2	13.5
49 Grand Rapids MI	278.7	314.6	35.9	12.9
50 Hartford-New Britain CT	432.9	314.4	-118.5	-27.4

Source: Real Estate and Construction Service Long-term MSA Tables, Wharton Econometric Forecasting Associates, Spring 1988.

California, but that is beginning to shift. More and more foreign money is going to Chicago for example. Where are the immigrants locating? I talked about the circulatory nature of immigration. Immigrants are not just coming in and staying. They go back and forth and this is going to have an impact on air passenger flows.

Discussion

Comment: Who are the workers going to be in the coming decade? Who is going to take care of the airport, the planes? Who is going to do all of the things that entry-level workers are currently doing?

Mr. Kasarda: There are going to be labor force squeezes. One of the unfortunate aspects is that people leaving are not just retirees. The modal category are college-educated young adults seeking employment opportunity throughout the Southeast. So, in addition to the stereotype snowbirds moving down South, many well-educated people are also relocating. As labor forces decline in certain areas, problems of finding appropriate manpower, both skilled and entry-level, will increase.

Comment: One of the things, in addition to propensity, that we look at in the FAA is how the propensity to fly by age group might also change the long-run forecast because of the significantly aging population. We assumed a constant propensity to travel and looked at that. We then broke it down by age group. First we did a forecast using the propensity to travel to 2010 just by the number of people that are going to be around using census data. Then we broke that down and looked at the different propensities of travel based on different age groups and looked at those age-group distributions projected in 2010. We found, very surprisingly, that it changed the long-run forecast less than one percent in 2010 by considering all of the distributions from the Gallup survey.

Comment: This is a good point because right now, all these groups have about the same propensity. I suspect that a lot of the regional distributions and the propensities for flying are correlated with income. From an airline perspective it is important to understand exactly where their growth is going to be, but from a broader perspective, if you are looking at an amount of money to budget 10 years down the road for facilities, the top-down forecast may give you a fairly good idea of how much money to budget. Then, as you get closer to the time for implementation, you have an idea of where to invest that money in facilities.

Mr. Kasarda: As industries change and income levels of certain groups rise, more demand for air travel and air facilities will occur.

Comment: We are seeing some different roles in society that are not directly correlated to age as they were in the past. For example, McDonald's is getting a lot of their new employees from people who are 60 and over. What other roles like that do you see changing? We are also seeing that older people are not necessarily all on the beach in Florida, some are still working somewhere part time.

Mr Kasarda: There are two factors playing a role here. One is that the younger age cohorts are declining in size. This is why I expect that in the 1990s immigration might play a greater role in aviation demand. I think there is going to be tremendous pressure on Congress from the business community to relax Simpson-Mazzoli, to put the drawbridges down and get more labor into the country. The Bureau of Census forecasts immigration stabilization at 500,000 per year. Given the demographic trends of shrinking younger cohorts, there is going to be political pressure to increase this. Part of the problem is that there are young people out there, but many do not even have the most elementary skills, -- interpersonal, let alone education or technical -- to assume jobs, or who are not inclined to take these jobs. Thus, we have the irony in many of our metropolitan areas where there are simultaneously labor shortages and high unemployment among youth, particularly minority youth.

This has a double-barrelled effect that is encouraging business to keep or to attract older labor, and I think this trend is going to continue. Then you have to ask, if they have the resources and they are working at MacDonald's rather than sitting home, are they more likely to fly? Likewise you have to ask what is going to happen as a result of the two-income families. Is that going to help or hinder air travel? I have a gut feeling it is going to help it, because we're going to have a larger percentage of people with quite a bit of discretionary resources that could be used for travel. Those people at that bottom, of course, probably would not be flying anyway.

Comment: In addition to the population distribution and the age effects, which have a major macro effect, consideration should be given to the fact that the population growth rate is now so much lower than it was when many of these models were being developed. Also, there may be some other correlation between GNP growth and population growth so that when GNP growth was basically going along at two percent a year or so, then you had population growth that was in the late 1960s growing at two percent a year. By the year 2010, we see population growth going down to less than half a percent a year. In fact, being very close to zero percent after that. Absent the wholesale immigration that was mentioned, this will be a major factor in the forecasts.

APPENDIX

ALTERNATIVE PROJECTIONS SERIES

A large number of government, nonprofit, and for-profit organizations produce projections and forecasts of a wide range of variables, several of which can be used as measures of real estate demand. A sampling of series produced by these firms and reviewed for this paper include projections/forecasts of population, employment, housing starts, and value of construction put in place (in 1982 dollars). Firms providing these projections/forecasts and the Bureau of Economic Analysis; the National Planning Association; Woods & Poole Econometrics, Inc.; and Wharton Econometrics Forecasting Associates (WEFA).

Projections should be distinguished from forecasts in that projections assume that past trends will persist; whereas forecasts build in anticipation of future events that may not follow a historical trend. Typical forecasting processes allow greater modification of the mathematical output based on judgement. Discussions which follow will use the term projection as a generalized reference to either a projection or a forecast.

Organizations producing projections must often trade off time and resource constraints against the benefit of comprehensive review on a series by series, or area by area basis. Similarly, the need for timeliness and comprehensiveness of the projected series and level of geographic detail may outweigh the ability of an organization to undertake a detailed review. Organizations like BEA build into their projections a major allocation of time for internal review, including adjustments for recent strikes, plant closings and openings, as well as a formalized process for local and State review. However, their projections are available only every five years, and include only about 35 variables at the MSA level. With this time lag, even if comprehensive analysis were undertaken, short-term projections may be out of line with current data by their release. On the other hand, for-profit firms, like WEFA, often provide quarterly forecasts of hundreds, if not thousands, of series for many, many geographic areas. The resources necessary to undertake a comprehensive review for all series, for all areas, for all periods would be prohibitive and probably would preclude many data users from purchasing their services. In addition, it would be unlikely that they could compete against other for profit firms, who control quality in the aggregate, not at every level.

To evaluate projections from different types of organizations, one must judge the quality, timeliness, and degree of detail of the of the overall projections program relative to cost. For private and not-for-profit organizations, the cost would be reflected through client fees; for government organizations, the cost would have to be determined through information on the direct funding of the projection program.

A brief description of the source, series, release date, and general methodological approach of each organization follows:

Source:U.S. Department of Commerce, Bureau of Census

Series: Population by State

Release Date: October, 1988

Methodology: These projections are developed using a cohort-component method which allows for different assumptions for each component of population change , categorized by age, race and sex, births, deaths, internal migration, and international migration. The base data are resident population of the States by sex and single year of age as July 1, 1986. These data are disaggregated into racial groups based on 1980 census information and administrative records. The projections for mortality are State-specific and assume a slight increase in overall life expectancy. The appropriate age, race, and sex survival rates by State are developed from the 1979-81 State life tables developed by the National Center for Health Statistics. Future births are developed from applying age-race-specific fertility rates by State to the projected number of females of child-bearing age by State. In general, these projections assume a slight increase in the levels of fertility to an ultimate level of 1.8 births per woman. Fertility differences across States are based on historical patterns. International migration is assumed to decrease linearly from an annual level of 600,000 through 1988 to 500,000 by 1998 and remaining constant thereafter. State-to-State migration rates are used to develop estimates of domestic migration. A set of synthetic data was created using migration rates from the Current Population Survey March Annual Demographic File, migration flows from the 1980 decennial census, and annual State-to-State migration flows from matched federal income tax returns. Final State populations by age, sex, and race are controlled to the middle series national totals, which are independently projected.

Source: U.S. Department of Commerce, Bureau of Economic Analysis

Series: Employment by State and MSA

Release Date: 1986(?)

Methodology: The Bureau of Economic Analysis develops detailed regional projections every five years, with the most recent set being the 1985 OBERS, BEA Regional Projections. BEA develops its State and metropolitan projections using a step down method, moving from a national projection, to state-level, to MSA level, where the smaller constituent areas are forced to sum to larger areas. BEA relies on gross national product and employment projections by detailed industrial sector from the Bureau of Labor Statistics for 1990 and 1995, extending these series further into the future themselves. BLS develops GNP projections by 1) projecting the labor force participation rate, applying it to Census projections of population to obtain the labor force, 2) projecting unemployment rates, applying them to the projected labor force to obtain employment through substraction, and 3) projecting output per employee and multiplying it by employment to yield projected GNP. BLS distributes GNP across about 150 industrial sectors using a variety of interindustry relationships. For State and substate level projections, BEA aggregates industry detail to 57 industry sectors. BEA adopts the middle series national population projections by age produced by the Bureau of Census.

Employment in each national industry is distributed among the States, according to whether an industry is basic (produces products generally exportable) or service (satisfies local demand) by use of a base-service model of the economy of each State. Each State's share of the basic industries is projected into the future and controlled to a national total. Service employment flows from basic employment with the relationship varying from State to State, sensitized by changing national trends.

Projections of population by State are driven by the employment base, taking into account changing State and national trends in this relationship. Total population is the sum of three separate age group projections, the population 0 - 14, 15 - 64, and 65 plus. The population 15-64 is developed through a ratio of age-group population to total employment by State, adjusted for trends in the State-to-national relationship of this ratio over time. The population under age 15 is developed from trends in the ratio of the under-15 category to the 15-64 category, sensitized by the State-to-national relative. The projection of population over 65 is developed similarly using the 0-64 population base.

At all phases of the State/industry projection process, the mathematical model results were reviewed and modifications made, when necessary, to adjust for 1) unusually rapid growth or decline, 2) a permanent event, such as factory shutdown, that primarily affected the level, rather than the trend in economic activity, 3) a temporary event, such as a strike, that should have no long-term impact, or 4) a planned event, such as an opening of a new facility after 1983, that was not reflected in the base data. The review process involved first BEA staff, followed by State review by Federal State Cooperatives for Population Projections and other State organizations knowledgeable in these fields. Finalized industry and population projections served as the controls for the MSA and non-metropolitan aggregate projections.

MSA projections flow from the State level projections. The historical annual growth rate in the MSA's share of the State level employment by industry is projected into the future at a declining rate, then applied to the projected state level employment. This assumes that economic forces will emerge which will preclude an MSA share from either growing or declining at a rapid rate for extended periods of time. Once again, preliminary projections are reviewed and modified based on current data. As with State population projections, MSA population is driven by the employment projections. For all series and all levels of geography, smaller areas are summed and controlled to larger areas.

Source: National Planning Association

Series: Population and Employment by State and MSA

Release Date: Late 1987 to Early 1988

Methodology: The National Planning Association uses the population, employment, earnings, and income historical data base from the Bureau of Economic Analysis as their core data base. NPA uses a regional growth accounting model which disaggregates a national forecast into consistent subnational forecasts. NPA allocates their forecast to economic areas of the country, then to counties within these areas through a two-step disaggregation process, utilizing relative growth rate differential and multiplier analyses. The counties are then aggregated into State, regional, and MSA area totals. Hisorical growth rate differentials, (the ratio of the area growth rate to the national growth rate) are projected to decay over the projection horizon. The resulting area specific growth rates are then applied to prior year employment, while controlling the sum of the areas to the national total. Population, as with the BEA projections, is driven by the employment projections. A similar methodology is followed for the counties, except differentials by county are used instead of multipliers, since at the county level, population (by place of residence) may not be as closely related to employment (by place of work) as in larger geographic areas where commuting does not influence the ratios as much.

Source: Wharton Econometric Forecasting Associates (WEFA)

Series: Single and Multifamily Housing Starts and Value of Nonresidential Construction Put in Place, in 1982 dollars

Release Date: Spring 1988

Methodology: Wharton Econometrics produces, on a quarterly basis, quarterly forecasts ten years into the future for a large number of economic and demographic variables. These series are available only to their clients, and detailed information on how the series is developed is unavailable for public distribution. WEFA in general uses an econometric approach in their forecasts by developing structural equations for all concepts, adjusting the forecasts through add factoring for deviations in the most current information which have not been picked up by the mathematical model.

MACROECONOMICS

Steven Morrison,
Brookings Institution

This session is listed on the program under "other perspectives," but I would claim, particularly after what I heard today, that macroeconomics is the primary perspective used in forecasting -- tempered with intuition or judgment depending on your place on the career ladder. While I come from what I consider to be the perspective, I do not come from the forecasting perspective.

What I have been doing is just the opposite of forecasting -- assessing what has happened in the past. Cliff Winston (also from Brookings) and I have assessed the impact of airline deregulation on travelers and carriers. We are the sources of what you may have heard of as the famous "$6 billion number" -- the annual benefits to travelers from airline deregulation. We are also the source of the not-so-famous "$3 billion number", the annual benefits to carriers from deregulation. These figures are in 1977 dollars. When expressed in today's dollars the benefits to travelers and airlines from airline deregulation would be something on the order of $15 billion benefits annually.

Today I am going to talk about the work that we have done to assess the impact of airline mergers, airport congestion, and Eastern's bankruptcy. We want to assess the effects of mergers on travellers' well-being because, after our book was published and our findings were greeted with general approval, a lot of things happened -- mergers in particular. We wanted to see how much they had affected the consumer net benefit.

For that, we developed a carrier/routing choice model where we took for granted that people were travelling by air and wanted to quantify the factors that influence whether they take, for instance, an American non-stop or a Delta connecting flight. We looked at such factors as fare, travel time, and connecting time. We also included accidents in the last six months, and a variable for capturing frequent flyer programs. We used that model of carrier/routing choice to assess the effect of mergers on route-by-route basis, which is where the forecasting aspect comes in. If you know that carriers are about to merge, you can say that on this route there will be some increased frequencies, or that fares will go up here, fares will go down there, and get some idea of the likely impact of the merger.

We looked at mergers of American - AirCal, USAir - Piedmont, USAir - PSA, Delta - Western, Northwest - Republic, and TWA - Ozark.

The estimated effects of these mergers on travellers ranged from minus $75 million to plus $71 million annually. The aggregate effect of these six mergers amounted to plus $67 million annually. Travelers, by our estimate, are better off in the aggregate because of these six mergers.

Our worst case scenario of the effect of these six mergers is minus $335 million annually. We did not find that a great impact when measured against the $15 billion of annual benefits that accrued from airline deregulation.

Another aspect of our work was to assess the impact on air travellers of congestion-based pricing of airport runways compared to the standard weight-based landing fee that is constant throughout the day. What if all airports in the country charged landing fees based on congestion? We looked at 30 airports and then extrapolated to get a figure for the country as a whole. We estimated that, if congestion-based landing fees were charged, net benefits would increase by $3.8 billion. This figure is comprised of gains in airport revenues and in fares to consumers. Airport profits would increase by $11.5 billion, minus a $7.7 billion increase in air fares, leaving a net effect of about $3.8 billion.

At four airports we examined in detail how imposing such prices would lower delay average over the whole day not just peak-hour delay. We estimated a reduction of four minutes at Washington, National, two minutes at Denver, 15 minutes at La Guardia, and two minutes at O'Hare. This would be accomplished, of course, by lowering aviation activity. We estimate an 8-percent reduction of operations by majors and nationals, a 33-percent reduction by commuters, and a 50-percent reduction by general aviation. Again, our goal is not to forecast the effects *per se* but to assess how good an idea congestion pricing would be.

The third thing that relates to our subject today is the effect of bankruptcy. We took our model/of mergers and looked at what happens when N carriers on a route goes to N minus one for a reason other than a merger (i.e. bankruptcy) and estimated what effect that would have on consumer well being. Our worst case scenario, unrealistic as it may be, was Eastern goes out of business, never existing again, and nobody entering the markets that Eastern left. We found that travellers would be worse off by $500 million annually. A more realistic scenario assumed that, where Eastern left a market, another carrier would enter and things would stay pretty much as before. A middle of the road scenario, which is the one that we took, was that on any route served by Eastern another carrier that already serves the origin and destination traffic (but not the route) would enter. That affects fares in our modek a little bit, and we found a $100 million annual loss to passengers if Eastern were to be gone forever. From a policy point of view, you need to balance that against the approximately one-million-dollar-a-day loss that Eastern was accruing in the latter days of 1988.

Comment: How do the benefits from congestion pricing relate to your earlier benefits that accrued to passengers from deregulation?

Mr. Morrison: There were two separate studies, but they can be pieced together. We did our study of the effects of airline deregulation by comparing 1977 with 1983. It is not that easy, but basically our model of the deregulated world looked at the 1983 world. Let us assume that there was no airport congestion in 1983 and all the congestion that we have now has developed since then.

We also calculated what the effect be if we priced airports efficiently under regulation. Traffic has grown, airports are more congested, therefore the benefits from pricing them are greater. We estimated that if airports were priced efficiently, the net benefits would be $1.6 billion. If we priced them efficiently in a deregulated environment, the benefits would be $3.8 billion because there is more traffic. So the failure to price efficiently under the deregulated system has led to a $2 billion decrease in benefits, so subtract $2 billion from the 1.5 billion deregulation number I gave you. But that is a worse case scenario.

Comment: How did you calculate the shadow price of congestion?

Mr. Morrison: We had aircraft operating cost data from FAA. We used our model of carrier/route choice to estimate the value of passengers' time. It was very simplistic in essence. We looked at current airport usage hour by hour by commuters, general aviation, international, cargo, and everybody else, and assumed an overall price elasticity of 1.5.

Comment: You said that if Eastern goes bankrupt, and no other carrier replaces Eastern's service, passengers would be would be worse off by $500 million annually. Did you take into account, for example, reduced congestion that would result? This would benefit airlines, and their yields would go up since there would be underutilized capacity.

Mr. Morrison: We did not attempt to measure any airline benefits. Fares would go up, which hurts consumers and helps airlines. And we did not take into account changes in congestion.

Comment: So reduced congestion could offset some of the public cost?

Mr. Morrison: Yes, $500 million is the worst case. $100 million is the more believable number.

Comment: With the $11.5 billion gain to airports as a result of congestion-based pricing, did you find that airports would invest in new runway capacity?

Mr. Morrison: No, but that $11.5 billion gain, was from a short-run model, assuming that prices (landing and take-off fees) were assessed to make best use of current capacity. That is the only number I mentioned today. We also had a long-run model. In the long run, if you rationally price a resource that cannot be expanded, you will have fees in excess of investment costs.

Comment: But you could use the money to subsidize off-peak operations.

Mr. Morrison: In a different scenario you could reduce the eight-percent ticket tax as well. The problem is that airports get increased landing fees, and the Federal Government gets the eight percent. In a different policy environment however, you could reduce off-peak fares. Of course, you would have to make sure that the rebates did not go back to the people who paid the higher peak-hour charges, or else the fees will have no effect. You would have to make sure that it went to different people or that it was distributed on a different basis than that on which it was assessed.

ENERGY AND ENVIRONMENT

James MacKenzie,
World Resources Institute

Introduction

The World Resources Institute is located in Washington and is a non-profit policy research center funded mostly by private foundations, with some money from United Nations Environmental Program and some from EPA. There is also some support from a few foreign governments to work on projects such as improved natural resource management in Africa. I work in the climate-energy-pollution program.

I would like to begin by first posing a question to you all. What do the following countries have in common: the USA, Holland, Japan, England, Soviet Union, and France? The answer is they are all having international conferences on the global environment within a period of about one year, which tends to support the comment that environmental issues are making a comeback. I think they are coming back with a vengeance that is going to shake us all up.

In preparing for this, I was planning to tell you a little about what I think are going to be the direct effects of climate change on energy use and on aviation over the next couple of decades. But the more I listened to previous speakers, the more I was thinking that "business as usual"--as I heard it described--is not going to be the case at all. Things like global warming are going to affect us in profound ways with impacts on water supply, agriculture, resource management, wildlife, and energy supply. Energy is a $450 billion a year business here, and it is going to change pretty quickly if we are going to cope with climate change. I see a lot of turmoil over the next few decades because the problem will get progressively more threatening. I am not at all sure that the sort of evolutionary future that we have heard discussed here is actually going to be as evolutionary as one thinks. I think it is going to be much more revolutionary.

Greenhouse Warming Effects

Let me quickly run through for you some of the expected impacts of greenhouse warming and how they relate to our energy supply and how I think these impacts are going to affect aviation.

First of all, no one can say for sure that the effects of greenhouse warming have arrived, but there are a number of signs that are consistent with it. We know that the earth has warmed five to seven tenths of a degree Celsius over the past century though the average global temperature has not always gone up monotonically. The six warmest years of the past century have all occurred in the 1980s. Sea levels are rising at an accelerated rate. The depth to the permafrost is getting deeper suggesting that the earth at higher latitudes is warming. Canadian lakes are warming and, worldwide, glaciers are retreating. James Hansen of NASA's Goddard Institute for Space Studies says he thinks the greenhouse signal will be clear within the next decade.

Principal Greenhouse Gases. The five gases that people worry about most are carbon dioxide, ground level ozone, CFCs, Methane, and nitrous oxide. I think carbon dioxide (CO_2) is the one that will be of primary concern to aviation. Ground-level ozone is not so much a problem for airplanes. CFCs are not too relevant. Methane and nitrous oxide arise primarily from biological and natural sources (e.g. methane arises from coal mines, rice growing, cattle, and from the warming tundra. Nitrous oxide arises primarily from fertilizers and from forest clearing.)

CFCs, chlorofluorocarbons, are a class of inert, non-toxic but very stable compounds used in air conditioning, refrigeration, as cleaning solvents for electronic components, and as foam blowing agents. CFCs are depleting the ozone layer in the stratosphere, and they persist in the atmosphere for several hundred years. We are going to have to find substitutes which will be shorter lived. The CFCs are also very potent greenhouse gases in addition to being ozone depleters, and that is another reason why they are of concern.

If you look at the expected global warming from the buildup of these 5 gases, the trend is not at all encouraging. (See Figure 1.) CO_2 accounts for about half the global warming problem now. It will be about a third of the problem several decades from now. This projected warming does not take into account the Montreal protocol which should reduce the expected CFC warming. Nonetheless, the picture is one of permanent incremental warming each decade. This is going to affect things in ways not seen for tens of thousands of years.

<u>How Transportation Contributes to Global Warming</u>. Let's look at where the CO_2 is coming from in this country. The two biggest sources are electric utilities, the largest source at about a third of total emissions, and transportation, which is about 31 percent. With the virtual abandonment of nuclear power, the utilities are pretty much hooked on coal. And transportation is essentially 97 percent dependent on oil. No surprises there. Industry and buildings account for a smaller and diminishing fraction of CO_2 emissions. That is because the U.S. economy is becoming more electrified.

If you look at U.S. sources of energy and CO_2 you see that oil supplies about half of our fossil fuel energy and accounts for about half of our CO_2 emissions. Coal and natural gas account each for about a fourth of our fossil energy supply but coal accounts for a much larger fraction, about a third, of our carbon dioxide emissions. (See Figure 2.)

The reason for that is very straightforward. It is because of the high hydrogen content of the natural gas, and the relative lack of it in coal. A lot of energy is released from burning hydrogen when you use natural gas. If you take natural gas as 100 units of CO_2 per unit energy, then oil releases about 40 units more, and coal about 75 units more CO_2 than natural gas. This is the reason why natural gas is now being pushed as a substitute for coal in power generation; it releases much less CO_2 per unit of energy.

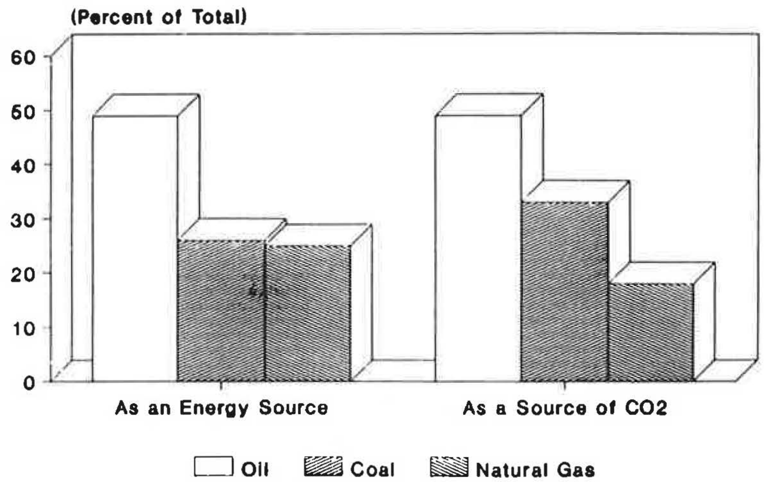

FIGURE 1. Fossil Fuel Sources and Carbon Dioxide Emissions

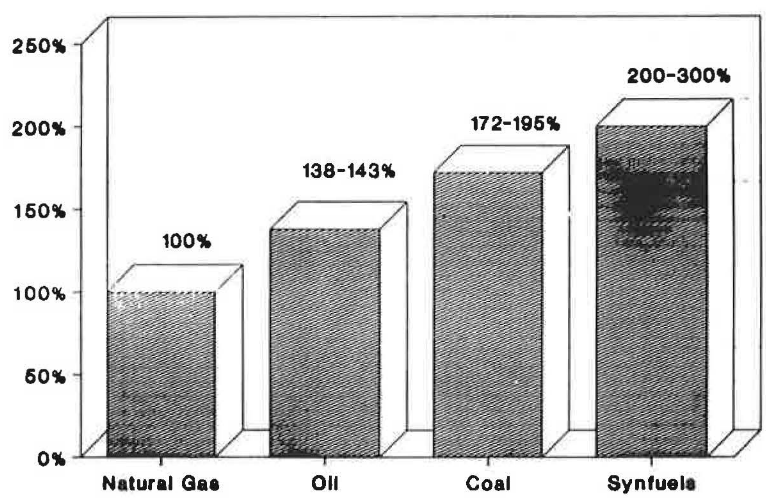

FIGURE 2. Relative Carbon Dioxide Emissions
(Natural Gas = 100)

If you look at the national emissions of CO_2 over the past 15 years, they basically reflect the price of oil. (See Figure 3.) Emissions went down after the first oil shock. As prices dropped, in constant dollars, emissions went up. In 1979, they started down again and, lo and behold, with low oil prices, they are have been going up again. So we have not done badly over the past 15 years but we must recall that the U.S. accounts for a fourth of global CO_2 emissions.

If you break it down and look at the sector trends, you start seeing where the problem lies. (Figure 4.)

The fastest growing source by far is electric power generation. Utility emissions have gone up substantially over the past 15 years. Right behind is transportation. As I said, emissions from buildings and industry have gone down. This trend reflects the electrification of the economy, the substitution of electricity for the direct use of fuels. Electric utilities are burning about 75 percent more coal now than they did 15 years ago, and if it were not for the increased use of nuclear power, we would be emitting far more CO_2 than what we do now.

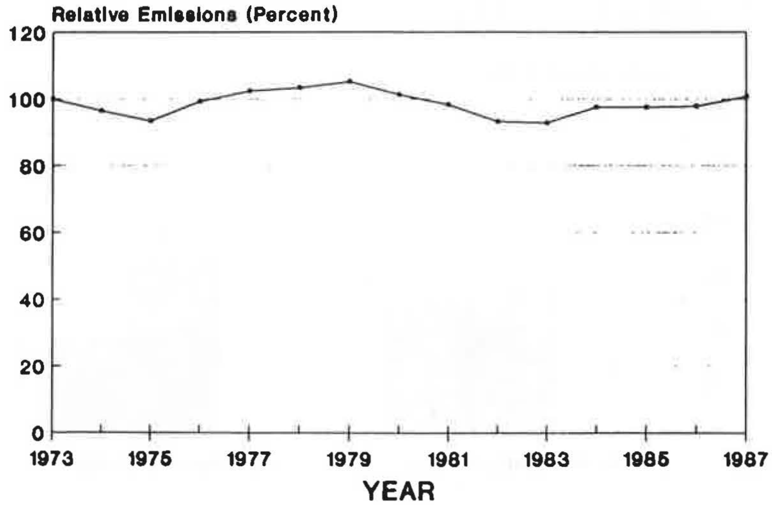

FIGURE 3. Total U.S. Carbon Dioxide Emissions
(1973 = 100%)

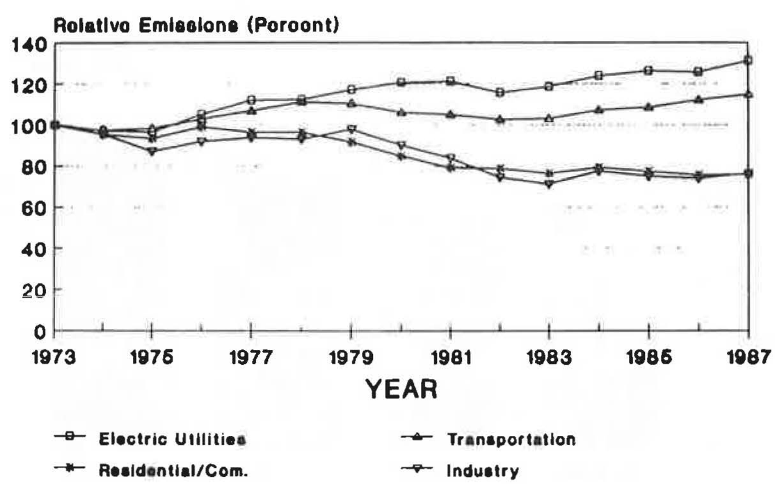

FIGURE 4. U.S. Carbon Dioxide Emission Trends
(1973 = 100%)

So transportation is, as you see, going up quite substantially. If you look at who accounts for the oil used in transportation you see that cars are the largest source, trucks are second, and planes are third. (Figure 5.) So airplanes are a part of the problem. Not the dominant source of the problem, but they are going to feel the impacts of policies to reduce CO_2 emissions.

If you look at total trends in oil use in transportation over the past 15 years, you see that oil demand has gone up, and it has come back down again. Aviation use -- and I am using jet fuel as the primary indicator for airplane fuel use -- has not changed very much. (Figure 6.) But if you look at trends over the past few years, you see that consumption is in fact beginning to rise, and that jet fuel demand has gone up by about 30 or 40 percent over the past few years. (Figure 7) So air transportation is not an insignificant part of the greenhouse problem.

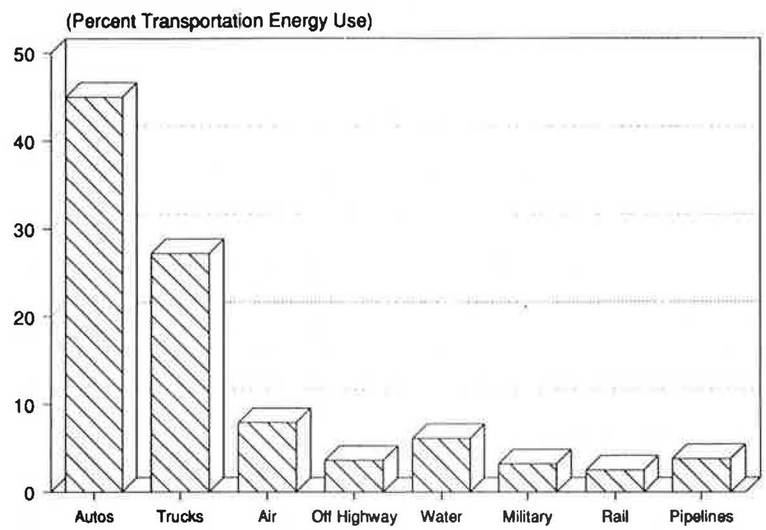

FIGURE 5. Fuel Use By Mode

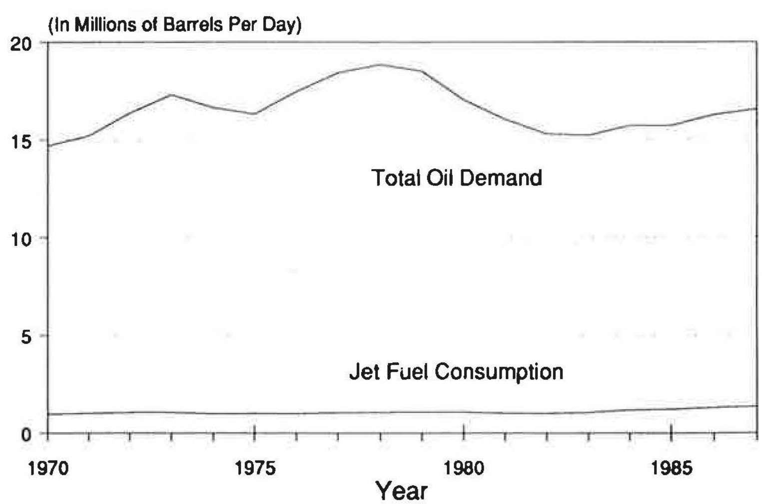

FIGURE 6. Trends in Jet Fuel and Total Oil Consumption in the U.S.

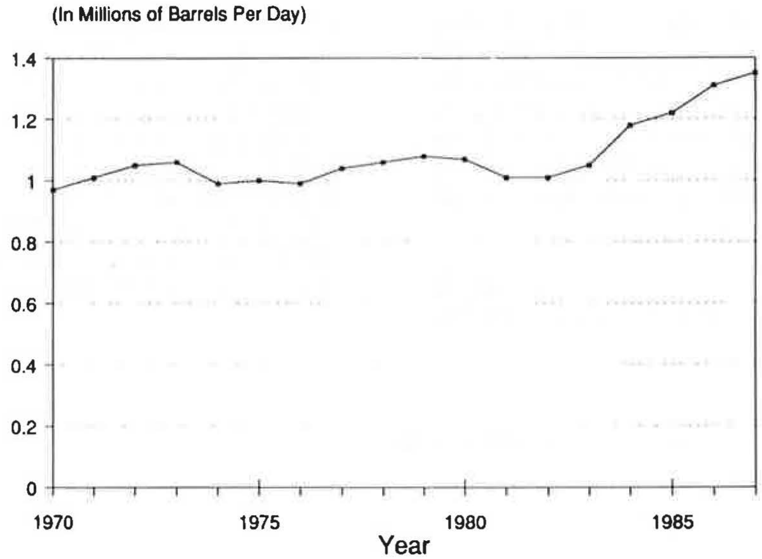

FIGURE 7. Jet Fuel Consumption

Impacts of Greenhouse Warming. Let me summarize some of the effects of greenhouse warming. I am going to describe some of the direct impacts of greenhouse warming on airports. These may be summarized as follows:

SOME EXPECTED IMPACTS OF GREENHOUSE WARMING

- **Higher temperatures, greater summer power demands, reduced cooling-water availability**
- **Worldwide shifts in rainfall patterns, monsoons, ocean currents, altered river flows, disruption of river and lake transportation**
- **Decline or loss of ecosystems that are unable to move or adjust to climate changes**
- **Dryer Midwest, Southeast, lower crop yields**
- **Sea level rise, erosion of beaches and coasts, damage to cities, ports, and other coastal structures, salt-water intrusion into coastal water supplies, flooding in low-lying countries, decline of fisheries with loss of coastal marshes and wetlands**
- **Stronger hurricanes, more weather extremes**
- **Melting of West Antarctic ice sheet (long-term threat) raising ocean levels many feet, submerging most coastal ports**

We can expect higher temperatures, shifts in rainfall patterns, a decline in ecosystems, and a rise in sea levels. Now, a lot of airports are at sea level: Hawaii, San Francisco, Boston, New York, so this is something you want to start thinking about. Sea levels 15,000 years ago were substantially lower than they are now because much of the northern hemisphere was covered with ice. As temperatures rose and the ice melted, sea levels rose and gradually levelled off. (Figure 8)

Figure 9 shows the recent trend in ocean levels. Sea levels are going up two to three millimeters per year. That does not sound like much, but it turns out that for every unit increase in the ocean level, the coast can erode back by a factor of 10 to 100. Coastal erosion, of course, may not necessarily apply to airports because of the way they are built.

The pluses on the chart indicate a rise in sea level and the minuses are decreases. There are two other factors reflected here besides the expansion of the oceans. There is subsidence due to oil and gas depletion, for example, off Louisiana where the sea level is rising, relatively, a centimeter a year. And there can also be coastal uplift from a glacial rebound which can give you the negative values. But by and large, the oceans are rising, there is no question about it, and there are the implications for airport planning.

RELATIVE MEAN SEA LEVEL

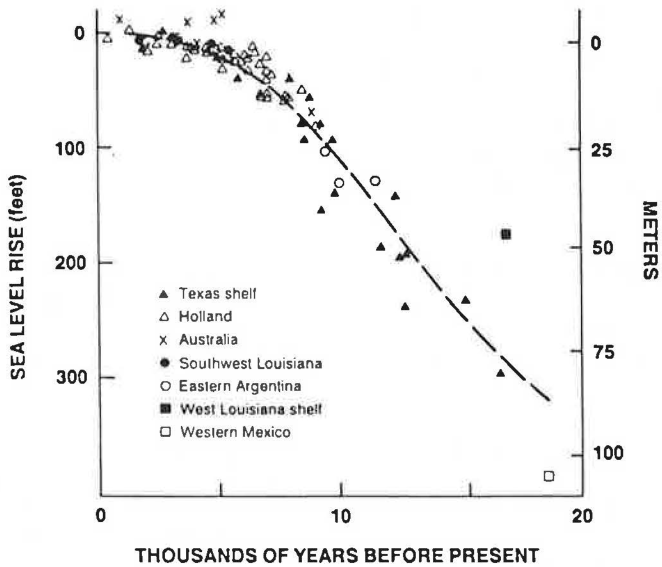

FIGURE 8. Sea Level Elevations vs. Time
(Obtained from Carbon 14 dates in relatively stable areas.
Adapted from Shepard - 1963)

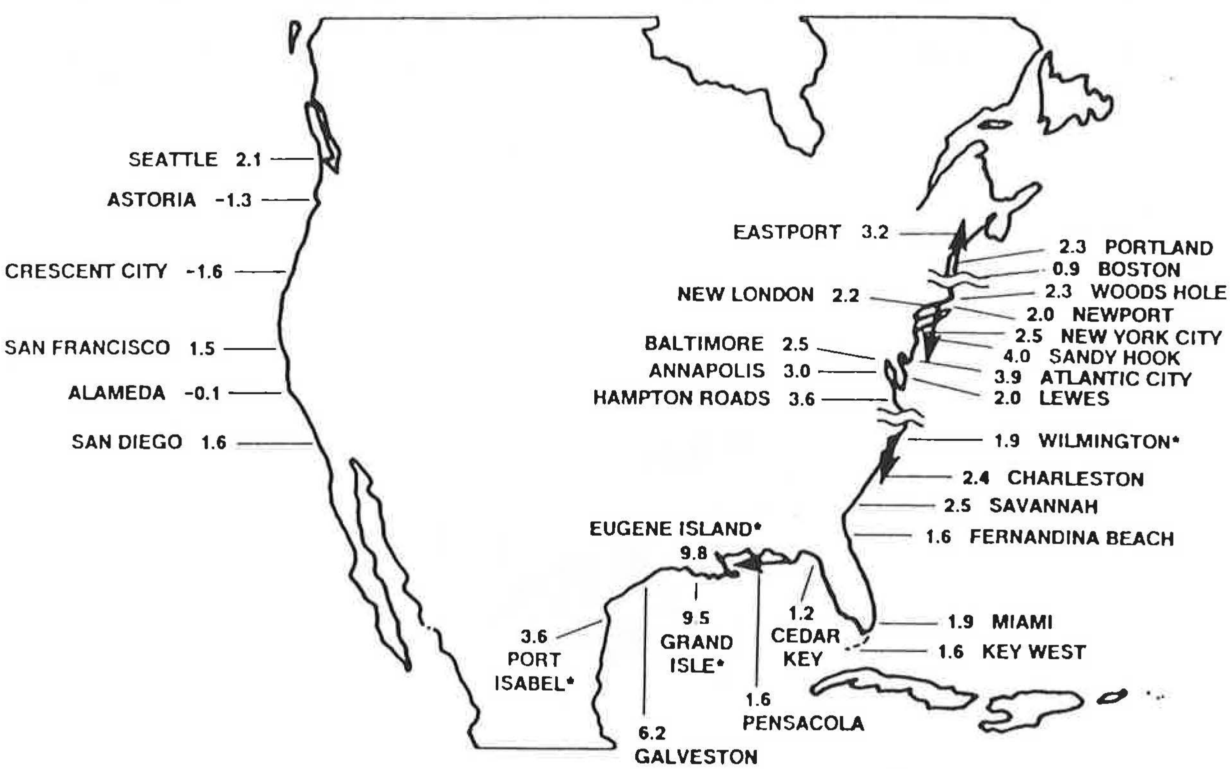

FIGURE 9. Local Relative Sea Level Changes*

*A summary of the present best estimates of local relative sea level changes along the U.S. continental coastline in mm/yr. The figures are based on the tide guage records over different intervals of time during the period 1940 - 1980.

Globally, the oceans have risen by about five inches over the past century and they are rising now two to three millimeters per year and accelerating. They could rise by four inches in the next 25 years and by up to one to three feet by the year 2100. Coastal airports are in low areas, and this has got to be taken into account in long-term planning. Some factors to consider are the following:

AIRPORTS AND SEA LEVEL RISE

- **Globally, oceans have risen by 5 inches over the past century. They can rise by 4 inches in next 25 years.**
- **They are now rising 2 to 3 mm per year.**
- **They could rise by 1 to 3 feet by 2050.**
- **Many coastal airports are located on low, filled-in land: Logan, LaGuardia, San Francisco.**
- **Rise of the sea level needs to be considered in long-term planning. Mitigation will be site-specific.**
- **There should be tide gauges at all major coastal cities with airports to monitor trends in sea level rise.**

One of the other effects of greenhouse warming is going to be an increase in tropical storms which will exacerbate the impacts of rising sea levels.

The last recommendation on the list is from a National Academy of Sciences report on sea level rise from about two years ago. They recommended that there be much more careful monitoring of sea levels at all major coastal cities, especially those with airports. By the way, rising oceans are going to have a big effect on places like Bangladesh and Egypt and other countries that are low. Holland is going to have to be very careful. I do not mean to downplay it, but the U.S. problem is not so big. We can cope with it.

Energy Security. When we get to energy supply and how it is going to be affected by greenhouse warming, I think we are getting into a much more interesting and much more rapidly changing problem than two millimeters per year of ocean rise.

About 42 percent of our energy supply is oil, and fossil fuels account for 90 percent of all our energy. (See Figure 10.) Our oil is increasingly being imported, and the underlying reason is very straightforward. We do not have much oil. The United States and Canada account for about 30 percent of world oil demand but have only about four percent of global oil reserves. Most of the world's oil is in the Middle East. (Figure 11)

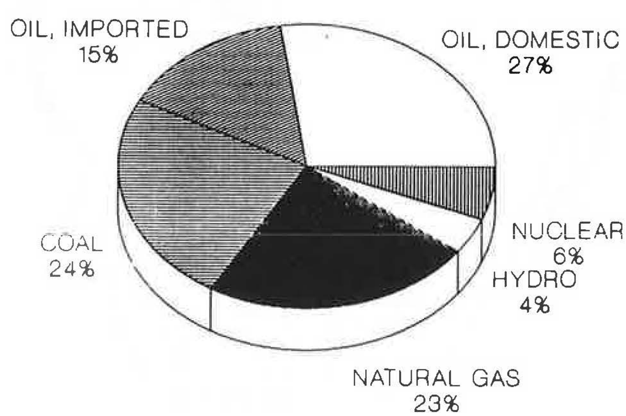

FIGURE 10. U.S. Source of Energy (1987)

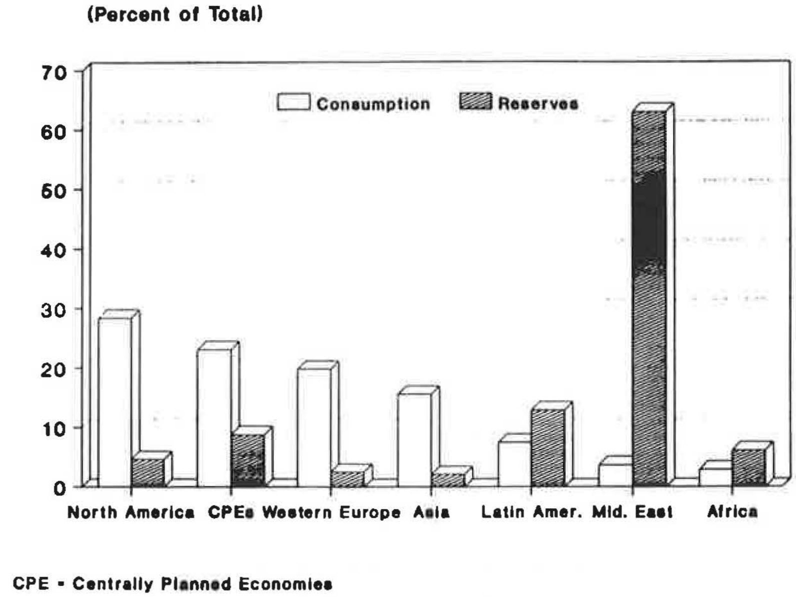

FIGURE 11. Global Oil Consumption and Reserves (1987)

Globally, OPEC has about two-thirds of global reserves. U.S. domestic production is declining and imports now account for 37.5 percent of our oil supply. (See Figures 12 and 13.) According to the Department of Energy, imports could reach 50 percent of supply by the mid-1990s, and they could be 75 percent by the turn of the century. I believe that OPEC will be back in control of world oil prices by sometime in the 1990s, simply because many of the other sources of oil such as the Soviet Union, are near their peak. Production from Prudhoe Bay also appears to be declining. The result is that more and more importers will be going to the same source, the Middle East.

Let me tell you why I think the U.S. is not going to do much better in expanding its domestic oil supply. You perhaps know of M. King Hubbert, a well known geologist now retired from Shell and the U.S. Geological Survey. Hubbert observed some time ago that if you depend on a non-renewable resource, eventually you use it up. Figure 14 shows cumulative consumption of a non-renewable resource. As you use it up, the price rises and you have to substitute something else for it. If you plot U.S. lower-48 oil production it follows perfectly such a curve (See Figure 15.) The squares give you the actual data for U.S. cumulative oil production for the lower 48 states. They lie perfectly on a logistic curve. If you take the derivative of this curve you get annual production.

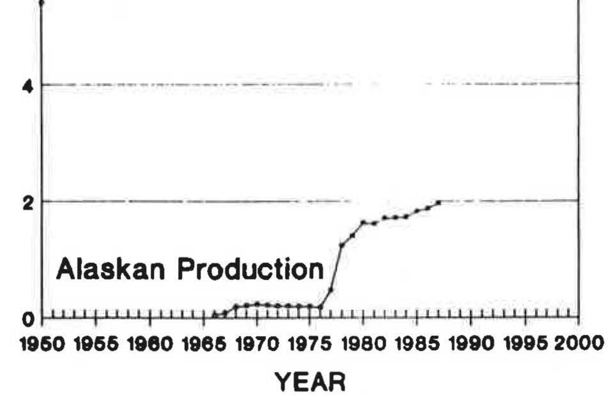

FIGURE 12. Trends in U.S. Oil Production
(in Million of Barrels per day)

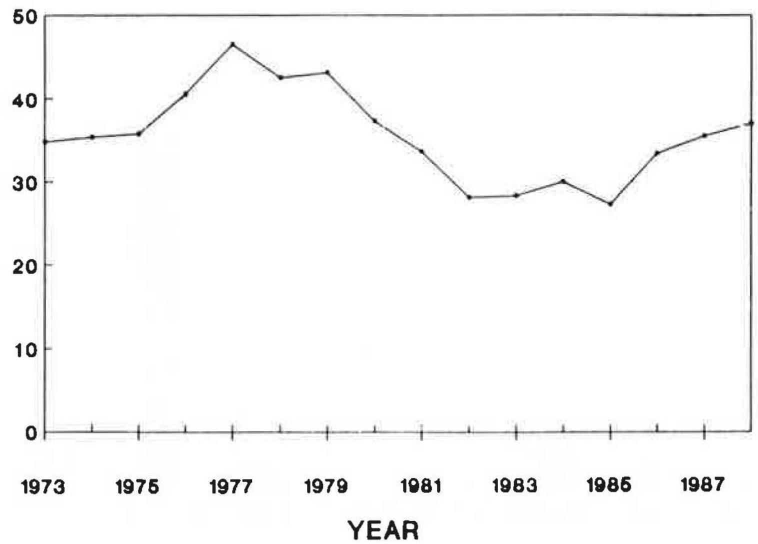

FIGURE 13. Trends in U.S. Oil Imports (Percent of Total Supply)

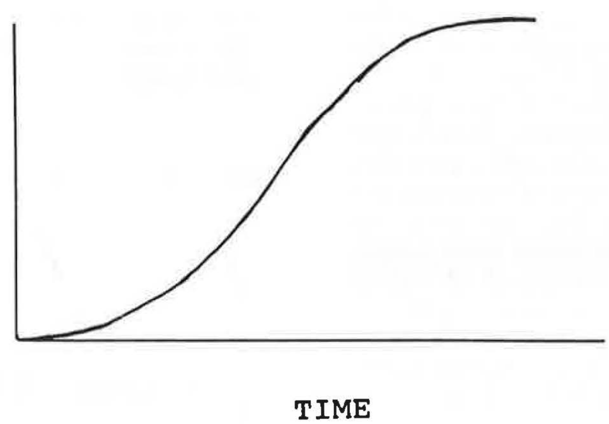

FIGURE 14. Cumulative Consumption of a Non-Renewable Source

U.S. oil production continues to decline. Production in the lower 48 peaked in 1970. It has gone down even more rapidly with the recent drop in prices. (See Figure 16.) Many of the small oil wells, so-called stripper wells, have been closed down and will not be reopened.

One of the participants pointed out that if an import fee were imposed, as has been proposed several times, it could change this whole picture.

MacKenzie responded that during the 1970s, the price of oil was high. The United States drilling effort tripled between 1973 and 1981. Yet, the United States could not even maintain constant oil reserves. With higher prices you will get the oil out faster but I do not think you are going to get significantly more out in the long run. You are not going to turn around this curve of declining production. Production in the lower 48 is going to continue declining. Alaskan production has helped. But production from Prudhoe Bay also appears to be declining, so total domestic production is going to continue to drop. More incentives and more drilling may temporarily slow it down, but certainly is not going to reverse it. Looking to increased domestic oil production is not a long-term solution to this problem. We are going to have to find replacements for oil.

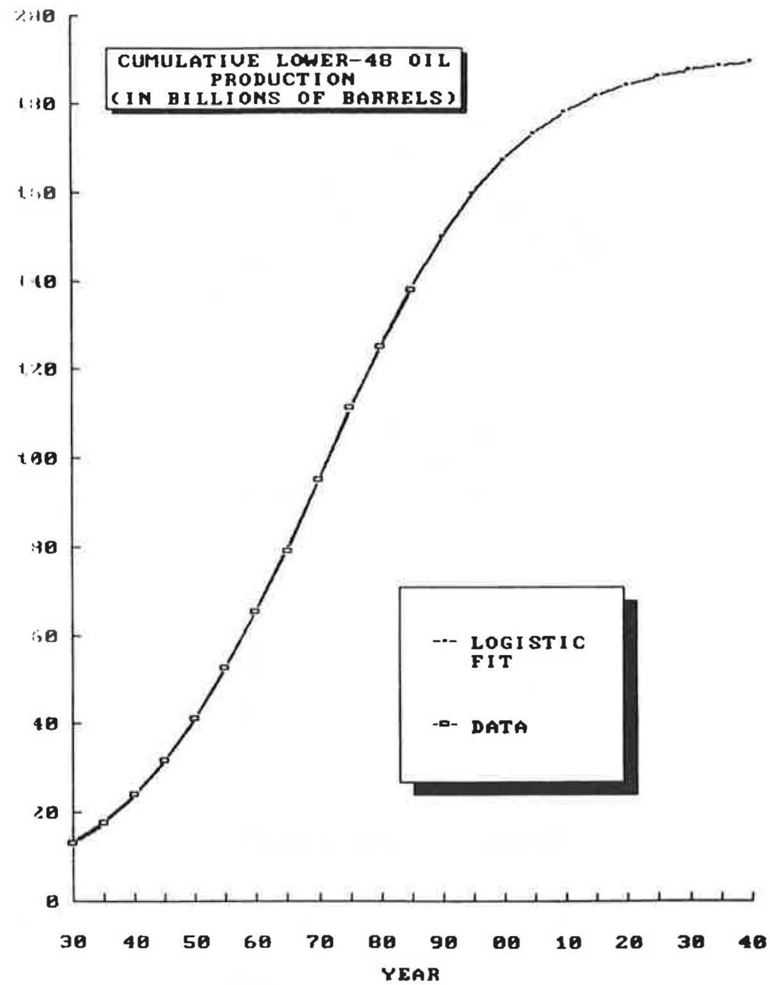

FIGURE 15. Cumulative Lower 48 Oil Production (Billions of Barrels)

Where do We go From Here?

The pressures to reduce CO_2 emissions worldwide are going to increase over the next few years. If you just ask the question, "by how much would the world have to reduce CO_2 emissions to stabilize atmospheric CO_2 levels?", it is probably 50 percent to 80 percent. There is a lot of scientific uncertainty there about how much CO_2 is going to stay in the air versus going into the oceans. But there is already international discussion about adopting a global goal of a 20 percent reduction in CO_2 emissions by 2005. We are a long way from there now with emissions from transportation and utilities going up. And this is why I believe the kind of discussion we have heard today--that things will be very evolutionary and that prices are going to stay low--is just not realistic.

With regard to global oil resources, you ask "how much oil is likely to be pumped from the earth using existing technologies?" that is, without going to tar sands and the like. If you look at the estimates that have been made over time, you find a range of estimates that are entirely subsumed within the Rand Corporation's estimate of 1,600 to 2,400 billion barrels. (See Table 1.) Of this, the world has already consumed about 600 billion barrels, so we still have a lot more oil to pump before we reach the half-way point. Even so, if you fit a logistic curve to cumulative world oil consumption you find that global oil data followed such a curve up to the 1973 embargo.

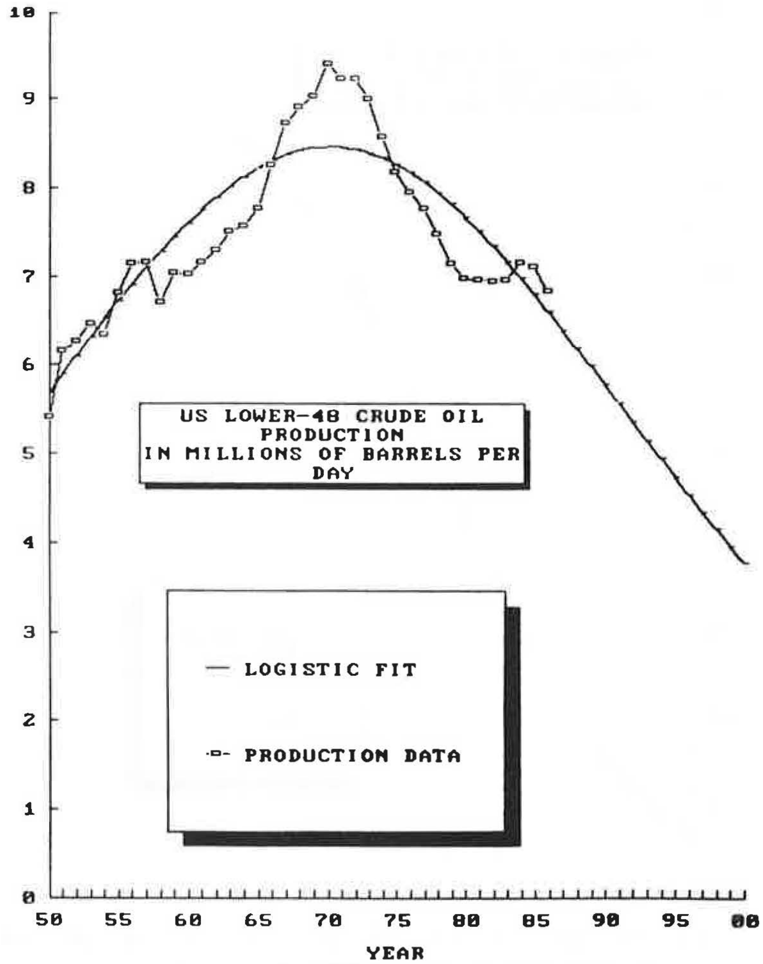

FIGURE 16. U.S. Lower 48 Crude-Oil Production
(Millions of Barrels Per Day)

Using the Rand estimates for the asymptote one concludes that -- absent the 1973 sharp rise in oil prices -- world oil production would have peaked sometime in the early part of the next century.

TABLE 1. ESTIMATE OF ULTIMATE RECOVERABLE GLOBAL CRUDE OIL

SOURCE	ESTIMATE (Billions of Barrels)	DATE OF ESTIMATE
Masters et al. (USGS)	1744	1987
Riva (Congressional Research Serv.)	1721	1987
Nehring (RAND)	1600-2400	1982
BP	2290	1980
Halbouty, Moody	2128	1979

As it is, of course, oil consumption dropped way down as a result of politically set high oil prices. Recently, with the weakening of the cartel and its inability to hold prices up, world oil demand is going up again. As a result the world production curve has probably been shifted several decades further into the future. Nonetheless, the message is clear that the mid-point of the oil era is only a matter of decades away. Please note that I am not saying that we are running out of fossil fuels; there is still a lot of carbon in the world in the form of coal. But I think that there is not going to be a whole lot more oil found outside of the Persian Gulf and that in our children's lifetimes, if not in ours, global oil production will peak out. (See Figure 17.)

All of this, I believe, has important implications for our use of fuels. In the short term we have got to make far more efficient use of energy. I say this recognizing that airplanes have already become much more efficient. The two consuming sectors now posing the biggest problem, where major changes are going to occur, are power generation and transportation. In light of both global warming and the finiteness of global oil resources, we are going to have to turn to new energy technologies such as hydrogen or electrically powered vehicles, certainly for ground transportation. I just do not see any alternatives for the longer term.

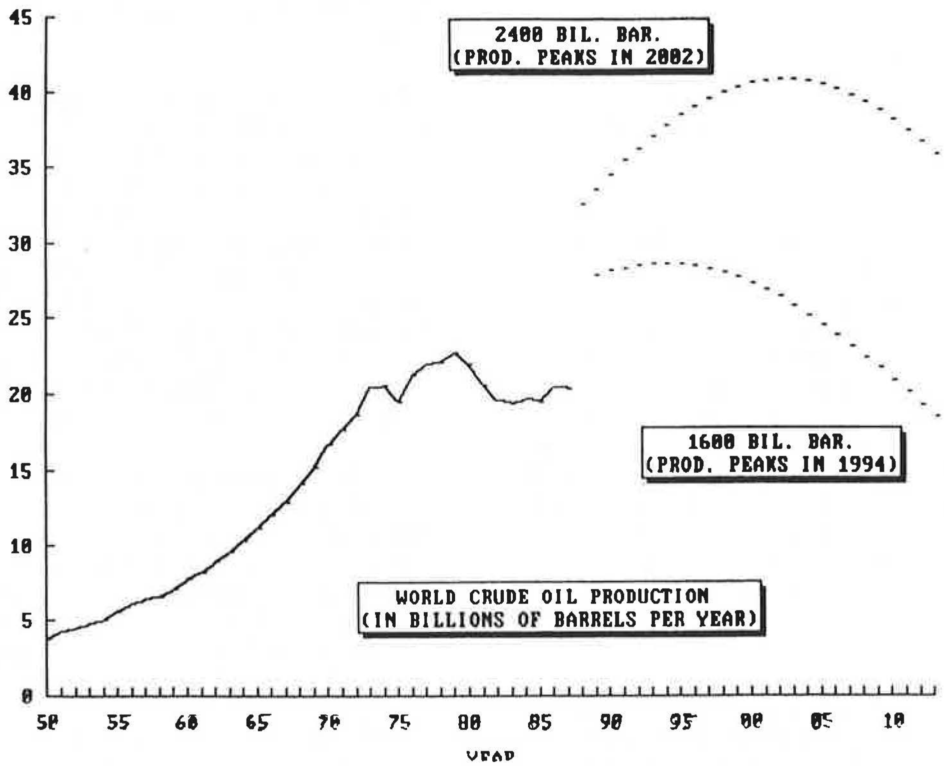

FIGURE 17. World Crude Oil Production
(Billions of Barrels Per Year)

Of course this does not mean that we have to eliminate all uses of oil and other fossil fuels and maybe aviation is exactly where we want to continue using them because it may be difficult to develop alternatives. In this case perhaps the problem will not be so severe for the air transportation industry.

Alternate Fuels. We should begin to move to non-fossil energy technologies, particularly, (1) hydrogen and/or electrically powered vehicles, and (2) renewable (PV, wind, etc.) and second-generation nuclear technologies for electric power generation. Hydrogen, the development of which is being explored in Germany, Canada, and the Soviet Union, is a good candidate to become the aviation fuel of the future. Hydrogen, of course, can be made using non-fossil sources such as nuclear power or solar energy.

Given the need to drastically cut CO_2 emissions, it is imperative that we start a transition to new, non-fossil energy sources. The renewables -- such as photovoltaic cells -- are well known but still expensive. They also need storage because they are intermittent. Second generation nuclear power plants are another possibility. These would be power plants with passive safety systems, ones that do not have all the reliability and sensitivity problems of the present generation of light water reactors.

Conclusion

Let me summarize by saying that the direct impacts on airports from sea level rise should be fairly small. A gradual rise in the sea level can be engineered against as long as you keep track of and monitor trends. The big changes from global warming are going to be in the economic conditions that will arise as we attempt to cope with rapid change. We should have begun to adapt some time ago. With a few more summers like the past one we can expect more nations of the world to turn more attention to this problem. Either we start planning or we are going to leave a very unpleasant climate for our children. And it will get progressively worse. There is no sign it is going to level off, unless all the climate feedback loops just happen to be negative, which seems unlikely.

The majority of feedback loops may, indeed, turn out to be positive: the clouds, the melting of arctic ice, the release of methane from the tundra, and the rest of it. At any rate, I think that the social changes are going to be much more revolutionary than evolutionary, and there are going to be a lot of changes in the use of the fuels -- much less use of coal, more use of natural gas as a transitional fuel, and a greatly accelerated attempt to introduce non-fossil energy sources. We consume far more fossil fuels than we need to. With five percent of the world's population we account for 25 percent of the world's CO_2 emissions. I do not see any way we are going to convince the third world, the developing countries, to cut back on their emissions until we do so ourselves. The United States has a real responsibility to take the leadership in controlling our energy appetite and developing new energy alternatives.

Discussion

Comment: Does the recent announcement on the cold fusion experiment in Utah, indicate that this may be an important alternative energy source?

Mr. Mackenzie: Fusion is an energy source, and you can make hydrogen with it, but we do not have to wait for fusion for alternative sources of energy. There are solar thermal power plants already operating in California. They are building them with 80 megawatts capacity, and the newest one is expected to produce power at eight cents per kilowatt hour. Photovoltaic power plants can produce competitive power at peak periods. Certainly, new sources are not going to be as cheap as before. At the same time, we must recognize that traditional energy prices have been subsidized by unpaid environmental costs. It has not yet sunk into our psyche that we have to incorporate these unpaid social costs into the price of fuels. The greenhouse problem is well known and has been since the 19th Century. We still have not started to incorporate it into our long-term planning.

Comment: We, the human race, do not learn from past mistakes, and this presentation is an example of it. Malthus, a few hundred years ago, predicted some dire things in the first edition. Luckily, in the second edition he learned a little. Also in the last century, Jevons did funny projections and concluded that in 50 years we are going to run out of coal. We have more coal now than we know what to do with. Thirty years ago in 1954, we were told that we had about 30 years of oil left, but today, the experts are saying we have 45 years.

Mackenzie: Some years ago experts said that U.S. lower-48 oil production wouldn't peak in the foreseeable future, and when Dr. Hubbert said in 1957 that it would peak around 1969, he was laughed at. As we now know, he was right on the money and production peaked in 1970 and has been declining since, despite the rise in world oil prices and a tripling in exploration. At issue is not the reserves-to-production ratio, usually cited as so many years of oil left. The important date is the year of peaking. That is the time when you must have ready new, replacement energy sources.

Comment: Where does it say that the United States should be 100 percent independent in everything? We have at least, in the world, 50 years of oil by today's standards. If in 12 months the fusion does not happen, it will happen in 30 years. Then we will have a lot of oil and we will say, "what will we do with this stuff?" It is the same story. It is the Club of Rome over again.

MacKenzie: You miss the point I was trying to make, namely, that we are not just running out of oil in a matter of decades but that we are going to be constrained in our use of it by a real problem. When President Bush entered office the National Academy of Sciences wrote him a letter saying that this was the most serious problem that they were aware of, that basically the physics is irrefutable, that it demands international attention. If you have some refutation of their argument, I would like to hear it. We are going around with a business-as-usual attitude when it is not business as usual at all.

Comment: I think you are both right. We did not run out of oil, but the price went up, and the price is still with us. We are still paying, in real constant dollars. We are actually paying less, but the effect on airlines and air passengers and airports and aircraft manufacturers was traumatic for those five or six years during the 1970s. Although there is still plenty of energy, it affected all of our jobs and what we do so I think you are both right. We need to monitor these.

Comment: What are the prospects of a tax on oil to reduce the carbon dioxide output.

MacKenzie: It is not likely. The country does not want to be taxed; it prefers to be regulated.

Comment: We are having a lot of environmental damage. That seems fairly clear. But the important question, with the industry is how that is going to affect them. Unless there are real restrictions, most likely in the form of a tax on the use of carbon based fuels, it is unlikely that there is going to be a major change in industry consumption because there are no incentives.

MacKenzie: There is a major international review of the greenhouse problem called the Intergovernmental Panel on Climate Change. It is supposed to release its findings in about a year and there will be a lot of pressure for an international protocol to reduce CO_2 and other greenhouse gas emissions. It may or may not affect the airline industry. There is enough oil that if the price goes up, they can still use it. What occurred to me this afternoon was that the kind of quiet business growth that is imagined here will not likely occur. It will be very different if we have to go through major changes in our energy resources to severely decrease CO_2 emissions. If you look at what it would take to reduce CO_2 emissions, it is formidable problem.

Let me give you an example. People have been talking about least-cost planning on the part of the utilities. This means paying the utilities, giving them incentives, to go in and install efficient new lights and other highly efficient electrical equipment in all our buildings. A number of studies have concluded that if you do most things that people can think of, you can just about imagine holding electricity kilowatt-hour sales even while supporting maybe 2.5 percent GNP growth. That is a long way from reducing emissions by a few percent per year, which will be needed to meet the goals that are being discussed. It is going to take even more aggressive kinds of programs and I do not know what they might to be. But it suggests that we are in the calm before the storm.

Comment: I do a lot of flying and notice more turbulence in the air. Is there is any projection on the actual climatic conditions that will prevail in the future. We may have all the oil but if we have to sit in turbulence for seven hours every time we go somewhere, it may not be as pleasant. For example, some areas of Canada, this winter was one of the windiest, believe it or not, on record, and it has an impact on aircraft operations.

MacKenzie: The models are not really good enough to answer that question. The models divide the atmosphere into boxes, typically of 200 miles on a side, so they do not have a lot of detail. Climatologists do not really know what is going to happen to clouds. Changes in clouds are not incorporated into existing models. It is a very complex issue. The feeling is, though, that there will be more weather extremes. It would be interesting to see an analysis done to determine whether a trend of such extremes can be observed.

Comment: The secret of success is going to be whether the new technology will become commercially feasible. Supporting research and making some of these solutions commercially feasible will help. Superconductivity, for instance, promises to (in some respects) make electricity generation, storage, and transmission very much more efficient. This could reduce the huge loss in transporting energy from the point of generation to where it is used. In the transportation field, the application of superconductivity to maglev (magnetic leviation) and then to levitated transportation systems offers something that will equal or beat an airplane within a 500-mile range at an energy cost of about 25 percent of what an airplane uses. With such technology, energy can be generated by non-fossil fuels. Things like that are on the brink of commercial feasibility.

MacKenzie: The problem is not only developing new technology. The problem is with our institutions. We continue to build more and more highways, and create more urban sprawl. We are just locking ourselves more and more into a sprawled, decentralized way of life, totally dependent on the automobile, and one that is just going to make it harder and harder to cope with the problem.

If you look at where the oil is being consumed, maglev will be just a very small part of the solution, at least in the near term. The problem is the large number of cars and trucks that are out there and that are changing only very slowly. The newest cars today average 27.5 miles per gallon. Even so, the national fleet average has moved from about 13 mpg up to only 19 mpg over 15 years because of the slowness in turning over the stock of vehicles. We do not have decades and decades. We are committing the world to a permanent increased warming of about a half a degree Fahrenheit per decade. By 2030, the Earth will be committed to warming as much as 9 degree Fahrenheit, a temperature rise which was sufficient to take the Earth from the last ice age to the warmest period known to man. It is a major issue that is going to move very quickly. It will require a rapid response, not a kind of a laissez faire, "wait until it all happens and then we will worry about it" kind of attitude, which is unfortunately the way we tend to deal with these problems.

TECHNOLOGY

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The technologies emerging over the next decade will provide the basis for the next generation of aircraft whether they come about through evolutionary changes in derivative aircraft of the current generation, conventional new aircraft, or revolutionary new designs with significant new capabilities. Technology developments will also allow for significant improvements in air traffic control capabilities.

Air Traffic Control

New ATC technologies being considered for use within the coming 10 to 15 years include precise four-dimensional navigation and guidance systems, improved capability for the transfer of weather, traffic, and ground information to the flight crew, and computerized controller aids for optimum aircraft spacing and sequencing. For the very near term, the Traffic Alerting Collision Avoidance System (T/CAS), now being evaluated, will provide aircrews with onboard capability for detecting and avoiding potential mid-air collisions. By 1991 the FAA will require aircraft that carry over 30 passengers, to be equipped with T/CAS. These capabilities will help accommodate the substantial growth in air traffic that is expected to occur in the future. Air travel should also become more convenient in terms of reduction in unanticipated ATC delays, and maintaining on-time departure and arrival schedules.

Subsonic Aircraft

In an evolutionary fashion, the aircraft manufacturers will continue to introduce new subsonic transport aircraft that will incorporate major technology advances in aerodynamics, structures, propulsion, and systems.

The most apparent change to the vehicle may well be the introduction of new propulsion systems incorporating advanced turboprop technology. General Electric has recently tested a gearless, counter-rotating unducted fan advanced turboprop engine, and Pratt and Whitney/Allison/Hamilton Standard are developing an advanced, geared, counter-rotating turboprop engine. Both Boeing and Douglas are currently investigating aircraft designs using these propulsion systems. The timing of their introduction will depend on economics as influenced by fuel prices.

In aerodynamics, further gains in cruise performance and efficiency are expected from new airfoils, fuselages, and nacelles, which incorporate advanced technology for improved laminar flow control and high-aspect-ratio wing designs. The ability to achieve the contour of these airfoil shapes, and at the same time reduce weight, will be realized by advanced composite materials which are anticipated to be used as primary structure in wing and fuselage designs for the next generation aircraft.

Flight control systems using power-by-wire technology will replace the heavier hydraulic and cable systems. These designs offer potential improvements in direct operating cost (DOC) of 25 percent relative to current jet transports, particularly those that were introduced 10-20 years ago. These same technology advances are also applicable to future generations of improved general aviation or commuter aircraft.

A major technology driver will be operating and equipment cost, as affected by fuel prices, maintenance, and manufacturing techniques.

Advanced Aircraft

In a more revolutionary sense, technology developments also under way will allow for the introduction of new aircraft with greatly extended capabilities: vertical or short takeoff and landing (V/STOL) aircraft, high speed rotorcraft, and supersonic cruise aircraft.

V/STOL. Recently, the success of NASA's V/STOL technology effort has led directly to the development of the V-22 Osprey tiltrotor aircraft by the DOD. The technology for the V-22 is based on over 20 years of NASA and Army research on the tiltrotor concept for high-speed rotorcraft flight, which culminated in proof-of-concept flight, testing with the XV-15 Tiltrotor Research Aircraft. The 900-aircraft V-22 program marks the introduction of a revolutionary aircraft concept into the nation's military fleet. The experience gained from the V-22 development will provide the basis for possible early transfer to civil application. The opportunity for large-scale intercity and interregional transportation using civil tilt rotor transports with the speed and comfort of a turboprop aircraft has led to a joint agreement between NASA, FAA, and DOD to study and quantify the civil technology benefits than can be derived from the V-22 tiltrotor program. Civil derivatives of the V-22 could provide an early opportunity for the development of tiltrotor transports capable of payloads of 20 to 70 passengers, ranges of 300 to 400 miles, and operating cost reductions of more than 25 percent relative to the V-22.

The specific advances in technology necessary to the success of the civil tiltrotor aircraft include control and guidance systems technology and lightweight fuselage designs. The controls and guidance systems must enable precision approaches and landing guidance that exploit the unique features of the aircraft and yet maintain compatibility with conventional aircraft operating in the National Airspace System. The fuselage design must be lightweight and yet large enough for payload economy and strong enough for cabin pressurization. Forecast topics which address the future viability of the tilt rotor as a commuter include sensitivity analysis of passenger fare prices versus added convenience or reduced travel time. Also, what are the potential impacts of improvements in other modes of transportation, such as high-speed trains or improved automobile highway systems?

Supersonic Aircraft. It has been 20 years since the first test flight of the Concorde, which has now provided 13 years of active commercial service. Thirteen years is long enough for the novelty to have worn off, and it is evident that there is a steady demand for high-speed transportation, even at premium fares. During the last 20 years, there have been significant advances in technology -- aerodynamics, propulsion, structures, and control systems -- that are applicable to a new generation of high-speed transport aircraft.

Design studies conducted by major aircraft manufacturers indicate that an advanced technology high-speed transport could economically carry up to 300 passengers over transpacific ranges (5000 to 6500 nautical miles) at 2.0 to 3.2 times the speed of sound. Operating cost estimates suggest that little, if any, surcharge over current fares would be required. These aircraft could be operated with kerosene-based fuels and be capable of using existing airports with a reasonable chance of satisfying community noise requirements. These projected improvements are based on several major technological advances: aerodynamics research indicating that a new wing design could achieve major reductions in cruise drag; propulsion technology advances, most of which have evolved from the subsonic quest for improved fuel efficiency; new materials for reduced airframe and engine weight; and flight control systems that allow more efficient flight profiles and two-man crew operation. Other factors critical to the success of a new supersonic transport which require additional technology development are methods to reduce the takeoff and landing noise, sonic boom reduction, atmospheric impact, and overcoming the high development costs. The projected cost for the high-speed transports is currently estimated to exceed $200 million per aircraft, assuming a total fleet of 500 aircraft.

Impact of Technology on Aviation Forecasting

Technology improvements over the next 10 to 15 years will provide major opportunities to future air transportation for both short-haul and long-distance travel requirements. The attempts to capitalize from these improvements will place increased pressure on forecasting. Especially critical will be forecasting the impact of technological, economic, and social factors that are outside the boundaries of current experience and not amenable to extrapolation from current trends.

PART III DISCUSSION AND CONCLUSIONS

SUMMARY

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DISCUSSION

Growth Factors

An ideal forecasting methodology or system should be internally logical and recognize explicitly the causative factors at work. Statistical relationships between demand for air travel and relatively abstract economic variables such as Gross National Product are forecasting shortcuts which produce generally satisfactory results but do not focus on the "real" growth factors, which may truly cause changes in the growth rate of demand. For example, it was noted that the statistical relationship between spending on air travel and Disposable Personal Income used by some as a forecast tool has followed an erratic pattern in the last decade, reaching a peak in 1980 then dropping sharply for three years and, in the past five years, rising again. (Table 1)

TABLE 1

U.S. AIRLINE INDUSTRY PASSENGER REVENUE AS PERCENT OF DISPOSABLE PERSONAL INCOME, 1968 TO 1988

1968	1.02	1979	1.32
1969	1.08	1980	1.46
1970	1.07	1981	1.44
1971	1.06	1982	1.35
1972	1.10	1983	1.32
1973	1.08	1984	1.38
1974	1.14	1985	1.38
1975	1.08	1986	1.33
1976	1.14	1987	1.40
1977	1.18	1988(est)	1.45
1978	1.21		

Workshop participants identified three sorts of "real" growth factors that determine the demand for air travel. First are factors concerned with population and income -- total population growth, migration, immigration, emigration, employment, demographic characteristics (especially age and income), and psychographic factors such as taste and life style. These population and income characteristics largely determine the need, desire, and ability to travel by air. Economic variables such as Gross National Product provide only an aggregate description of these population and income factors.

Market research indicates significant differences among various sectors of the population with respect to the propensity to travel by air for both business and personal or pleasure reasons. Ideally, a forecast methodology should try to account for changes in the makeup of the population and changes in the incidence of air travel by sector and trip purpose. Unfortunately, data to perform this sort of analytical forecast are limited.

The second set of variables concerns the cost of air travel. The important factor is the cost of air travel relative to the cost of other things -- often referred to as the "real" cost of air travel. It was noted that the average revenue yield per revenue passenger mile which is often used in forecast equations is probably not representative of the relevant cost for most air trips. Average yield has been reduced significantly since deregulation by the increasing shift to discount fares. Consequently, the average yield in "real" terms (deflated by the CPI) has declined to a greater extent than either the full fare real yield or the discount fare real yield. (See Table 2.)

TABLE 2. DOMESTIC OPERATIONS, U.S. MAJORS

Index of "Real" Yields
(1981=100)

	Full Fare	Discount Fare	Average
1981	00.0	100.0	00.0
1982	3.3	89.6	88.4
1983	4.1	89.7	86.0
1984	04.0	93.8	90.2
1985	05.4	86.4	82.0
1986	09.8	78.9	73.1
1987	12.2	79.6	72.6
1988	17.8	80.6	74.4

Source: Based on ATA reports

It was noted that most forecasts project a continued downtrend in the average real yield. Boeing projects a drop of 2.2 percent per year in the real yield on a worldwide basis from 1987 through 2000. Douglas projects a decline of 1.9 percent. The most recent FAA forecast projects a decline of 0.7 percent per year for domestic U.S. operations and 1.1 percent for international operations by U.S. carriers.

However, it appears that many of the underlying costs of producing air travel may be on the rise so that it may be difficult for airlines to hold increases in fares below increases in the consumer price index. It was also noted that competitive conditions in the industry have changed so that the outbreak of price wars may be less likely than in the early years of deregulation. In any event, FAA forecasting methodology should focus sharply on future fare levels and the causative factors that determine them.

The third set of growth factors which influence the demand for air travel concerns the quality of air service. Over a long period of time, significant advances in speed, safety, comfort, reliability, and convenience have unquestionably increased the demand for air travel. In the 1950s, 1960s and 1970s air travel captured nearly all of the ocean steamer and rail travel market and much of the long distance auto travel market. Improved quality also generated much travel by reducing the elapsed time of long journeys and demonstrating to the public that it was not only glamorous but also safe to fly.

Some recent developments suggest that quality of air service is no longer improving. Average flight times have increased due to system congestion. Seating is more crowded, and load factors are higher. Terrorism and aging aircraft have raised serious safety concerns in travelers' minds. With respect to quality factors, passengers' subjective perceptions are more important than objective measurements of quality.

With the exception of the possibility of a second generation SST some time after the year 2000, there do not appear to be any positive developments on the horizon with respect to the quality of air travel which would suggest a new growth surge in the demand for air travel. The worsening congestion of the airport and airway system may cause a continued deterioration in the perceived quality of air travel.

The experience in the domestic U.S. market in 1988 may be indicative of some negative developments with respect to these three basic groups of growth factors. Domestic air travel was virtually unchanged from 1987 in spite of continued robust economic growth with rising employment. At the same time, travel by private auto and AMTRAK posted healthy gains. It has not been widely noted that the airlines were losing market share to other modes in 1988. The reasons are not surprising: air fares have been rising more than inflation since late 1987, and concerns about safety and congestion have been widespread.

The present FAA forecast methodology does not explicitly consider these qualitative factors either as explaining historical growth or as influencing future demand.

Forecast Reliability

Forecasts have many uses ranging from short-run airline earning estimates to guide investment decisions to very long-range forecasts to support decisions to build new airports or to design new aircraft. The purposes for the FAA forecast are not the same as those of the airlines, airports, manufacturers, and others who also may use the FAA forecast in their planning. The degree of accuracy needed varies with the use of the forecast.

In general, forecasts are needed to make better plans and decisions. However, the central purpose of a forecast is to minimize the risk of making a serious error. Forecasts achieve this by identifying contingencies and focusing on the relevant causal factors so that managers can make plans on a better informed basis. Judging the quality of a past forecast simply in terms of its absolute error is less relevant than determining whether the forecast led to sound decisions.

Some noted that there appears to have been a persistent tendency in recent years for both FAA and aircraft manufacturers to underestimate future demand. The consequences of this alleged conservatism include the shortage of airport capacity, congestion of the airways, and the inability of manufacturers to produce airplanes as rapidly as their customers want them.

However, it was noted that in most cases excessive optimism in forecasts leads to more serious consequences than does conservatism. Overcapacity based in part on overly optimistic forecasts has tended to produce economic disasters such as destructive fare wars among the airlines. Chief financial officers usually prefer forecasts to be on the conservative side. Airport managers are subject to political criticism if they have an overbuilt "white elephant" on their hands.

One compromise suggested was that short-run forecasts should tend to be conservative, but long-run forecasts should err on the side of optimism. This puts the burden for making reliable forecasts on the federal government which is most concerned with longer-range forecasts. Airlines could plan conservatively in the short run but be able to take advantage of unexpected growth spurts if there are no capacity constraints in effect. Such deliberate biasing of forecasts seems an unrealistic concept at best.

Especially for forecasts prepared by FAA, political credibility is an important consideration. This can be achieved by demonstrating a history of reliable forecasts. It also helps to use "objective econometric models" which give the appearance of freedom from bias. In fact, it was acknowledged that such models are not free of the need to make subjective assumptions regarding many key input factors. Successful use of models depends on getting good input data and the best available assumptions on judgmental factors. FAA noted that they have received good cooperation from airlines and others on those occasions when they have requested a review of forecast assumptions. Forecasts based on a consensus of experts have proved to be superior to individual predictions over the long run.

Market Maturation

Considerable discussion was directed toward the issue of whether the market for air travel has matured to a degree that relatively robust growth expectations will turn out to be unrealistic. The case for slow growth and a mature market is supported by the experience of 1988 in the United States, where the expectation of rising costs and fares and air travel survey results suggest that the demand for air travel has leveled off. (See Table 3.)

TABLE 3. ATA/GALLUP SURVEY

Percent of Adult U. S. Population

Survey Year	Ever Flown	Flown During Last 12 Months
1971	49	21
1972	54	23
1973	54	25
1974	55	24
1977	63	25
1979	65	27
1981	65	24
1983	66	22
1984	70	27
1985	70	28
1986	72	31
1987	72	30
1988	73	29

Optimists pointed out several reasons for expecting continued strong growth: about two out of three adults in the U.S. do not fly in any given year although many have the means to do so; virtually all analyses indicate an income elasticity greater than 1.0 which indicates that spending on air travel should rise faster than incomes; population migration will continue to stimulate travel growth; the globalization of business will stimulate international travel, and rising incomes in the rest of the world are leading to the development of middle classes with the means to travel. The truth of the matter may be that there are both mature and growing sectors within the total air travel market.

Most airline marketing activity seems to be directed at gaining market share, especially share of the frequent business traveler market which accounts for a majority of passenger revenue. Future growth may depend on increased airline marketing effort targeted at potential growth sectors in addition to the lucrative but mature business travel market. Market research to discover and exploit such growth sectors is need; for example, demographic trends indicate that future population growth will be greatest among the elderly who have a relatively low propensity to use air travel according to surveys but could represent the best growth opportunity. The strategy of market segmentation which is common in many sectors of business holds promise for stimulating future growth of air travel. It is not clear how this possible development can be utilized in forecasting.

Forecasting Air Transport Costs

The cost of air travel is a critical input factor to all forecasting methodologies. There is uncertainty as to the impact on airline pricing of the recent concentration of the U.S. airline industry and the evolution of hub and spoke route systems. Some believe that oligopolistic competitive conditions and the absence of low fare airlines such as People Express will mean that air fares will remain relatively high. Others point out that oligopolies in other industries have not precluded fierce price competition.

It was observed that the airline industry has not experienced a downturn in the business cycle since becoming fully deregulated in the United States, or "liberalized" in other parts of the world. Profit-oriented airlines in a free market environment, free from government control and protection and with a lowered public-utility type of obligation to meet societal needs, may respond to a drop in air travel demand by seeking to protect profitability even if service to the public suffers. It was suggested that there is a possibility that new low-cost carriers could arise from a recession using surplus airplanes to fill service gaps created by contraction of major carrier service. This is an example of an alternative scenario which could have a profound impact on the aviation industry.

There is current evidence that if airlines appear to be engaged in price gouging or other anti-competitive behavior, government may intervene to restore more competitive conditions. Congress has expressed displeasure with the loss of low fare service, threats to Essential Air Service, safety problems, alleged harmful effects of airline controlled computer reservation systems and dominance of airport hubs by one or two "mega-carriers." The Justice Department may take a more restrictive view of proposed airline mergers or route trades. It may be realistic to assume that a combination of political pressure and market conditions will prevent a significant rise in "real" air fares in the United States.

Even though there is no evidence of a strict linkage in the short run it was agreed that in the long run air fares must reflect changes in unit operating costs. A review of individual cost and productivity factors indicates that most will put upward pressure on unit costs and, ultimately, fares. Specific factors include the following:

1. Wage rates, especially for skilled workers, have bottomed out. Future labor shortages may cause some wage rates to increase more rapidly than the cost of living. Labor productivity should continue to increase and the hiring of new workers at "B" scales will also hold down labor costs. The most recent ATA cost data show that airline industry average compensation per employee increased about 4 percent in 1988 following an increase of only 1.6 percent in 1987 and a decrease of 2.1 percent in 1986.

2. Fuel prices have risen recently as a result of OPEC production cutbacks and the effect of the Alaska oil spill. In the long run, most forecasters expect relatively stable oil prices in real terms for at least the rest of the century. However, the threat of increased taxes on petroleum products cannot be dismissed. New aircraft will increase fuel efficiency, but it now appears that the breakthrough promised by propfan technology will not take place soon.

3. Capital costs will be affected by interest rates, the increased tendency to lease rather than buy airplanes, and the enforced reduction in average utilization due to ATC system constraints. Some airlines fear that stringent new noise rules may force premature retirement or retrofit of noisy airplanes, which will raise capital costs. The cost of expanding airport capacity will be passed along to customers in the long run.

4. Airline productivity may be near its peak in some areas. Passenger load factors are at historic high levels. Aircraft utilization is actually lower. Seating density is probably at its limit. Average trip speeds are held down by system delays. Only an increase in average airplane size holds much promise for higher productivity. Recent orders indicate a continued preference for small jets to serve smaller hubs and to open new transatlantic gateways.

These cost and productivity factors need detailed consideration in order to forecast where future cost levels will be. The statistical relationship between unit costs and average yields may be expressed for analytical purposes by the breakeven load factor. For the large U.S. carriers, the breakeven load factor in 1988 was 59 percent. The range among 15 airlines was from 54 percent to 65 percent. Actual load factor was 62.4 percent with a range of 58 percent to 68 percent. (Table 4)

If unit costs should rise, either fares must rise also or the breakeven load factor must rise. If market conditions rule out a significant increase in already high load factors, airline strategy will strongly favor passing along higher unit costs to customers. The question is whether oligopolistic competitive conditions will allow such cost pass-throughs.

TABLE 4. LARGE U.S. CARRIERS, 1988

Airline	Passenger Load Factor Actual	Breakeven	Spread
American	63.5%	56.2%	9.4 pts
United	68.0	61.1	6.9
USAir	60.3	54.5	5.8
TWA	61.9	56.6	5.3
Delta	58.0	54.0	4.0
Northwest	65.5	62.1	3.4
Pan American	63.3	65.2	(1.9)
Texas Air	61.0	63.3	(2.3)
15 Airlines	62.4	58.9	3.5

Source: Aviation Consulting Services

The problem of predicting future price levels thus involves a combination of detailed analysis of voluminous objective cost and operating data and the exercise of judgment as to airline management's probable response. FAA's methodology should encompass both aspects. Previous efforts to predict fares by objective models have not been satisfactory.

Market Research Support for Forecasting

In the United States, as a legacy of CAB regulation, public data on air travel are much more detailed than in the rest of the world. However, compared with other industries, there are relatively little data available to identify, measure, and track the various segments of the air travel market. These segments vary widely in their marketing characteristics and their growth potential.

Four major segments are:

Nondiscretionary business travel

Discretionary business travel

Nondiscretionary personal travel

Discretionary pleasure travel

The key marketing characteristics which distinguish these market segments include:

Size of market,

Frequency of travel,

Price sensitivity,

Service and schedule sensitivity and flexibility,

Lead time in travel decisions,

Experience level, sophistication,

Brand loyalty,

Demographics -- age, sex, income, race, etc., and

Seasonality -- day of week, season of year, time of day.

This information is relatively easy to obtain by market research survey methods, and at least two major U.S. airlines conduct regular in-flight passenger surveys which produce this type of data. However, the industry as a whole has not supported an industrywide survey in the past. FAA would have great difficulty in getting airline cooperation in instituting such a survey. The Census Bureau has no plans to revive the Census of Transportation which might include such a survey. Until and unless a private sector initiative succeeds in this area, most airlines will continue to lack essential data for the forecasting and planning which is commonplace in many industries.

CONCLUSIONS

The present FAA forecast procedure appears to be generally satisfactory under the circumstances. Inaccurate forecasts were not seen as a primary cause of present difficulties of the air transportation system. FAA did acknowledge that it failed to anticipate the initial growth stimulus generated by deregulation and that it has erred in anticipating a revival of general aviation. It should be recognized by the government that the FAA forecast, which is primarily intended as a tool for FAA to plan activities and to allocate resources, is widely used by the aviation industry for a variety of other puposes.

There is a need to use the forecast process to explore more thoroughly possible contingencies and alternative scenarios. Some of these contingencies include business cycles, large swings in the price of jet fuel, imposition of noise rules, higher or lower yields, and system capacity constraints. The forecast methodology should be able to estimate the sensitivity of various aspects of the aviation system to such contingencies.

No strong need was expressed for the development of improved forecast models although the recent effort to appraise the quality of the existing models was applauded. The primary needs are for broader and better data concerning market characteristics and an expanded effort to obtain a broad consensus on critical assumptions from a representative cross-section of industry experts. It was recognized that some of this improvement depends on private sector cooperation or initiative. Specifically, it was noted that airline participation in the workshop was less than would have been desirable since so much of the raw data and analysis are generated by the airlines.

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