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Methods and Approaches

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FORECASTING CIVIL AVIATION ACTIVITY

Methods and Approaches

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FOREWORD

In June and September 1990, the Transportation Research Board conducted a series of workshops on methods of forecasting civil aviation activity. Organized at the request of the Federal Aviation Administration, these workshops brought together experts from various sectors of aviation to discuss indicators of fleet activity, modeling and forecasting techniques, and future trends that could affect the demand for aviation facilities and services. The purpose was to examine methods and practices used by FAA and others and to identify ways in which the reliability and utility of forecast products could be improved.

Three separate workshops were held, each dealing with a particular sector of civil aviation: business and general aviation, June 11, regional and commuter airlines, June 15, and major air carriers, September 10-11, 1990. The invited participants included representatives of airlines, airports, aircraft manufacturers, academic institutions, consulting organizations, industry associations, and the Federal Aviation Administration. Participants are listed at the beginning of each workshop report.

Special acknowledgement is due to John M. Rodgers, Director, Office of Aviation Policy and Plans, and Gene S. Mercer, Manager, Aviation Forecast Branch and their associates Robert Bowles and James Veatch of the Federal Aviation Administration for their support and guidance and to Gerald S. McDougall (Wichita State University), Frederick P. Dibble (SAAB Aircraft of America) and John W. Fischer (Congressional Research Service, Library of Congress) who organized and led the workshop sessions. We are also indebted to Dong W. Cho (Wichita State University), J. Bruce McClelland (British Aerospace, Inc.) and Vicki L. Golich (The Pennsylvania State University) for recording and reporting the workshop proceedings and to all who contributed their time and experience to the discussions.

TRB staff members Larry L. Jenney and Marcela Deolalikar provided coordination and administrative support. Mary DeMinter prepared the Circular for publication.

PART I FORECASTING GENERAL AVIATION ACTIVITY

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SUMMARY

Forecasting general aviation activity is increasingly difficult because of changes in public policy, a greater reliance on market forces, infrastructure constraints, changes in the pilot population, and shifts in general aviation flying patterns. Nonetheless, timely and accurate forecasts are important to the Federal Aviation Administration, state and regional planning agencies, and the general aviation industry--all of whom are interested in improving the operation and safety of the nation's air traffic system, and increasing the level of transportation services provided. Because of the wide interest in FAA general aviation forecasts, it is important that FAA identify deficiencies in current general aviation data, develop methods for getting around any deficiencies, and continually improve FAA data collection and forecasting methods. The findings summarized below are listed according to the organization of the full workshop report. The foundation for any forecast, regardless of forecasting method, is complete and accurate data.

Despite the difficulties over recent years in generating accurate general aviation forecasts, one should not discard traditional statistical forecasting techniques. In addition to possessing desirable statistical and modeling properties, econometric models are able to explain historic movements in general aviation acitivity. Econometric models can generate relevant base line forecasts over reasonably long forecast periods.

Finding: Traditional forecasting models are valuable tools, and FAA should continue to use them in projecting future general aviation activity.

However, it is unreasonable to expect statistical models to capture all of the nuances of GA activity, especially in the dynamic environment of the 1990s. For this reason, it would be prudent for FAA to develop alternative forecasting methods and approaches to augment traditional statistical methods. Likewise, FAA should develop alternative data sources describing GA activity and to take advantage of GA data collected by state and regional planning agencies.

Finding: Alternative forecasting methods can also be used to advantage.

In particular, the use of pilot certificate data, when combined with data from the General Aviation Activity and Avionics Survey, can provide indications of trends and causes underlying growth patterns. Periodic publication of information about the pilot population would be a valuable addition to the GA data base.

Forecasts are only as good as the data feeding them. FAA should continue efforts to protect the integrity and representativeness of the data collected through the General Aviation Activity and Avionics Survey. Other surveys to gather information not now available about GA activity should also be considered.

Finding: The quality and utility of GA data and surveys could be improved in several ways.

Efforts should be made to:

(a) revise the General Aviation Activity and Avionics Survey form to make it less imposing and to apply stratified sampling techniques to insure representativeness;

(b) gather activity information from aircraft operators rather than registered owners;

(c) separate commuter operations from other GA activity categories in statistical reports and summary measures;

(d) develop and report summary GA activity measures by flight-hour groups,

(e) reinstitute periodic surveys of fixed based operators (FBOs) and report GA flight activity based on IFR flight plans, and

(f) develop better information on GA import and export activity, both for the active fleet and new aircraft production.

INTRODUCTION

Forecasting air traffic and aviation activity has become a difficult task. Airline deregulation, along with a public policy orientation toward greater reliance on market forces, has created concern about the nation's transportation system and uncertainty about its capacity to support continued growth in air travel. In a changing and uncertain environment it is important to have timely and accurate forecasts. FAA and state agencies need reliable forecasts to develop plans to accommodate increased air traffic, while maintaining safety, improving the quality of service, and increasing system efficiency. The payoff for private industry from improved forecasts shows up in more rational production plans, reduced costs, and increased profits.

In response to the need for better general aviation forecasts, the Federal Aviation Administration requested that the Transportation Research Board (TRB) sponsor a special workshop to review and discuss (1) recent trends in general aviation activity, including fleet size, flight hours, and new aircraft shipments, (2) current forecasting practices, (3) issues and problems related to data collection and reporting, (4) alternative data sources and forecasting strategies, and (5) issues which may affect long-term forecasts of general aviation activity. This report summarizes the discussions and presents suggestions made during the workshop.

BACKGROUND

A major trend in general aviation (GA) is the growing divergence between nonbusiness flying and business flying carried on with for-hire pilots. The two segments are different in function and services provided and in the way market forces and public policy affect them.

While single-engine piston aircraft, with over 160,000 units, constitute the largest part of the active GA fleet, the production of new single-engine aircraft has virtually vanished. In 1978 GAMA members shipped over 17,800 units, but new production has declined 96 percent, with approximately 628 new piston units shipped in 1989. This market contraction portends diminished personal flying hours as fleet attrition begins to take its toll on the active piston fleet. Shipments of new turboprop and jet aircraft also declined substantially during the early 1980s. Nonetheless,the U.S. domestic fleet has grown modestly,

with a commensurate increase in flight hours. Overall, however, it appears that GA is losing market share to commercial carriers in providing air travel services.

In the discussions that follow, the level of GA activity is measured in terms of fleet size, flight hours, and new shipments. The population of active pilots and student pilots is examined as an indirect indicator of future aviation activity. Unfortunately, detailed data on general aviation exports and imports, and fleet attrition due to obsolescence and other factors are not available. Operating cost data are collected by FAA, but these may not be reliable because of differences in interpretation of terminology by survey respondents. Frequency of flights and origin-destination information are not currently published, although partial data are collected through IFR flight planning. This kind of information would be particularly useful in assessing GA peak-load demands, air system capacity constraints on GA activity, and GA use patterns, as they affect forecasts.

At one time, FAA sent the Activity and Avionics Survey to all aircraft owners, with a response rate of approximately 75 percent. Presently, FAA constructs estimates of fleet size, total flight hours, and other measures of GA characteristics and activity using annual survey data collected from approximately 30,000 aircraft owners. The reliability of the estimates derived from the Activity and Avionics Survey are coming under question because: (1) the survey is sent to registered owners rather than operators, while (2) the transfer of ownership is not always properly accounted for in the Federal registry; (3) many aircraft listed on the registry are no longer operable (i.e., "dead" aircraft); (4) there is a great deal of heterogeneity among owners, who range from individuals operating single-engine piston aircraft for recreational use to Fortune 500 corporations operating fleets of large general aviation jets internationally; and (5) a response rate which may be too low to reflect accurately the GA flying population. Because of the diversity among the flying population, the current response rate (although exceeding 60 percent) may underrepresent some segments of GA users. Because of budget constraints, it is difficult for the FAA to address some of the sample survey problems and develop uniform definitions and standard terminology that cover both the personal flyer and the corporate operator.

Furthermore, FAA forecasting efforts have been complicated by infrastructure constraints and regulatory and market changes that have occurred since 1980. New statistical models and forecasting methods may be needed to reveal the shifts that have taken place in the purchase and use of GA aircraft. For example, Mayer (Transportation Research Circular Number 348, August 1989:9-29) notes that econometric prediction of air traffic using the data generated during the regulatory period tends to underestimate the actual growth path in commercial air traffic under deregulation. Older statistical models do not pick up this change.

FAA recognizes the need to develop better long-term GA forecasts and placed the following questions on the workshop table:

1. What are the deficiencies in current FAA data?
2. How can FAA get around these data problems?
3. How can FAA improve its data collecting and reporting?
4. How can FAA improve its methods of working with current data?

TRADITIONAL ECONOMETRIC MODELING

Despite the difficulties over recent years in generating accurate general aviation forecasts, one should not dismiss the applicability and usefulness of traditional econometric techniques when modeling GA activity. However, to develop the best possible forecasts, the forecaster must be aware both of the strengths and weaknesses of statistical models and techniques. Of course, the quality of data limits the forecaster's ability to anticipate the future regardless of statistical prowess. Some of the inherent weaknesses in econometric modeling can be overcome by augmenting statistical results with other kinds of information, and judgments always are an important component of a good forecast.

The use of econometric methods forces the modeler to reveal basic relationships, define important variables, and make explicit assumptions about external events or factors. An econometric model is unambiguous in what is included in constructing the forecast and equally clear about what is not. This kind of disclosure is especially important to the user of forecasts since the model structure and assumptions drive any forecast. If a model is developed thoughtfully and if assumptions about external conditions are reasonable, the forecast results will likely gain acceptance.

Econometric models permit sensitivity analysis and thereby allow the forecaster to evaluate the robustness of the forecasts generated. At the same time, by playing out alternative scenarios, it is possible to identify factors that are especially critical in determining forecasted outcomes. The user of the forecast can track the critical background variables and revise or modify actions if some of these critical variables deviate from initial assumptions.

Although often overlooked, forecast errors can be used as a diagnostic tool to improve subsequent forecasts. Forecast errors often result from incorrect assumptions about external events, rather than from using an inappropriate model or incorrect parameter values. By comparing actual background conditions with initial assumptions it is possible to identify where or why a specific forecast broke down. This information can be used to evaluate the structure of the econometric model and identify where greater attention is needed in developing assumptions about future background conditions.

Of course, econometric models include only those things that are observable and measurable; that is, those factors that are quantifiable. As a corollary, forecasts are only as good as the data available. There are many things that seem to affect GA activity that can not be quantified--tastes and preferences for recreational flying, for example. Others, such as the "hassle" associated with flying because of crowded airspaces or limits on airport access, are not measured well. Still other influences are difficult if not impossible to anticipate. The shipment forecasts presented below, for example, do not take into consideration future technological advances or new product introductions. Forecasts based on alternative data sources are one way of checking for these influences, and professional judgment can be used to adjust statistical results for those factors that can not be quantified.

The forecasts presented below demonstrate that a statistical model can tell a lot about future general aviation activity, thereby minimizing the data requirements and allowing for timely forecasts. The following guiding principles played a strong role in developing the forecasts:

1. The econometric model(s) should be simple as possible.
2. The data requirements should be minimal.
3. The model should reflect behavior of GA participants.

Figure 1 presents a stylized picture of general aviation activity and focuses on the relationship between market forces that determine sales of new general aviation aircraft and the factors that determine the use of aircraft in the GA fleet. In the absence of detailed discussion tracing out the various links in this picture, simply note that the forecasting model described below is consistent with this structure.

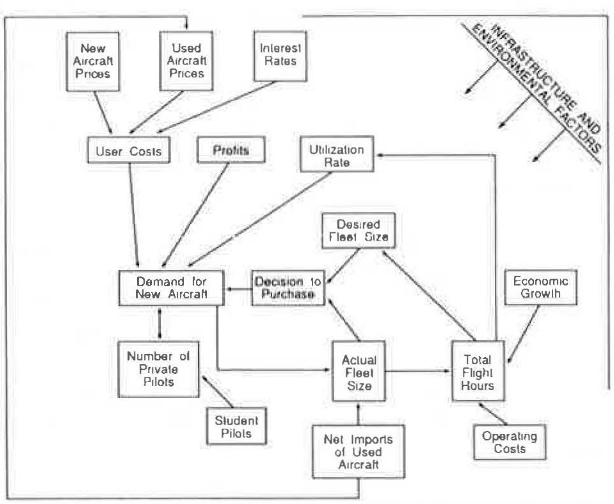

FIGURE 1 Model of the General Aviation Industry

The following three-equation recursive model is used to develop forecasts of new shipments, fleet size, and total fleet hours. New shipments refers to worldwide production of new GA business aircraft, while fleet hours and fleet size reference the U.S. domestic GA fleet.

A SIMPLE GA FORECASTING MODEL

(1) Fleet Hours = f(Fleet Size, Real GNP)
(2) Fleet Size = g(Lagged Fleet Size, New Shipments)
(3) New Shipments = h(Lagged Price,Lagged Retained Earnings, Lagged Foreign Exchange Rate)

Equation (1) is a reduced-form expression capturing supply and demand factors that determine the level of transportation services produced each period. Fleet size is a supply variable measuring GA capacity to provide transportation services. Real GNP is a demand variable reflecting the notion that the demand for transportation services is derived from real economic activity.

Equation (2) looks like an accounting identity, but it is not. The equation acknowledges that the size of the current fleet is linked to the net flow of aircraft from the previously existing fleet and the flow of new aircraft from current production. The international flow of new and used aircraft, however, makes this more complex than a definition, and the effect of GA exports and imports is captured by the estimated parameters on the two right-hand variables.

Equation (3) is a demand relationship for new aircraft. The right-hand variables are lagged under the assumption that there is a production backlog. Current shipments reflect purchase decisions made in the previous period. Retained earnings are included under the hypothesis that internal money is not perfectly substitutable for external money, and therefore important in determining the level of corporate investment in plant and equipment.

Notice the system is recursive: shipments from (3) are substituted into (2), driving the forecast for fleet size. Forecasted fleet size from (2) is substituted into (1) and drives the forecast for fleet hours.

Separate turboprop and jet models are estimated because turboprop and jet markets react differently to changing conditions. The models are then solved using predicted values for the external factors (exogenous variables) to derive forecasts for new shipments, fleet size and total fleet hours over 1989-1995, a seven-year forecast period.

The exogenous variables are real GNP, corporate retained earnings, the trade-weighted foreign exchange rate, and sales-weighted average prices for new turboprop and jet aircraft. Except for price, DRI forecasts are used for the future values of these variables. Sample period values for the price variables calculated by the authors are presented in Table 1. It is

assumed that real weighted average prices remain constant at their 1989 level over the forecast period. This assumption about average price implies that either real purchase prices and the sales composition remain unchanged, or that any changes in these balance, to keep real weighted average purchase prices constant.

TABLE 1 Average Weighted Prices for New Jet and Turboprop Aircraft

Year	Jets	Turboprops
1968	3187031	1301912
1969	3092311	1389404
1970	3165954	1458422
1971	3243670	1345861
1972	2694400	1452323
1973	2434449	1416314
1974	2534442	1345116
1975	2811177	1375654
1976	2872769	1444296
1977	3136361	1419250
1978	3322361	1394576
1979	2974151	1403982
1980	3460905	1391702
1981	4134497	1520219
1982	4919614	1611373
1983	5021009	1740863
1984	5425024	1844443
1985	4859130	1957926
1986	5430730	1980830
1987	6822952	2111719
1988	7430821	2164306
1989	7588670	2053380
1990p	7588670	2053380
1991p	7588670	2053380
1992p	7588670	2053380
1993p	7588670	2053380
1994p	7588670	2053380
1995p	7588670	2053380

Base year = 1980
Weights = new unit sales
p denotes year in which a predicted value was used for generating forecasts

Source: Calculated by authors

The endogeneous variables are new GA business aircraft shipments, fleet size, and fleet hours. Annual fleet size and fleet hour data are derived from FAA publications, based on the "General Aviation Activity and Avionics Survey." Annual shipment data are derived from General Aviation Manufacturers' Association (GAMA) reports and "Business Aviation." The latter reports shipments for non-GAMA members and is used to augment the GAMA reports.

Actual values for new aircraft shipments, fleet size, and fleet hours for the sample period 1970-1988 are shown in Tables 2 and 3; columns 2, 4 and 6 respectively. New shipment data are available for 1989 and shown also. Predicted and forecasted values for shipments, fleet size, and fleet hours are shown in columns 3, 5,and 7. It is useful to refer to Figures 2 through 7, which compare actual with predicted values over the sample period 1970-1988, and present forecast values over for the years 1989-1995. Consider first, general aviation jet aircraft and Figures 2-4.

The simulations from the general aviation jet model appear to track well with the historic series. The estimated shipment equation (see Figure 2) does not pick up the record 1981 peak in new jet shipments, but general aviation manufacturers were extremely optimistic about future sales and produced (and therefore shipped) a great many aircraft in anticipation of sales. Similarly,over the 1984-1987 sub-period, the fleet size equation underestimates actual jet fleet size. Finally, the model misses the abrupt changes in jet fleet hours in 1972, 1975, 1981, and 1987. Nonetheless, there is a rather large systematic component in jet hours, and this is captured by the fleet hours equation.

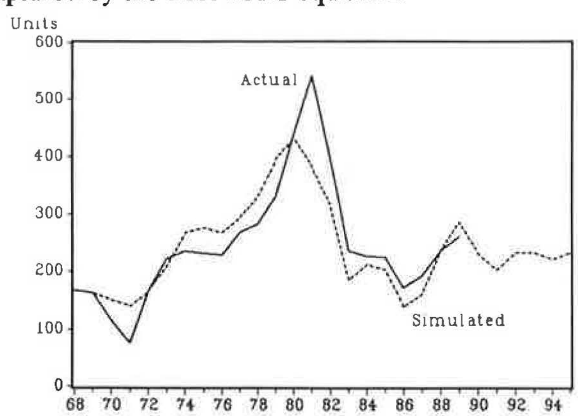

FIGURE 2 Simulated General Aviation New Jet Shipments

For the estimated jet forecasting model, the mean absolute percentage prediction error is 18 percent for jet shipments; 7 percent for jet fleet size, and 6 percent for jet fleet hours. The seemingly large mean prediction error for jet shipments reflects, in part, the inability of the model to detect completely the large decline in shipments in 1971 and the large increase in shipments in 1981. As such, the jet shipment equation performs better than this summary statistic suggests.

New jet shipments are projected to remain stable, around 230 units per year, over the forecast period. Fleet

TABLE 2 Actual and Simulated Values: General Aviation Turboprop Aircraft

Year	Units Shipped Actual	Units Shipped Forecast	Fleet Size Actual	Fleet Size Forecast	Fleet Hours Actual	Fleet Hours Forecast
1970	137	172	1458	984	970	888
1971	118	121	1492	1290	958	930
1972	239	207	1509	1284	1000	963
1973	305	245	1865	1530	1126	1058
1974	308	367	2120	1743	1247	1120
1975	335	423	2519	2074	1326	1213
1976	378	395	2486	2330	1327	1313
1977	449	468	2890	2667	1549	1437
1978	566	575	3130	3070	1606	1586
1979	659	707	3579	3583	1871	1753
1980	798	791	4090	4149	2240	1922
1981	898	666	4660	4602	2155	2069
1982	423	511	5186	4915	2186	2149
1983	292	206	5453	4968	2173	2184
1984	202	271	5809	5074	2506	2255
1985	217	269	5407	5176	2080	2306
1986	128	88	5964	5126	2881	2309
1987	125	12	5274	5013	2177	2297
1988	117	119	5259	4991	2370	2317
1989	123	209		5046		2359
1990		116		5022		2360
1991		22		4920		2344
1992		93		4879		2347
1993		84		4832		2348
1994		44		4753		2340
1995		70		4697		2339

Forecast values are truncated.

TABLE 3 Actual and Simulated Values: General Aviation Jet Aircraft

Year	Units Shipped Actual	Units Shipped Forecast	Fleet Size Actual	Fleet Size Forecast	Fleet Hours Actual	Fleet Hours Forecast
1970	115	149	950	894	474	440
1971	74	138	991	1120	481	574
1972	164	163	1123	1214	500	653
1973	221	207	1406	1429	703	752
1974	235	266	1579	1655	806	834
1975	231	275	1776	1903	874	914
1976	227	266	1938	2120	1000	992
1977	267	292	2277	2363	1165	1073
1978	282	329	2480	2631	1194	1161
1979	330	394	2653	2958	1259	1258
1980	438	432	2992	3309	1332	1355
1981	541	381	3171	3595	1387	1438
1982	395	314	3996	3799	1611	1490
1983	234	182	3898	3857	1473	1513
1984	225	210	4320	3942	1566	1551
1985	223	200	4375	4013	1622	1578
1986	169	137	4430	4015	1654	1585
1987	190	158	4338	4039	1528	1599
1988	234	233	4187	4141	1678	1636
1989	259	285		4292		1686
1990		229		4379		1713
1991		199		4432		1733
1992		232		4517		1761
1993		232		4598		1788
1994		219		4662		1811
1995		231		4737		1837

Forecast values are truncated.

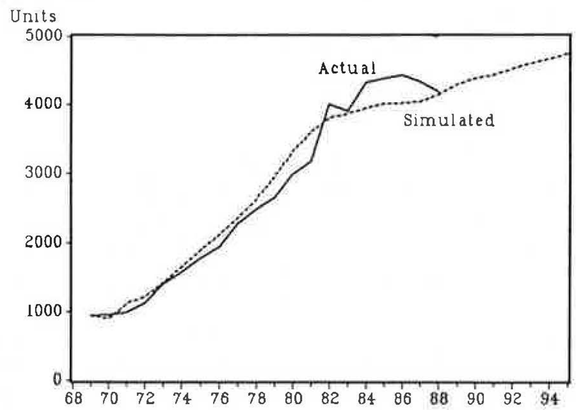

FIGURE 3 Simulated General Aviation Jet Fleet Size

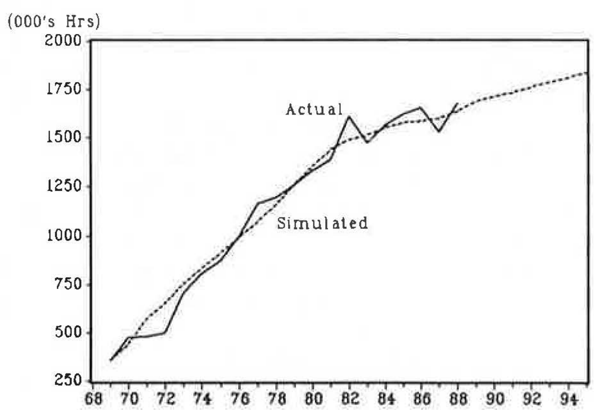

FIGURE 4 Simulated General Aviation Jet Fleet Hours

size is projected to increase to 4,737 jets. This corresponds to an average annual percentage increase of 1.7 percent, using the 1988 actual fleet size as the base. Commensurate with the growth in fleet size, annual jet fleet hours are projected to increase from approximately 1.6 million hours to 1.8 million hours. This corresponds to an average annual increase of 1.7 percent over the forecast period.

The simulations from the GA turboprop model (see Figures 5-7) are on par with those from the jet model. Simulated new turboprop shipments track with actual shipments over the sample period, although the turboprop shipment equation misses the record 1981 peak in new shipments. The model tends to underestimate turboprop fleet size; especially over the 1980-1988 period. Nonetheless, and despite the erratic movements in turboprop hours reported between 1982 and 1988, the model seems to do a reasonably decent job of describing the growth in fleet hours.

Over the sample period the mean absolute percentage prediction errors for the turboprop model are: 20 percent for new turboprop shipments; 10 percent for turboprop fleet size, and 6 percent for turboprop fleet hours. The rather large prediction error for new turboprop shipments reflects the extremely large percentage errors in 1987 and 1989; 90 percent and 70 percent, respectively.

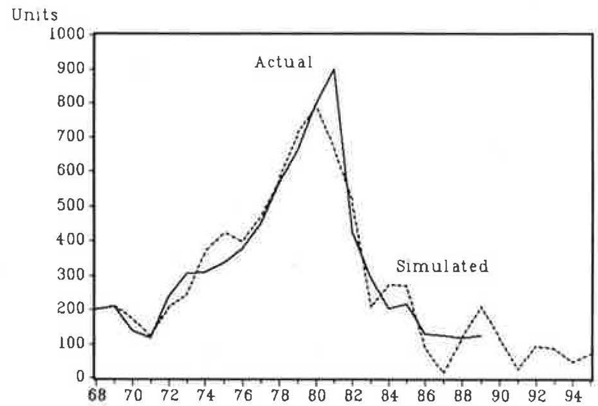

FIGURE 5 Simulated General Aviation New Turboprop Shipments

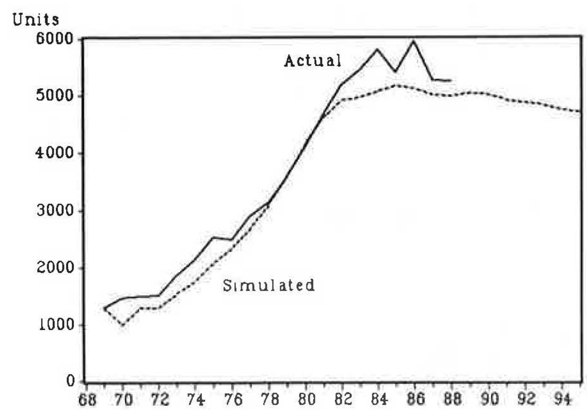

FIGURE 6 Simulated General Aviation Turboprop Fleet Size

Although there are oscillations generated by the new turboprop shipments equation, annual shipments appear to be stabilizing around 120 units, and there does not appear to be any growth trend in shipments over the forecast period. The turboprop fleet is forecasted to decline to approximately 4,700 units in 1995. This corresponds to an average annual negative growth rate of 1.6 percent, using the actually 1988 turboprop fleet size as the base. Despite the decline in fleet size, turboprop fleet hours are projected to remain relatively

stable around 2.3 million hours. Apparently the positive effect of real GNP growth balances with the negative effect of the projected decline in fleet size.

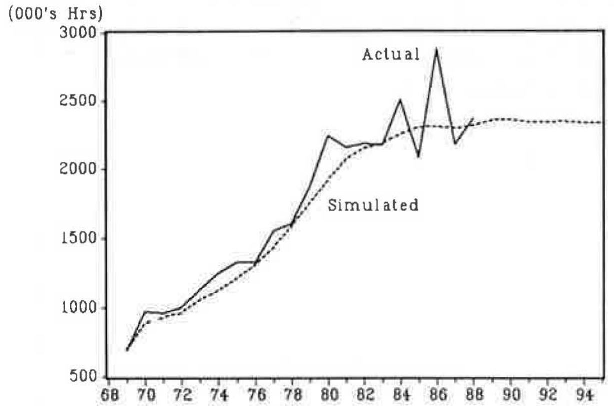

FIGURE 7 Simulated General Aviation Turboprop Fleet Hours

It appears that simple econometric models are able to explain historic movements in general aviation turboprop and jet activity. Two corollaries follow:

(1) Econometric techniques can provide relevant base-line forecasts over reasonably long forecast periods. This model generated predictions over seven years.

(2) Simple models do not generate large prediction errors, necessarily. Mean prediction errors from this exercise seem to fall within acceptable bounds. Nonetheless, econometric models can not capture all of the nuances of general aviation activity, and this is reflected in relatively large prediction errors in some, but few, years.

A DEMOGRAPHIC APPROACH TO GA FORECASTING

The large prediction errors in some years raises a question about alternative methods that might be useful in forecasting GA activity. The recent erratic movements reported in turboprop and jet fleet size and fleet hours also raises questions about the availability of alternative data that could be used to insure that forecast errors are not, in fact, errors in data.

Regina VanDuzee and David Rubin, both of COMSIS, have been involved in innovative work to develop an alternative forecasting methodology based on a bottom-up demographic analysis. They have constructed a data base with at least 11 years of data (1978-1988) gathered from federal sources:

- population of licensed pilots, by category
- registered aircraft, by category
- population
- employment
- personal income and disposable personal income
- hours flown by pilots, by age and medical certificate class
- operations, by category from towered airport data and Form 5010 data
- aircraft usage data from the GA activity and avionics survey

This data base is being used to test and evaluate alternative methods for forecasting FAA's general aviation activity measures: operations, flight plans filed, etc. They have adopted a dichotomy between compensated pilots and uncompensated pilots, as a surrogate to distinguish those flying high performance aircraft from those flying lower performance aircraft. Class 1 and 2 medical certificates are compensated pilots. Preliminary results portend success, and they will be trying a number of approaches to analyzing the data.

In addition to pilot medical certificate data, the COMSIS analysis is using survey data gathered from industry representatives, fixed base operators, managers of corporate aviation departments, and industry and pilot trade associations. Because the primary data are taken from medical certificates, their forecasts of GA activity will be categorized by medical classification (Class 1, 2, and 3) rather than aircraft type (piston, turboprop and jet). Additonal aggregation will show GA activity by compensated and non-compensated pilots.

Although specific forecasts from the COMSIS work will not be available until late 1990, it is useful to outline their approach since it will provide forecasts that can be compared with traditional econometric forecasts such as those presented above. Their work has additional interest because it makes use of flight activity data (pilot hours flown) available through the medical certification process.

The COMSIS approach is based on ratios describing the pilot population and flying characteristics by pilot subgroups. The ratios are used to build up a forecast of flight hours from the pilot base. The forecast of total flight hours can then be factored down to a forecast of fleet size and operations.

To gain an appreciation of the approach and the data used in the COMSIS method, refer to Figures 8-11. The forecast approach is a step-by-step process, enumerated below in simplified form.

Step 1: Forecast the pilot population. Figure 8 shows the ratio of pilots per capita. If this ratio is stable or the trend known, independent population projections from the census bureau can be used to predict the future pilot population. This can be done on a state, regional or national level.

Step 2: Forecast the pilot population by medical class. Figure 9 shows historic information on the number of pilots in each medical class. This information can be

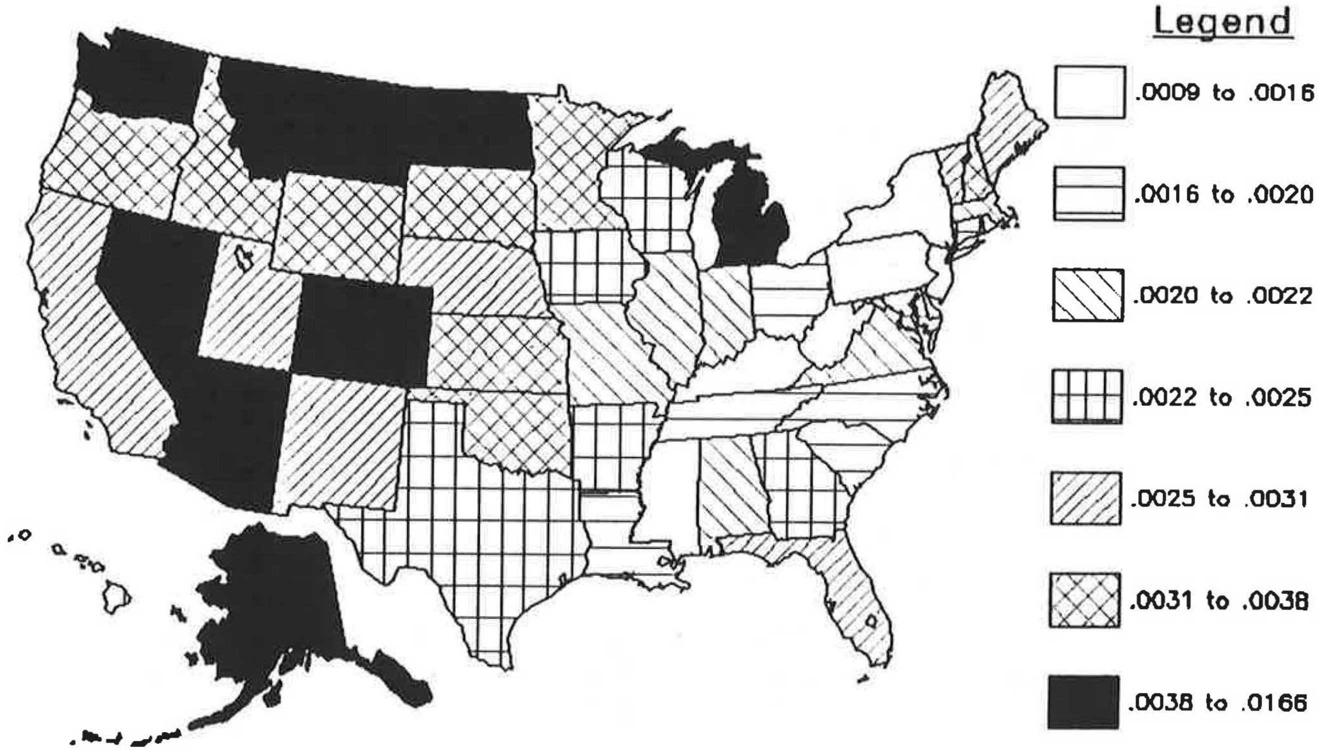

FIGURE 8 Percentage of Pilots in Population by State, 1988

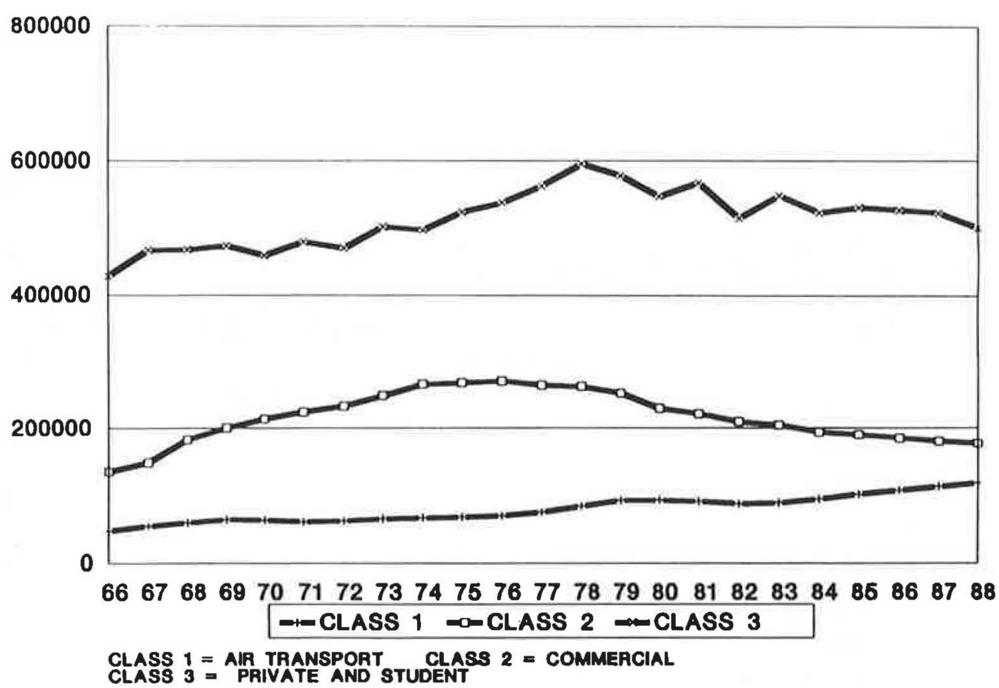

FIGURE 9 Number of Licensed Pilots by Class, 1966-1988

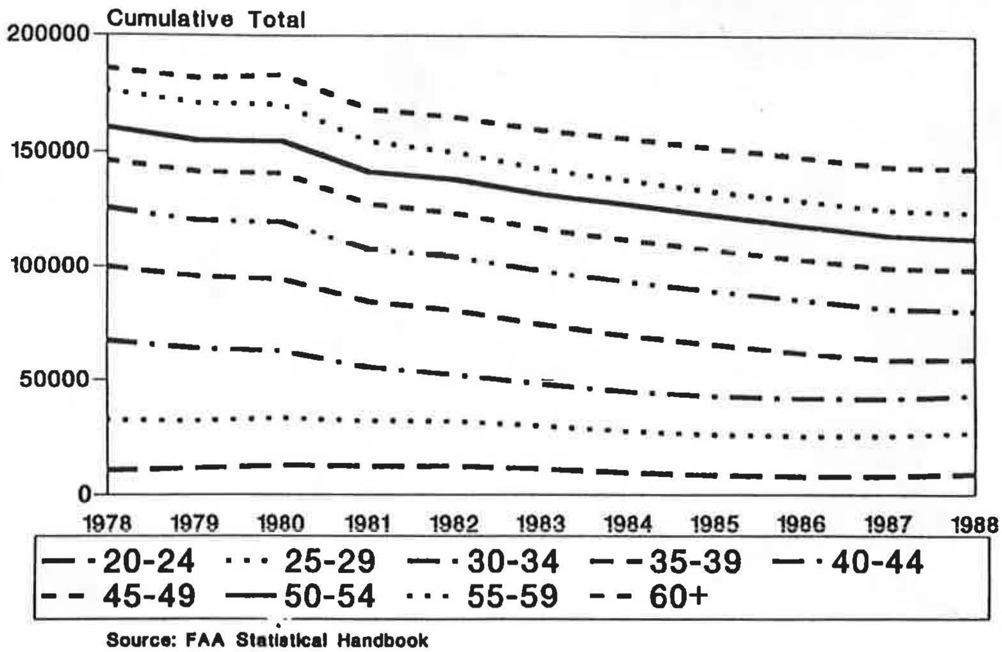

FIGURE 10 Commercial Pilots by Age, 1978-1988

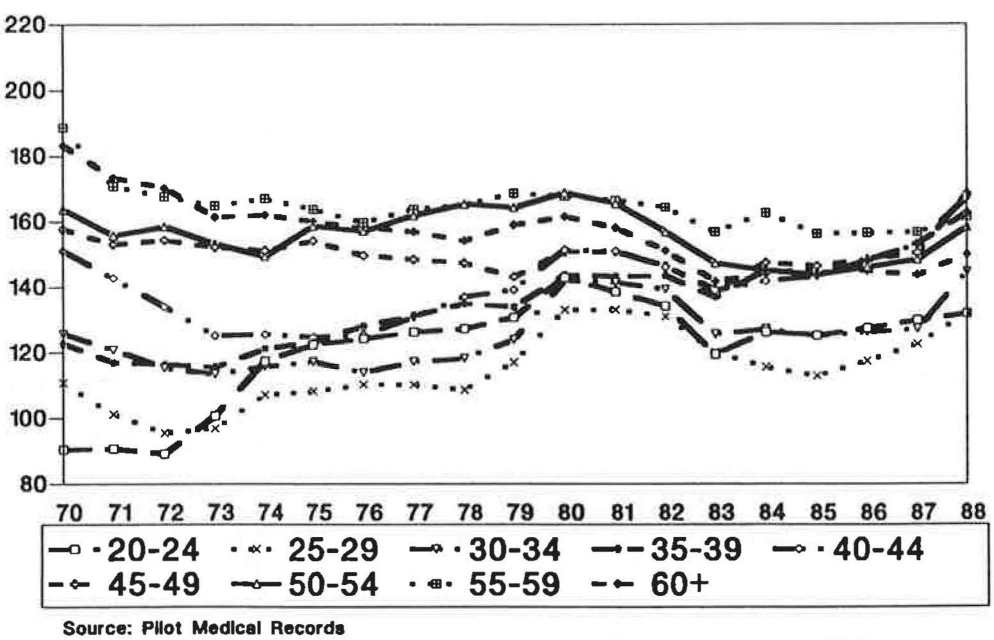

FIGURE 11 Hours Flown by Commercial Pilots by Age, 1970-1988

used to derive the proportion in each class. For discussion purposes consider Class 2, commercial pilots. The proportions or ratios by medical class can be used to decompose the forecasts over the pilot pool into forecasts over medical class.

Step 3: Forecast age profile of the pilot population by medical class. Figure 10 shows the age profile of Class 2 pilots. Extrapolating from historic data it is possible to decompose the medical class forecasts into age group forecasts within each class.

Step 4: Forecast hours flown by each age group, by medical class. Figure 11 shows historic information on hours flown for Class 2 pilots by age category. By extrapolation, similar information can be used to forecast hours flown for each forecasted age group in each medical class.

Step 5: Forecast total hours flown. Forecasts for total pilot hours can be constructed by aggregating over age groups and medical classes.

Step 6: Estimate fleet size. Use information on the average number of pilots per aircraft to develop a forecast of fleet size.

A critical assumption underlying this forecasting approach is that key ratios either display historic stability, allowing current values can be used directly in the calculations, or they display a strong discernible trend such that future values can be estimated with a high degree of confidence. This bottom-up demographic method can be applied to develop state or regional forecasts, as well as national forecasts since it is based on population projections. In fact, COMSIS is undertaking formal analysis to evaluate the usefulness of regional forecasts because of geographic differences important to GA flying behavior and patterns.

In conjunction with the demographic analysis COMSIS is investigating the use of delphi-like techniques to improve and refine GA forecasts. This approach has proven both useful and accurate in other applications by other agencies--most notably in forecasting passport activity. In the context of forecasting GA activity, a delphi-like approach may be useful in gauging the effect of factors difficult to quantify or changes that are unique or one-time occurrences. Specifically, through an extensive interview process, COMSIS is trying to flesh out factors affecting flying activity both by compensated and non-compensated pilots. A tentative list of factors is presented in Table 4. In the end, some of the factors identified through the interviews may be quantifiable. For others, it will be necessary to assign weights based on professional judgments and apply these weights to refine base-line forecasts.

TABLE 4 Factors Affecting Flying by Compensated and Non-Compensated Pilots

Hassle of flying in congested airspace
High price of new aircraft
Cost of liability insurance
Curfews and other airport restrictions
Hubbing
Expenditures on market development and promotion
Fleet management and chartering
Operating and maintenance costs
Reduced supply of new and used aircraft
Very little new technology
Cooperative promotional activities
Changing life styles
Cost of learning to fly
Strong interest in home-built aircraft
Employment opportunities for pilots
University aviation and aerospace programs

Source: COMSIS

It will be interesting to have the forecasts developed from this bottom-up demographic approach. Regardless of the forecast performance, the COMSIS work has introduced FAA and the GA industry to an interesting data set that can be used for a variety of purposes. For example, the medical certificate data suggest many important GA activity characteristics (eg., the number of pilots in the 50-54 age group, hours flown by pilots in the 45-49 age group) are stable, or stable around a clearly discernible trend. This point is taken up further in the section outlining data issues important to improving FAA forecasts of GA activity.

ISSUES AFFECTING LONG-TERM FORECASTS

Availability and access to airports has emerged as a major infrastructure issue and possibly constrains any future growth in general aviation activity. If one equates capacity with numbers, it would appear the nation has sufficient capacity to accommodate growth in GA activity. Nationwide there are about 5,600 public-use airports. Simple division into the GA fleet gives an allocation of approximately 40 GA aircraft to each airport (based on approximately 210,000 aircraft in the active fleet). Unfortunately, the geographic distribution

of airport capacity does not match the distribution of GA activity. There are significant local and regional disparities. While the high plains states may have excess capacity, most areas in the Northeast region are losing GA airports through urban expansion. Increased land prices have made GA airports economically less attractive, and environmental concerns have prompted restrictive zoning laws and other regulatory constraints. Local governments are losing interest in owning and operating airports as the economics change and federal grants disappear. Ironically, the areas losing GA airports are those most likely to have increased demand for GA activity arising from rapid population growth and above-average economic growth. Although the surviving airports tend to be better equipped and financially stronger, localized bottlenecks are emerging as GA traffic is diverted to fewer local airports.

Product liability insurance costs still prevent recovery in the piston segment of GA activity. Despite some valiant and innovative entrepreneurial efforts to alter the economics of new piston production, most manufacturers are unwilling to place their companies at risk by aggressively reentering this market. At the same time, it now appears that the product liability issue has adversely affected flying behavior and the private pilot population. As part of their withdrawal from piston production, GA manufacturers have reduced their promotional expenditures which called attention to general aviation, created public interest in flying, and attracted individuals to their local airport or fixed based operator. Although this appears to be a rational short-run reaction to a declining market situation, the long-term, indirect effects, are only now appearing. There is reason to believe that the reduction in promotional activity both by the industry and FAA has lowered the perceived "price-value" relationship and contributed to the decline in the number of student and private pilots, as well as the decline in piston hours flown.

Although it is difficult to quantify the effects of a reduced number of GA airports and local air congestion on state, regional, and national forecasts of GA activity, any long-term forecast should be cognizant of localized GA congestion and the emerging mismatch between GA activity and the distribution of GA airports. Likewise, A forecaster or forecast user should be prepared to adjust forecasts if the product liability issue is resolved in favor of the GA industry.

DATA ISSUES AND IMPROVING GA FORECASTS

The workshop identified some important data issues that should be considered in efforts to improve the FAA forecasting process for GA. These issues include:

1. A continuing issue is the wedge between the registered owners of GA aircraft and the actual operators. It would be extremely helpful in tracking and forecasting GA activity to have information on operators so that more appropriate forecasting models might be developed. For example, from a study of the Federal Aircraft Registry, it would be easy to conclude that the banking and financial sector is a heavy user of general aviation aircraft and that statistical models should be built around this industry classification. Actually, in most instances the bank is a financing agent holding title. The level of use is determined by a second party (the operator) and not the "owning/registered" financial institution.

2. The General Aviation Activity and Avionics Survey is the most important and comprehensive source of GA information. For this reason, FAA should make every effort to protect the reliability of this data. It would be prudent to design the survey form so that it is less imposing to the respondent, and it might be worthwhile to implement a stratified sampling strategy so that sample biases are minimized. Econometric models seem to be able to track the FAA data, but it is becoming less clear if the survey results accurately reflect general aviation activity overall.

3. Access to flight plan data would be helpful in tracking GA activity and in trying to anticipate turning points. Trends are easy to forecast, but turning points are more important. At one time FAA made available data from a "two-percent sample." Perhaps it would be possible to routinely (monthly) report information from a sample of general aviation IFR flight plans. Although this is only one segment of GA activity, it is likely to be a very important segment, both to FAA in tracking flight activity and to the industry.

4. Given the increasing importance of international trade flows, it would helpful to have information on GA imports and exports of new and used aircraft by type (piston, turboprop and jet). A comparison of changes in fleet size with new aircraft shipments is convincing that the international flow of GA aircraft is significant and affects FAA workloads through changes in fleet size and fleet hours.

5. Current reporting of GA activity includes commuter activity. This distorts some of the aggregate measures since commuter characteristics are much different from those of the other general aviation categories. In some cases it is possible to adjust the data for commuters, but this should be done routinely in FAA reports. It would be helpful to have summary statistics excluding commuter activity reported.

6. It would be beneficial, both for forecasting purposes and in understanding GA development, to have published information by flight-hour groups. Partial information is available through the General Aviation Activity and Avionics Survey, but it would more useful if more comprehensive summary measures were compiled from the survey and reported regularly.

7. It would be helpful if FAA reduced the time lag in publishing summary data from the General Aviation Activity and Avionics Survey.

8. Forecasts should be internally consistent. The medical certificate data suggest that many ratios exhibit stability over time, including (a) pilots/airplane, (b) GA hours/pilot, and (c) hours/plane. FAA could check the internal consistency of its forecasts by computing these or similar ratios for the forecast period.

9. In some cases states are doing an excellent job in tracking general aviation activity, including registrations and airport operations. Given the gaps in the Federal Aircraft Registry, FAA may wish to inventory various states known for their GA tracking systems and, where appropriate, take advantage of state-collected data. It may be possible to extrapolate from state data to derive national estimates.

10. It would be useful to reinstitute a periodic survey of Fixed Base Operators (FBOs) to gather additional information on GA activity. FBOs may be a very good source of information concerning changes in flying patterns, the mix of general aviation activity, and GA uses. An FBO survey could be undertaken biennially.

Data are never perfect, and forecast errors are inevitable. Nonetheless, participants in the TRB Workshop spoke optimistically about the possibility of improving FAA forecasts of GA activity. Simple econometric models are capable of describing historic patterns in GA activity, and it reasonable to believe they can generate base line-forecasts of future GA activity. The base-line forecasts should be adjusted, when necessary, using professional judgments and additional information available through state agencies, supplemental surveys, workshops, and industry forums. Alternative forecast methods are being developed, and these can diversify the FAA forecaster's tool kit and add a "checks-and-balances" system to the forecasting process. FAA personnel are experienced in data collection and recognize the strengths and weakness of their survey results and estimates of GA activity. A variety of suggestions to improve data collection and reporting were offered. With appropriate support, encouragement, and cooperation, it will be possible to devise improved forecasting methods which can be applied to improved data sets to insure better GA forecasts.

As a closing observation, the role of GA as part of the Nation's transportation system should be reexamined. The need for transportation services is a function of GNP. If the GA fleet capability and flight activity does not increase as fast as GNP, GA will lose market share in the transportation system. In fact, the current "flat" fleet size in the context of modest real economic growth and increased intercity travel implies GA is losing market share. Something has changed in the "price-value" relationship in general aviation. This, in turn, suggests the need to explore the factors contributing to the change in the price-value relation (such as reductions in promotion expenditures, elimination of the investment tax credit, and the product liability tax) throughout the GA chain from component manufacturers to local fixed base operators.

PART II FORECASTING REGIONAL AIRLINE ACTIVITY

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BACKGROUND

Since economic deregulation of the U.S. air transportation industry in 1979, the regional airline sector has shown continued strong growth. This growth, pushed by an evolution in marketing and ownership arrangements with the major airlines, combined with the availability of modern, new technology aircraft, has positioned the regional airlines as important elements in the national air transportation industry.

The regional airlines have grown, as measured by passenger enplanements, at an average annual rate of just over 10 percent since 1979. This represents an increase in market share of total domestic enplanements from 4 percent in 1979 to an estimated 8.5 percent in 1990. To put this into perspective, the U.S. airlines will enplane approximately 460 million domestic passengers in 1990. The regionals will account for an estimated 39 million of those passengers.

The growth of the regionals through the 1980s occurred for many reasons. National economic development and demographic shifts were important elements underlying this growth. But two other factors have contributed more than anything else: development of new aircraft specifically designed for this market and the shift from small independent regional airlines (i.e. air taxis) to large regional airlines closely affiliated with the major airlines.

In the late 1970s, several airframe manufacturers saw gaps in market coverage for aircraft seating between 19-65 seats. The industry at the time was making do with general aviation type small aircraft or larger turboprop aircraft originally developed in the 1950s. The core technologies for engines, avionics, and airframes had advanced to the point where developing fast, reliable, cost-effective aircraft for the emerging regional airlines was possible. Once these modern aircraft became available in the mid-eighties, the U.S. regionals ordered them in large numbers.

The transition from small independently operated air taxis occurred in several steps. First was development of interline baggage and ticketing agreements between the air taxi commuter operators and the major airlines. When the competitive advantages of providing additional passenger service at little or no extra cost to the major airline became apparent, the relationships were then

formalized into an exclusive marketing and operations coordination program called code-sharing. The evolutionary cycle has continued with many of the major airlines consolidating control of their regional airline partners through equity positions or outright ownership. This vertical integration has served as a traffic stimulus in many markets through increased service levels provided to small and medium-sized communities.

Continuation of the regional airlines development cycle will occur as the major air carriers transition into a more consolidated industry. The extent of the development will be contingent on many different elements: technology, energy resources, infrastructure (airport) capacity, economic development, and others. This workshop brought together experienced individuals to share not only their understanding of the development cycle but how they approach analyzing the direction of this complex industry for the future.

FORECAST METHODOLOGIES

Charles Moles, Federal Aviation Administration

The Federal Aviation Administration (FAA) is responsible for forecasting the regional aircraft fleet mix and passenger enplanements. These provide a basis for allocating resources in response to changes in the regional airline environment that affect facilities planning and future staffing requirements.

FAA's regional aviation forecasting process is not overly complicated. It relies on a data set developed primarily from the 298-C filings by commuter air carriers. Additional data are also included on air carriers like Westair and Aspen that operate as commuters. FAA does not include operations of primarily jet carriers like Air Wisconsin, Presidential, or Altair. The operating definition of what constitutes a regional airline is based on seat size. Currently the Department of Transportation classification of 60 seats and below is used. This allows for the inclusion of the new small jets (less than 60 seats); but it has not been resolved how to deal with the British Aerospace ATP and Aerospatiale-Aeritalia ATR 72, both having between 60 and 70 seats. Additional data are obtained from the Regional Airline Association and the FAA's Utilization and Reliability reporting system.

The FAA forecasting model is an econometric model using Gross National Product (GNP), an oil and gas deflator, and the Consumer Price Index (CPI) as the major input variables. Historical trends in revenue passenger miles, available seat miles, and passenger enplanements (obtained from commuter airline filings) are integrated into the forecast model. The forecast assumptions are then developed based on analysts' opinions and experience and used to drive the model. The results are evaluated in light of other industry forecasts, professional judgment, and expertise. This evaluation process may lead to additional iterations with revised assumptions and/or modifications to the model. Once the output is finalized, the results are used in the decision-making system to allocate resources.

Stephen Martin, Massachusetts Port Authority

Over the last few years severe congestion has developed at Boston's Logan Airport, which consistently ranks among the airports showing the greatest delays. The airport's capacity fluctuates due to the constantly changing wind conditions. Although we have three runways, they intersect and have different hourly capacity limits. Therefore, the airport's capacity can range anywhere from 45 to 110 movements per hour depending on weather conditions. In addition the effective capacity is difficult to determine because we experience unfavorable weather conditions about 30 percent of the time. To help optimize the capacity and minimize the delays we have been working with the National Oceanic and Atmospheric Administration data on hourly wind conditions over the past ten years. This has helped, but it is not a panacea.

Boston's airport is slightly different from most other congested airports in that only 8 percent of the passengers are connecting passengers. However, operations by regional airlines account for 40 percent of the flights at Logan, and half of the passengers using regional airlines are connecting. Yet regional carriers move only 5 percent of Logan's passengers.

I believe that Massport's attempts to address these congestion issues provide a good case study of data needs and shortfalls that affect the regional airline segment of the industry.

Over the past year and a half, Massport has tried different ways to alleviate congestion. Traditionally, Logan has had a 100 percent weight-based landing fee with no peak hour pricing. We then moved to a 33 percent weight-based fee, the rest being made up using a flat operating fee. Next we decided to look at a cost-based fee as a way of alleviating congestion. Before implementing it, however, we wanted to assess the impact of various price structures. First, we measured the impact on a per-passenger and/or per flight basis. To accomplish this, we needed to find out what tickets actually sold for—not just the full fare or the discount fare, but what people were really paying, not only those flying in and out of Boston but also connecting passengers.

Second, we wanted to quantify how much of a reduction in demand would be experienced on a market-by-market basis. For example, there were 40 daily flights between Boston and Hyannis with an average size of 19 seats. On the other end of the spectrum was Laconia, NH, which only had three flights

a day with a nine-seat aircraft. What we found was that, of the cities on the higher end, 70-80 percent of the passengers came from markets where jet service had once been provided. Deregulation caused the jet operators to abandon many of these markets, and the demand was met by the smaller turboprops operating with greater flight frequencies. In certain markets formerly served by two jet flights a day, the demand was met with 25 turboprop flights.

In an effort to assess whether an airline could replace a smaller aircraft operating at higher frequency with a larger aircraft serving the same market with lower frequency, we developed a special data base to track the aircraft in service. We believe that, because of the flexibility in pricing fares, the supply of aircraft determines to a great extent the demand for air service. Too much capacity causes fares to drop and demand to increase. It becomes a circular problem where demand creates supply, which in turn creates demand, and so on. In the regional markets it is a little more difficult to assess; but by analyzing operations by market we found that it was possible to substitute bigger aircraft at reduced frequency in the larger regional markets, thereby reducing the incremental cost associated with replacing the weight-based fee with the operational-based fee.

This fee structure was in effect for six months until terminated by a court action. The good news is that this was enough time for us to test our initial calculations. It was heartening to see that the actual effects were very close to what we had forecasted they would be. In terms of traffic growth at the regional level, we found that during the trial period passenger traffic was flat from the like period the year before. Before implementation of the fee, traffic had been growing moderately (3 to 5 percent annually), although exogenous factors, such as the New England economic slump and the strike at Eastern Air Lines, probably contributed to the decline in growth rate.

The lesson we learned was that meticulous study of individual markets yielded the best results. Perhaps FAA does not need that level of detail, but I do feel an individual case study using some sort of bottom-up approach is the best way to evaluate data collection needs. Perhaps some efficiency can be gained by concentrating on the biggest markets. This would require a stratified forecast. For commuter markets, perhaps the way to go about data collection might be to use the classic 80-20 rule, eliminating those 80 percent of the routes that generate 20 percent of the traffic.

William Spaeth, Metropolitan Washington Airports Authority

The Metropolitan Washington Airports Authority (MWAA) operates two completely different airports--Washington National and Washington Dulles International.

Washington National is a purely domestic origin-and-destination airport. It is slot-constrained to an hourly limit of 37 air carrier slots and 13 commuter slots which are limited to aircraft that carry fewer than 55 passengers. The commuter slots are divided into 11 regular commuter slots and two STOL slots. The airport operates under a curfew system that was put in place before the Stage III aircraft noise rules came out. Between 10 p.m. and 7 a.m., only quiet aircraft complying with strict local noise abatement levels may operate. There are not many flights into National after 10 p.m.

Washington Dulles International Airport is very different in that it has a wide variety of traffic. Twelve percent of the traffic is international, and the airport serves as a hub for United Airlines. There are plans to add two more runways, which will increase capacity to 130-140 IFR operations per hour, and eventually to construct six midfield terminals, which will have a capacity for 40 million passengers. The airport is connected to the I-95 Interstate by a dedicated roadway, and there are proposals to extend the Metro line out there.

When WMAA authority does a forecast, it is primarily concerned with facilities planning and how operations are going to affect those facilities. Commuter forecasts are especially important in assessing airfield, ramp parking, and terminals.

The problem is defining just what a commuter, or regional, airline really is. In our analysis, we consider the size of the aircraft, whether it is a turboprop or a jet, and whether it is operated by a code-sharing or an independent carrier. Commuter slots were created largely for noise considerations and have very little reflection on the industry. Furthermore, the ATC system at National categorizes any turboprop aircraft as an air taxi, whereas at Dulles there is a distinction between air taxis and regionals. This has caused some confusion in the past, but it is slowly being cleared up.

We see some interesting characteristics in the regional carriers using the Washington airports. At National, approximately 40 percent of aircraft enplanements were connections during the 1970s. During the 1980s connecting traffic almost completely disappeared. We believe this is because most of the connecting traffic that used to come to National is now going to Dulles and Baltimore/Washington International. The code-sharing carriers at National are flying origin and destination passengers, and not connecting passengers as they do at most airports.

It is also interesting to note that code-sharing carriers have virtually all of the regional airline traffic. What happens with regional traffic at National, however, is that the aircraft tend to be fairly large, and they have

some unusual roles. For example, all of Pan Am's and most of American's code-sharing traffic is going into JFK as feed to international flights. We find that the larger carriers do not want separate check-in and baggage-claim facilities for the code-sharing regionals. Nevertheless, we have to plan for the possibility that some of the code-sharing arrangements between regionals and majors might break up.

MWAA is expecting that traffic at National will grow from its present 16 million passengers to nearly 19 million by the turn of the century. Because of slot limitations, this can be accomplished only by using larger aircraft. It is planned that, when improvements are completed, National will be able to accommodate 767-size aircraft. The passenger cap of 16 million passengers was removed when the airports reverted from Federal Government to MWAA administration.

Dulles is completely different from National. Enplanements have grown enormously, especially connecting traffic, as a result of airline hubbing at Dulles. After some intense competition, United has become dominant. Commuter activity at the airport is almost entirely dominated by United Express. I should note that United Express Air Wisconsin figures are included in the air carrier statistics. We expect that the Dulles hub will grow about 4 to 5 percent per year, with commuter traffic increasing at about the same rate.

Dulles really does not act as a reliever for National. Even today, about 40 percent of the passengers who fly into Dulles end up in downtown Washington. Presumably they would still prefer to go to National if the option were available, since it is so much closer.

John Mason, Air Wisconsin

An airline has a slightly different perspective on forecasting than a manufacturer. We are in the day-to-day fight of trying to fill our airplanes with passengers. Our forecasting method is not overly complicated. We tend to take a fairly conservative approach.

To assess the potential of a proposed new service, we do a market forecast. First, we try to define the universe of data that is available. We also look at what aircraft would be available in our fleet and identify those constraints that could influence our decision.

The data we typically compile include origin and destination data from the DOT traffic records. We find these fairly reliable for the larger cities, but for some smaller cities where other carriers have been less than diligent in their reporting of passenger traffic, the data are not as reliable. Other quantifiable data we include are: airport history before deregulation, demographic trends, competitive service levels, and destinations. We also analyze data on changes in the mix of business and pleasure travel, promotional history, and fare levels. These data can give a fair picture of the market base.

Other factors that can influence our decision to penetrate a new market can come from our partner, United Airlines. As Air Wisconsin, we have the ability to penetrate new markets and expand as we determine; but as United Express, we are fairly well controlled. Their plans have a strong impact on ours. We have also found that the predominance of a particular CRS system can make a difference in some markets, as can a strong, competitive frequent flyer program.

If this new market is to serve Chicago O'Hare, we must consider the slot limitations and determine the impact of alternative service scenarios utilizing those slots.

An important step once the market analysis is completed is to compare all the factors with those of other markets of similar size that we serve. From this comparison, based on our experience in the various markets, we can estimate the expected traffic levels if we were to enter that market.

We must also look at how this service would affect aircraft utilization and cost structure. Expected schedule-completion factors must be included in this analysis. At Air Wisconsin, we aim for 97 percent plus on flight completions; if we fall below this target, we notice an impact on advanced bookings several months out.

Over the past three to five years we have not been putting much effort into macroforecasting. We do, however, review our total system on an annual basis in addition to quarterly and monthly updates. Most of what we do in this area is to assess future bookings and seasonal influences. We then include industry projections. The final step is to do a reality check: Is this forecast a plausible view of the future, given past experience and present business conditions?

Bouke Veldman, Fokker Aircraft

Historically, Fokker used a traditional top-down forecasting approach that took into account the various economic parameters normally used in forecasting models. Recently, we have been developing a bottom-up approach in which we look at each airline and assess its individual requirements. This method has an additional application for our sales managers. By analyzing the carriers in this way we can help them identify opportunities.

Another, more basic result of this current bottom-up forecast, and one that is more germane to my department, is to assess the market for a new aircraft between 50 and 100 seats. Using existing data is fairly straightforward because one can do an OAG analysis of existing routes and equipment. The problem comes in

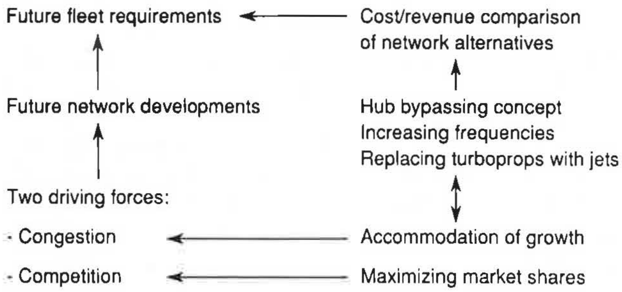


FIGURE 12 Hub-Bypass Forecast Methodology

trying to figure out future network requirements and opportunities.

In assessing the market for a new aircraft, we break the new opportunities into three groups:

- Hub bypass or raiding
- Increased frequencies
- Turboprop replacement

I will focus on the methodology for quantifying the first group. We define a hub by the number of non-stop flights out of that city, not necessarily how much one carrier serves that hub. Generally speaking this is a minimum of 35 cities in the United States and 30 cities in Europe and Asia. This presentation is about Europe because the U.S. study, while complete, is not ready for presentation.

To do a hub-bypass analysis one needs a very large and powerful computer, like the IBM mainframe that Fokker has in Amsterdam. The data base is too large and complex to be handled effectively in any other manner.

In Europe, we have identified 32 hubs (50 in the U.S. and 32 in Asia). To quantify the hub-bypass possibilities, we have had to become a bit subjective in our thinking. You should appreciate that the level of information available on the U.S. market is not available on the European market. Therefore, we have to look at aircraft seat miles (ASM) generated and make some assumptions about load factors in order to derive passenger demand.

Hub bypass is defined as a flight from point A to point B without having to change planes in an intermediate point C. Some of the possibilities include trips between two hubs that bypass an intermediary hub, flights between a hub and a non-hub city that bypass the intermediary hub, the reverse situation, or flying between two points that are not hub cities.

As an example, we decided to consider the possibility of flying between Hamburg (HAM) and Rome (FCO), which is not presently a direct-service route. Normally, a passenger taking this flight would be forced to go through Frankfurt (FRA) and change planes, which adds about one hour to the flight time.

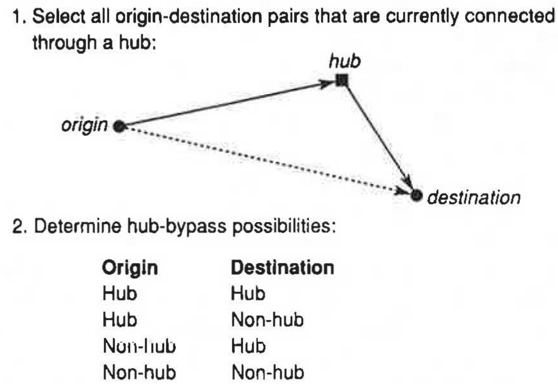


FIGURE 13 Hub-Bypass Concept

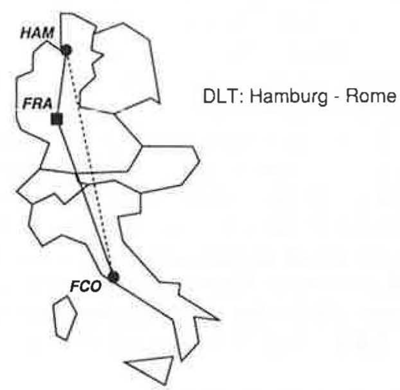


FIGURE 14 Example of New Route Formed by Hub Bypass

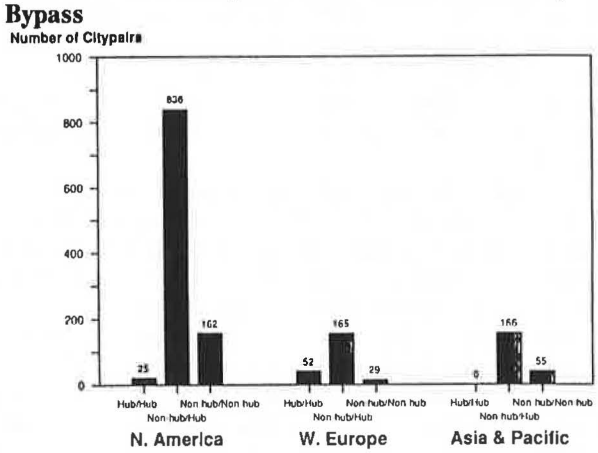


FIGURE 15 New Routes of Less than 1200 nm per Region in 2004

In calculating the potential for new direct service between city pairs we examined only those routes of

1,200 nm or less. To determine hub-bypass possibilities we concentrated on cities, not airports—selecting city pairs that were more than 100 nm apart and where a hub-spoke service route would be less than 1.5 times the length of the direct nonstop route and the flight legs from origin to hub and hub to destination would form an angle greater than 45 degrees.

For example, the distance between Hamburg and Rome with a change of planes in London exceeded the distance from Hamburg to Rome multiplied by 1.5 and

3. Determine **realistic** hub-bypass possibilities

- Origin and destination are considered as city-codes
- Distance between origin and destination > 100 nm
- Distance between origin and destination via hub < 1.5x Distance between origin and destination non-stop
- Angle of direction between origin and destination via hub > 45°

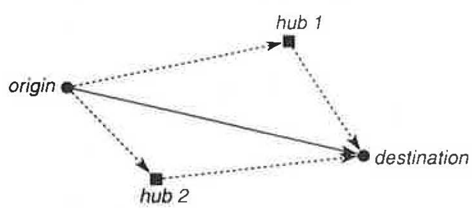
FIGURE 16 Hub-Bypass Criteria

was therefore rejected as a hub-bypass candidate. In another example, because the angle of flying between Hamburg and Rome with a change of planes in Copenhagen was less than 45 degrees, this option was also rejected.

To estimate traffic, the total number of seats coming into a hub, in this case within Europe, was calculated. The available seats on the origin city is a percentage of this total. We then applied that factor to the percentage of seats going to the final destination and to come up with the traffic flow between the two points.

Going back to the Hamburg-Rome example, we found several options, which would be the case for most city pairs. In most instances the destination could be reached via more than one hub. So to calculate

Potential origin-destination route by-passing more than one hub



- In most cases the destination can be reached via more than one hub. This means that the potential of available seats on the origin-destination route comes from ALL existing routes within the region.

FIGURE 17 Example of Multiple Hub Bypass

fully the real flow one must calculate everything. You begin to see why a big computer is needed for this method.

Having done this, we needed to correct for true origin and destination flows, because not all passengers at a hub are connecting. In the United States almost 39 percent of passengers connect at airports. This has been growing since 1980, when it was 32 percent. Furthermore, between larger cities, there are fewer connecting passengers than between smaller cities. In hub-to-hub markets in the United States, for example, we calculated on the basis of historical data that the average for connecting traffic is likely to be 20 percent in 2004. In hub-to-nonhub markets the average is closer to 75 percent. In Europe, the average is 28 percent connecting passengers, but higher at larger hubs. Using these figures, we came up with the connecting percentages for the United States, Europe, and Asia, adjusting the figures in each region, especially Europe and Asia, for the effects of deregulation.

We then added an expected traffic growth between 1989 and 2004 averaging 5 percent annually in Western Europe, 2.8 percent in North America, and 5.75 percent in Asia and the Pacific.

Having determined traffic, we then began the process of selecting routes. In selecting the routes, we chose only those city pairs in which there was enough demand to allow for 400 weekly available seats. Stated another way, this would allow for two daily flights (one each way), five days a week, using an aircraft with a minimum capacity of 40 seats.

This approach has been successful, as you can see by the newspaper clipping announcing DLT's order for the regional jet in which Hamburg-Rome was cited as an intended route. In fact, our analysis showed that there were five routes from Hamburg not presently served that could be accommodated in this same manner.

Using this method, we have identified several new routes, the vast majority of which are in the United States. Furthermore, the indications are that the average distance of the city pairs (around 750 miles) implies a requirement for jet equipment rather than turboprop equipment.

Unfortunately the effects of these new routes on congestion are likely to be minimal, because so many of the possible routes would be feeding into existing hubs, rather than rerouting traffic away from them. This requires then further analysis on the impact of increased frequency and cost-revenue comparisons. As you can see, it is a very complex problem.

Josef Simmerl, Dornier GmbH.

Dornier uses a simple forecasting model for turboprops. We do not consider the smallest commuter segment (6 to 14 seats) because Dornier does not manufacturer any

aircraft smaller than the 15-19 seat class. However, we do a large number of airline studies, which are used in our sales campaigns, and serve as the basis for our work.

One of our exercises is to segment the market into large and small commuter airlines. This is primarily a tool used for sales forecasts. The basis of the information is the JP Airline Fleets, which we now have on tape. We find this data to be useful and accurate. We use the OAG schedule tapes for additional insight. We try to forecast growth demand in North America, Europe, and the rest of the world. Because we do not know actual total passenger figures in Europe and parts of Asia, we take the actual seats supplied and convert into passenger miles by using actual load factor data or assumptions. Then we make a trend analysis and forecast growth demand. We split the aircraft market into three segments: 15-19 seats, 20-39 seats, and 40-70 seats. Our forecasts look out 15 to 20 years in five-year intervals.

We do not count every aircraft. If an aircraft is already 30 years old, we take it out on the assumption that if it has not been replaced by a larger aircraft by now, it never will be. If you look at the replacement cycle of aircraft, you will see that the replacement cycle for turboprops is about 25 years. Our replacement assumptions are that 50 to 75 percent of current 19-seat aircraft will be replaced by larger aircraft based on an analysis of trends in market volumes by seats and by size category. We see some unnatural peaks early in the cycle but do not expect that to recur, and therefore we apply judgment and smooth out the peaks.

We see the non-airline side of the market as significant. This includes aircraft used in military, cargo, government and utility roles. Data on non-military aircraft movements is much too optimistic, as high as a 50-percent overstatement in some cases. We therefore have to back up our forecasts with field experience and familiarity with the market.

Marian Thompson, British Aerospace, Inc.

British Aerospace develops forecasts for production planning, determining production mix, assessing new aircraft opportunities, and supporting sales campaigns. At this time we focus on the macroeconomic side of the forecast. In looking at specific markets, such as the regional jet, our forecasting procedure works on an on-going basis using a traditional approach.

Generally, we start with historical trends in ASM to establish the overall market. We define our segment of the market as between 12 and 130 seats including turboprops and jets. This allows us to translate traffic into RPM for each of the market segments. The forecast is then subjected to comparison with the quantitative economic picture. GNP is important because, if there is no economy, there is no traffic; but we do use various other quantitative measures. In this step of the forecast process, so much depends on the relationships between the different market sectors when trying to establish future traffic and fleets. We look at the relationships between the groups and apply a lot of careful judgment.

What we see in the regional airline industry is that traditional barriers are coming down, largely because of the regional jet, which has a tendency to blur the edge between the regional and the major airlines. This is especially true in the United States, where the distinction has always been greatest. The jet is part of the natural progression which was started by the interrelationships between regional and major airlines. As the regionals mature, they look for ways to grow within their feeder role. As this process unfolds, I would say that the biggest need will be for good consistent reporting of quantitative data.

Karl Zaeske, Rockwell International - Collins Avionics

Collins is in the business of supplying avionics for business and commercial aircraft. We use our short-term forecasts to as inputs to production planning. Longer-term forecasts are used for strategic positioning, product planning, and resource allocations. As an original equipment manufacturer we use input data from airframe and engine manufacturers, government sources, and our own sales and marketing personnel. We also analyze data from numerous other outside sources.

- Short-term
  - Market viability customer potential
  - Direct input to production plan process
  - Order, backlog and delivery projection system
  - OEM viability and capacity assessment
  - 3 scenario monthly 3 year production forecast process
- Long-range
  - Product market growth assessment by sector, OEM
  - New opportunity selection process
  - Capital and manning plan
  - Corporate commitment rationalization
  - Structural and demand measurement market study (continuous effort)

FIGURE 18 Regional Markets: Forecast Objectives and Approach

The short-term forecast methodology is driven by the order rates, backlog, projected deliveries and projected backlog. These are analyzed in a historical context as well as an industry structural context. This requires a bottom-up approach segmenting the markets by operator and aircraft type. We also segment the overall market by geographic region. Where are the aircraft scheduled to go? Are they for replacement or growth? What are the particular operating characteristics

of each airline? We analyze the OAG data tapes to determine scheduled utilization for block hours, cycles, and sector length. This part of the analysis is also important for our planning of avionics spares support. In this short-term forecast it is essential to monitor constantly the business environment of each operator in the data base. Mergers, dissolutions, new competitive moves, and changes in affiliation are just some of the operator structural changes that can influence order and delivery schedules. Operating revenues, expenses, and profits also provide insight into the viability of the order backlog on an individual, group or geographic region basis.

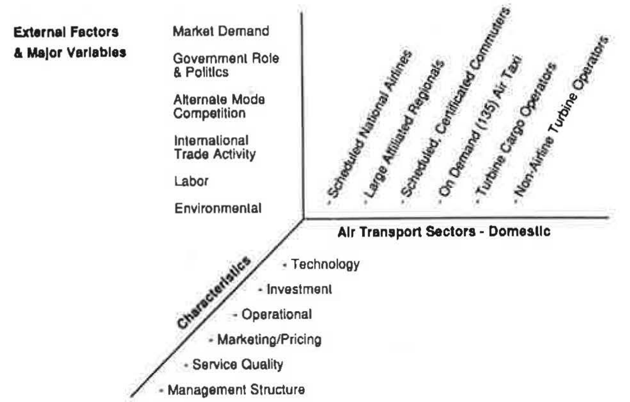
The long-range forecast requires careful analysis of fundamental exogenous factors. To develop the traffic growth estimates, we utilize several outside economic forecasting services that produce alternate scenarios. We also watch regulatory authorities for developments that would force premature obsolescence or increased avionics sophistication. The long-term financial characteristics of each market sector are monitored for signs that indicate an ability or lack of ability to meet the increasing demands for capital or cash flow to acquire the equipment needed for growth.

A very important element in our forecast is the analysis of fleet trends and aircraft flows between various geographic regions and operator segments. We track the free world's aircraft up to 110 seats. The data are stratified by region, size, and operator type (scheduled, non-scheduled, freight, etc.). We also maintain a complete history by model and serial number for each aircraft. This helps provide an understanding of changes that occur in the existing fleet over time.

Aircraft replacement will account for almost 30 percent of the seats required to meet expected demand by 1998. What are the factors that will cause aircraft retirements from the active fleet? Is it age (i.e., airframe life)? Has the aircraft become too costly to operate because of maintenance requirements? Or has marketplace competition forced the operators to acquire newer equipment? We look very hard at the underlying causes to see how they could affect the fleet characteristics in out-years.

We also track new aircraft programs: first, for potential as a customer, and second, to see how the introduction of that new aircraft would affect current product markets; but also for major changes in real productivity. A cost-effective increase in productivity can influence the number of aircraft in the fleet required in the future.

The development of a total market forecast such as ours requires linking all these various elements together. The interactions between elements are studied, and the relationships are quantified where possible. Critical judgments based on historical experience are applied where necessary to test the process at intermediate points. This type of forecast cannot be made into a linear model because of the many interrelationships involved.



Source: Adapted from Research Needs Related to Intermodal Freight Transportation, Transportation Research Board, Circuar 338, October 1988

FIGURE 19 Taxonomy of Air Transportation System

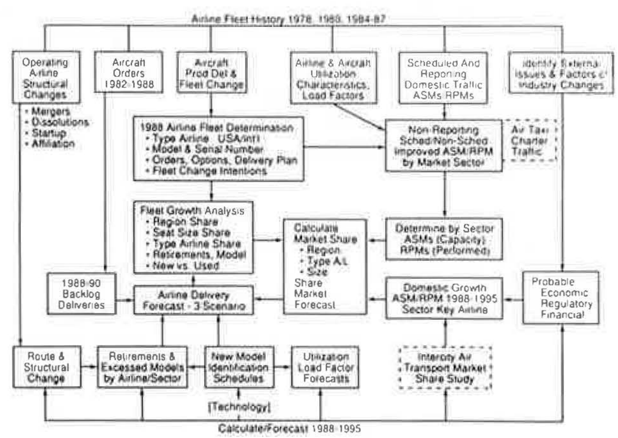


FIGURE 20 World Regional and Commuter Aircraft Forecast Process

Joe Torchetti, Pratt & Whitney of Canada

When we are asked to prepare a forecast, the first thing that must be understood is what will be the use of the forecast. Our market sector is any aircraft under 100 seats: business jets and turboprops, utility aircraft, and regional airliners. It takes five years to develop a new aircraft turbine engine. It is not enough to have just a good near-term understanding of what other airframe

and engine manufacturers are currently producing. We must focus on the short-term as well as the long-term aspects of production in addition to positioning new development programs years out.

We look at the market from several different angles. Each is an integral part of the process and must be reconciled with the others. Supply and demand over

- Top down demand
- Supply side: operators
  - Factors
  - Changes
- Supply side: Manufacturers
- Bottom up demand
  - Gaps

FIGURE 21 Forecasting Considerations

the long term should balance. The forecast process for the U.S. regional airlines tends to be iterative. We proceed under the basic assumption that the airlines are rational. We begin by taking a top-down approach to forecast demand for air travel. This is driven mainly by economic factors. We then test various assumptions for productivity, aircraft seating capacity, traffic or market patterns, and load factors to arrive at a projected fleet requirement. As an example of this method, our model shows that U.S. regional airline passenger enplanements should reach 90 million by 2000. Critical judgment

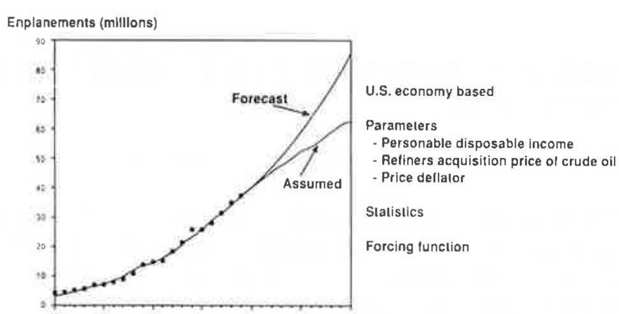


FIGURE 22 Passenger Enplanement Model for U.S. Regional Airlines

indicates that the market is maturing somewhat from the high growth rates of the past few years. This means that the growth rates will slow as the market reaches about 8 percent of total U.S. domestic enplanements.

To understand the market it is necessary to develop a good historical perspective based on trends. We utilize the OAG data extensively to see how aircraft under 100 seats are used in scheduled service.

The regional airline marketplace has been in constant change since deregulation. Structural issues that have an impact on the operators are studied. Many of these issues are not easily or directly quantified into terms of demand, but the identification of these issues can reflect back into the forecast in the judgmental decisions or assumptions made during the process.

The manufacturing sector of the aviation industry has had a large impact on the growth of the regional airlines. New aircraft and engines were the key to the expansion of the middle and late 1980s that continues into the early 1990s. From a longer term perspective we watch technological developments in airframes and powerplants. How they affect productivity and costs are key factors. In the near term we carefully track production, orders and options, and customer deliveries as a means to determine capacity. The supply of new aircraft can drive traffic growth because of increased seating, higher utilization, and development of new routes. We track the utilization of each aircraft type to further improve our forecast.

Finally, we use the bottom-up approach to close the loop. We look in detail at each airline. We analyze their fleet utilization patterns, retirement plans, new aircraft orders, options, and delivery schedules. Historical trends in ASM, RPM, and enplanements are examined. Airline finances are also studied for trends.

- Current fleet
  - Retirement rates
- Traffic
  - ASM
  - RPM
  - Growth
- Orders & options
- Gap fleet mix

FIGURE 23 Bottom-Up Approach to Airline Fleet Planning

This method of analyzing the market from the top down and bottom up allows us to identify market gaps for new products and estimate the timing and size of the potential opportunity.

ECONOMIC AND STRUCTURAL FACTORS AFFECTING LONG-TERM FORECASTS

The discussions on events or conditions that would affect the long term forecast centered on three main areas: economic factors, aircraft fleet development, and airline industry structure.

Economic Factors

A major driver of any aviation forecast is economic assumptions and the influence or weight assigned to each in the forecast. Most of the participants focused on aggregate indicators such as GNP, consumer spending, net income, and disposable income as useful in determining the trends and turning points of the forecasts. Several forecasters indicated that they also used an energy cost element based on the price of oil. Interest rates were also mentioned as influencing the demand for capital equipment such as aircraft.

In predicting the direction of the economy, most participants agreed that a slowdown or recession should be included in any forecast for the near term. The timing and the severity, however, were subject to debate, with the time frame indicated ranging from "We're already in it" and late 1990 to midyear 1991 and early 1992. The estimated severity ranged from flat to a strong correction. Although there was diversity in the near-term environment, estimates of the long-term outlook for the economy showed considerable consistency. Over the long run, participants felt the fundamental strength of the U.S. economy would be good and that it would allow for further expansion of regional air services.

A concern was expressed by several workshop participants about the availability of capital for equipment purchases, with competition coming from demand for rebuilding Eastern Europe and expected large purchases of new aircraft by the major airlines of the world. Would this cause pressure on interest rates and would the portfolios of the major lending institutions be dominated by large aircraft? These were seen as factors to be watched for indications of upward pressure on money rates for regional airliner acquisitions.

Aircraft Fleet Development

The U.S. regional airline fleet has almost doubled since 1978. The number of seats in scheduled service has increased 233 percent over the same time. Several of the workshop participants felt that a major element of near-term growth would be new aircraft delivery schedules and older aircraft retirements. The assertion was that through the use of aggressive yield management programs, the airlines were creating demand by offering seats in the marketplace—a capacity-driven growth scenario. By carefully following aircraft orders and deliveries and analyzing the productivity characteristics of individual aircraft types it would be possible to establish the in-service fleet at a near-term point (1-3 years) and thereby estimate passenger traffic levels. It was agreed that careful tracking of the scheduled fleet replacement was a key element for developing accurate forecasts. Essential elements of the fleet to be tracked were

- Current in-service fleet,
- Movements into and out of the fleet by older aircraft,
- New aircraft delivery schedules,
- Order backlog and option commitments, and
- Productivity characteristics of all aircraft:
  - Block hours flown or scheduled,
  - Typical stage lengths,
  - Departure rates, and
  - Seating configuration.

Airline Industry Structure

The discussion of structural issues centered around two areas: the physical infrastructure of the airport and airways system and the future composition of the U.S. airline industry as related to the regional airlines.

Most participants felt that the rapid growth of the air transport system was outstripping the investment in and the development of airport and airway system capacity. The capacity limitations that are beginning to appear will force many airport operators to rationalize access by developing pricing structures based on some form of resource cost allocation. This could force regional airlines to cut back service levels at some communities in the short term or to shift their marketing strategy from smaller aircraft operating at higher frequencies to larger aircraft and lower frequencies. Access to the airports will not be the only constraint facing regional airlines in the near future. Ramp space and gate access were seen as potentially limiting at some of the more congested airports.

An additional element that could constrain expansion at some airports is the growing community resistance to the increased noise generated by the higher traffic levels. Several workshop participants noted that community concern about the environment and aircraft noise would put additional pressure on airlines and airport operators to restrict operations of all types. The affect on regional airlines could be particularly severe due to their higher frequency of operations.

On the positive side, development of more direct origin-destination service to bypass the congested hub airports was identified by several participants as an avenue for growth in some markets. As regional passenger flows into and out of hubs are better

understood by the major airlines through the use of their computer reservations systems, viable point-to-point or hub-bypass markets will emerge. In addition to helping alleviate congestion and saving the traveler time, regional airlines will also be able to charge a premium fare for this time-saving and convenient service.

The future composition of the major U.S. airlines will directly affect the development of their respective regional affiliates. Continued consolidation of the industry will provide increasing vertical integration not only in the services offered to the public but also in airline operations. The regional airlines will further integrate their development in several ways. The regional airlines affiliated with the strongest major air carriers will continue to grow at above-average rates as they gain market share in existing markets and expand into new markets. They will increase the sophistication of their planning and operations by tying directly into the massive data systems of their major affiliate or owner. Economies of scale will allow them to generate the cash flow necessary to continue to acquire new, efficient equipment and thereby further increase their competitive position through cost reductions.

SUMMARY

As with any industry that has undergone a period of rapid change and growth, the public agencies, airframe and component manufacturers and the airlines themselves must adapt to these changes in planning for the future. The future is not a clear, simple picture for the regional airline industry. It is a complex series of interactions between the economy, demographics, technology, natural resources, and infrastructure capacity. Change is the constant. Some will be rational and paced; some will be fast, even instantaneous. Planning for the future in this environment requires continuously assessing events and long-term trends and developing methods for weighing their impact on the U.S. regional air transport industry.

PART III FORECASTING AIR-CARRIER ACTIVITY
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LONG-TERM TRENDS AND FACTORS INFLUENCING AVIATION FORECASTING

General Trends and Issues

Reliable long-term forecasts are critical for all parties involved in commercial air transport, including airlines, aircraft manufacturers, airport operators, corporations dependent on air transport for air cargo or express services, tourist agencies, hotel operators, and so forth. If the Federal Aviation Administration is to perform its several functions related to the promotion and facilitation of aviation (air traffic control, airport maintenance and expansion support, and safety inspections), the agency must have a reasonably reliable forecast of future demands on the system. It is imperative that FAA, as well as other actors involved in the air transport system, know when and where various demand levels will exist. They must know where people are most likely to require air service and airport facilities, how many aircraft will be in the system, how fast and at what capacity they will be flying, and at what frequency service between points will be provided.

Decision making and policy implementation are not simple, straightforward processes. Even when some variables are known, several factors continue to make forecasting difficult. Each factor has somewhat different forecasting needs. For example, FAA and manufacturers are more concerned about long-term capital investments, while airlines are more interested in accurate short-term forecasts to guide decisions about such matters as aircraft leasing or large equity investments. For airport authorities and local government officials, political factors make it difficult to anticipate when and what projects may receive government funding. Elected officials, who make spending decisions, must balance constituent needs and demands with those of the Nation at large. It is not easy to vote for funding measures which could have a negative effect on constituents. Planning airport facilities, ATC computer acquisition programs, or weather prediction equipment are ultimately politically affected choices. Likewise, identifying alternative plans and research and development projects worthy of government funding can be politically influenced.

At the global level, discussions affecting international air transport are often even more problematic because they involve multilateral negotiations. The characteristics of large, diverse groups make international decision making a longer, more complicated and even less predictable process than at the domestic level. Global-level decisions which affect aviation take place primarily by agreements between nations. The International Civil Aviation Organization (ICAO) and to a lesser degree in the International Air Transport Association (IATA) also play significant roles in formulating a global system. The most critical types of decisions made by ICAO are those establishing standards, such as noise pollution or safety standards, which must be met by all nations.

Uncertainty of some input variables affects the quality of FAA forecasting. One way to deal with this uncertainty would be to create alternative future scenarios instead of single-point forecasts. Pursuing the multiple-scenario approach might result in more useful forecasts, in that it would be possible to identify the parameters (demographic, environmental, technological, energy, and so forth) that could delimit aviation behavior. Such a forecasting approach might also provide more effective and efficient means to identify significant technological research and development needs. In the early stages of technology-related research and development, it is difficult to predict which alternative might be the more likely to result in the most beneficial returns. Choosing one out of several technologies to fund essentially eliminates the competitive development of alternative technologies. Establishing parameters rather than specific outcomes may facilitate better decision making about issues such as these.

Similarly, forecasting might be enhanced by reframing fundamental questions about the future development of aviation. For example, are airlines in the business of flying airplanes, managing assets, providing intercity transportation of goods and people, or all three? Each perception of an air carrier's purpose generates a different style of management and set of forecasting requirements.

Energy Issues

The long-term availability and cost of energy remain important and somewhat uncertain variables. Aviation forecasting could be improved if a reliable indicator were developed. While petroleum supplies appear to be sufficient to support aviation for the next 20 years, the real questions are access and cost. Despite political instability in the prime producing region of the Middle East, there are enough sources of oil elsewhere in the world that certainty of supply and access are virtually guaranteed, even though these sources may be more difficult to reach.

Energy costs are affected by technological advances in various stages of production and the introduction of energy substitutes. Historically, these two factors have resulted in stable and, in fact, decreasing real costs of energy. Energy costs are also affected by supply and demand. Whenever access is threatened and demand remains constant (as during the OPEC embargoes of the 1970s, the initial stages of the Iran-Iraq war, or the current situation in Iraq), costs rise. This has a negative effect on air carriers because they are heavily dependent on oil products and because airline profit margins are historically slim. Thus, it is difficult for them to absorb higher commodity costs without raising fares, which in turn might affect consumer demand.

While the direct effect of oil price rises on operating costs for air carriers is significant, perhaps more dramatic will be the effect on the U.S. economy as a whole. Teetering on the edge of recession and dangerously dependent on petroleum for continued productivity, high energy costs for a sustained period of time could cause corporations and individual consumers to cancel travel plans, especially if they involve higher air fares.

Currently, aviation industry analysts estimate that oil prices will peak in the winter of 1990-1991 at a level 5 percent higher than prior to Iraq's invasion of Kuwait. Aviation analysts generally agree that this will be a short-term shock. Nevertheless, increasing energy costs coupled with a weak, if not recessionary, economy will probably contribute to a decline in air traffic. If these predictions are accurate, 1991 promises to be only the third time in the modern history of commercial aviation that traffic has decreased. Short-term air carrier responses to rising fuel costs will probably be limited to grounding old, fuel-inefficient aircraft and operational practices to reduce fuel consumption.

Equipment

Predicting equipment requirements is critical to both aircraft manufacturers and air carriers. Manufacturers need long lead times to develop and produce aircraft and engines. They must also be aware of special needs--such as range, capacity, and fuel efficiency--in order to plan production. Air carriers need to know when and what type of equipment is available for purchase or lease. Fleet management decisions are rational, but only as good as the information upon which they are made.

Perhaps the most dramatic influence on equipment needs has been the result of technological advances to increase the durability of aircraft and engines. With proper maintenance, the practical life span of the average commercial aircraft has increased dramatically from the once standard notion of 25 years to a potential 40-50 years. Virtually no commercial jet aircraft have been retired over the last 10 years worldwide. This trend is likely to persist into the future. If combined with a recession and slowed growth, this could have a devastating impact on equipment manufacturers.

Three other factors could influence future equipment needs:

(1) If oil prices stabilize at a much higher level than the currently predicted 5-percent increase, there may be an intensified demand for improved fuel efficiency. Airframe and engine manufacturers might return to designs (e.g., unducted fan engines) that were begun at the end of the 1970s in response to high energy prices but left on the drawing board. While costly from the standpoint of research and development funds, long-term benefits in the form of new and necessary products could accrue from commercialization of such technology.

(2) Manufacturers are concerned that current orders reflect a desire on the part of air carriers to ensure aircraft availability rather than an accurate assessment of their fleet needs based on perceived expansion plans. Aircraft orders far exceed what typical forecasts of traffic growth would indicate are appropriate.

(3) Any type of mandatory retirement regulation would affect equipment producers and airlines. Such a requirement could be the result of safety or environmental concerns about noise or air pollution.

SHORT-TERM TRENDS AND FACTORS INFLUENCING AVIATION FORECASTING

Short-term forecasting is a little easier than long-term prediction. Nevertheless, information about some relevant variables is still uncertain, and some data are subject to different interpretations with respect to the overall effect on aviation.

Domestic Effects

For at least the next two years, the U.S. economy is going to be hovering between slow or no growth and a recession.[1] Three factors will affect the continuing stability of the domestic economy. (1) Energy prices: If energy costs rise too far, they will exacerbate efforts to improve productivity throughout all parts of the U.S. economy. (2) Deficit Management: A classic monetarist solution to the U.S. budget deficit could contribute to a recession by taking money out of the economy. Therefore, management must incorporate a more creative set of policies. (3) Interest rates: If interest rates increase they this could also trigger the onset of a recession.

As with many other issues affecting aviation, management of the U.S. economy is essentially a political issue. Policy makers will attempt to avert a recession because they recognize the costs (including the likelihood of triggering a global recession) could be too severe. The track record of policy makers in this regard, however, is somewhat less than perfect.

Assuming a slow growth rate at best, most aviation analysts believe at least two major U.S. carriers will cease to exist over the next two years. In addition, a few national carriers could be eliminated. The options include merger, acquisition, or bankruptcy accompanied by asset sales. Federal policy decisions will affect the nature of this transition to fewer carriers. The most important policy question, anti-trust concerns, will be answered by Justice Department actions.

Little room now exists for new investment in new air carriers. Wall Street no longer views new entrants as plausible because gate space and routes are already saturated. Even if the demise of existing carriers opens up a number of routes and gates, no potential new entrant is likely to gain access to enough of them to be profitable.

The net effect of a slow growth economy and fewer carriers competing in the market will be higher fares, which could further depress traffic growth. Increased fuel prices and the loss of Continental Airlines as the ticket discount maverick will further contribute to a decline in air transport traffic.[2]

These gloomy forecasts are countered by historical data which reveal that the oil crises of the 1970s and early 1980s were not disastrous for air transportation. From 1980 to 1981, yields jumped 33 percent; from 1981 to 1982 yields increased by 15-20 percent; and yields rose again in 1984. Furthermore, air carriers should have learned how to adjust to short-term decreases in traffic. They can achieve cost control by parking inefficient planes, cutting employees, and other such belt-tightening measures.

Air cargo carriers have less flexibility. They must fly a fixed set of routes to get goods from sources to delivery points. At the same time, however, their fuel costs are not as high because they do not fly their airplanes as much.

International Effects

Air carriers with international routes enjoyed a tremendous year on the North Atlantic in 1990 because (1) new service to new points was available, (2) many potential tourists had postponed travel plans due to financial and political constraints in the preceding years, and (3) real international fares were at an all-time low compared to domestic fares.

However, 1991 does not promise to be as lucrative for international carriers. Economies on both sides of the Atlantic are weak, especially those of the United States, the United Kingdom, and the Federal Republic of Germany now that it must adjust to the costs of reunification with the former German Democratic Republic. On the whole, incorporation of Central Europe into the western trading system should have a neutral effect in the short term. While some costs associated with improving productivity and environmental clean-up in the former Soviet Bloc will be high, the return benefits are expected to counter the costs fairly soon. Another factor that could affect the profitability of international carriers is the recent action by the International Air Transport Association to increase fares, which should depress traffic demand. Instability in the Middle East, such as that sparked by Iraq's invasion of Kuwait, always raises the specter of terrorist activity, which depresses traffic demand.

Traffic on the Pacific Rim is also likely to slow. While flights originating in the United States will probably remain steady, those from Japan will decrease. Japan's economy is also weakening, as evidenced by the 38-percent drop in the value of the Nikkei Index since January 1990.

South American traffic is good and is likely to remain stable.

Infrastructure Issues

To promote more global traffic while alleviating the increasingly heavy traffic burden on such traditional international gateways as New York, Boston, Los Angeles, and San Francisco, the idea of opening alternative international hubs in the interior of the United States has gained popularity. Confronted with decreasing gateway availability and the constraints of existing bilateral agreements, European air carriers have been particularly eager to open new gateways. Furthermore, the likelihood that the United States will open its domestic air travel market to cabotage[3] is decreasing. Therefore, European carriers would like to serve those travelers who seek non-traditional U.S. tourist and business destinations.

U.S. carriers fear the Europeans are really trying to grandfather routes in the United States before the European Community merges into a single market in 1992. U.S. carriers worry that the U.S. Government--particularly the Departments of Transportation and State--are too eager to give away the comparative advantage of domestic carriers by granting too many landing rights to foreign carriers, while not doing enough either to protect U.S. carriers in their own domestic markets or to help U.S. carriers penetrate potentially lucrative foreign markets.

Concerns about opening up internal, alternative international hubs are exacerbated by the increasingly limited Federal resources available to support new airport and airspace infrastructure. Given that customs and air traffic control systems are severely strained already, it is hard to justify adding more capacity at previously domestic-only airports to accommodate foreign-carrier traffic.

The Federal Aviation Administration takes seriously its charter to promote commercial aviation. Historically, airlines have pursued their individual survival strategies, and FAA and has somehow managed to catch up with the new demands placed on the system by air carrier actions. Nevertheless, it appears that the structural changes in the air transport industry which have occurred since degregulation may call for reexamination of certain FAA policies and activities.

Given budgetary and infrastructure constraints and the need to reexamine FAA's role in facilitating air transport, several ideas were offered regarding possible new incentives and methods for providing air transportation services. A primary concern was the elimination of free riders from the system. As the system currently works, the air traffic control, customs, and airport operating and maintenance services are provided, and air carriers operate within that system. While airlines pay fees for these services, the fees are not necessarily directly related to the actual costs imposed on the system. Therefore, some air carriers do not pay their full share of costs.

For example, since economic deregulation of the U.S. air transportation system in 1978, virtually every carrier has adopted a hubbing strategy, which generates more income because it enables a carrier to channel traffic more efficiently from point to point. Hubbing also requires very close timing for landings and takeoffs of feeder aircraft. Thus at busy times of the day--typically early morning and early evening for the business traveler--airports become highly congested as they try to serve a concentrated number of aircraft. Similarly, densely traveled routes place a heavy burden on certain air traffic control facilities.

Often getting to and from the airport can be more difficult than the flight itself. Problems associated with landside constraints also raise questions about who is responsible for improving airport access.

Various mechanisms whereby users would pay true costs were discussed. One option is peak-hour pricing (differential landing fees for use of runways and related airport facilities) designed to recover the costs imposed by airline operations at hours when demand for airport capacity is highest. Another option is a passenger facility charge (a head tax levied by airports directly on passengers) based on the time and conditions of airport use. Privatization of the infrastructure is a third option in which a profit-based private corporation operates the airport and imposes charges (on airlines or passengers) proportionate to the cost of providing service. A somewhat different approach--directed at airspace rather than airport congestion--would be a system of fees paid by airspace users (aircraft) on the basis of the duration of time they operate under air traffic control and the level of service received.

No solution seemed to satisfy all participants. Air carrier representatives expressed concern that any real "user pays" system will increase the costs of flying. Since fares are not completely inelastic, traffic would decline as fares rise. While higher fares might may solve the problem of congested skies in the short run, they would create painful long-term costs for air carriers and those who provide them vital goods and services.

Without some change in infrastructure cost management, congestion of the airport and airways the system may become intolerable. As fewer air carriers compete in the marketplace, the potential increases for fares to rise. Whether they rise due to user fees or monopoly hubs, the effect on commercial aviation will be the same.

A second approach to solving congestion and infrastructure problems could be reexamination and change of the hubbing concept. Since deregulation, virtually every U.S. airline has adopted a hubbing strategy to manage traffic flow. A good primary hub requires a strong local traffic base. While there is room for developing a few more primary hubs, the airport system is reaching the saturation point.

It may be possible to develop more secondary hubs to relieve pressure on the existing primary hub structure. A recently published FAA report identifies 28 presently underutilized airports that could serve as secondary hubs. Significant improvements in regional commuter aircraft, in terms of range, speed and capacity, make the "catchment" area for a secondary hub encompass a much wider circle. Efficiently operated secondary hubs could ease congestion at primary hubs by drawing off a portion of present tránsfer traffic or by providing a way to accommodate future growth.

Finally, the discussion of possible solutions to infrastructure constraints turned to the role of technology. In addition to technologies related to improving efficiency and safety, such as those for monitoring weather conditions and guiding traffic, technological advances also offer the promise of alternative modes of transportation. For example, a combination of improved tiltrotor aircraft and dedicated rotorport facilities has been suggested as a way of alleviating current congestion problems. The technology is available for putting this combination system into place, but there are major obstacles to implementation. The start-up capital costs associated with building the airports and establishing new route systems, not to mention adding tiltrotor aircraft to air carrier fleets, are very high. As with other issues discussed at the workshop, such a decision to implement this technology requires political commitment in the form of incentives and leadership.

A relatively new technology may hold more promise--high speed transportation via magnetic levitation (maglev). Here research and development are in earlier stages. As with the combination concept above, the start-up capital costs will be great--approximately \$12-15 million per mile.[4] Once in place, incremental operational costs are believed to be very low. Maglev transportation could require up to 60 percent less fuel than the current intercity transportation systems in the United States. Decreased dependence on fuel coupled with the promise that maglev would to be virtually noise-free means that it could be very clean environmentally.[5] Mag lev transportation systems could be fully automatic, saving 90 percent of labor costs. However, it seems unlikely that the public would be willing to ride in any high-speed vehicle without some human presence as a check on technological failure. Maglev systems can respond easily to traffic demand changes because vehicles can be readily shifted from large to small capacity with varying degrees of service frequency. Finally, maglev promises to be 99 percent reliable.

Potential problems of maglev technology are its high start-up costs and the environmental impact of guideway placement and construction. Everything will have to be new--especially the guideways, which will need to be as level and straight as possible to attain the speeds necessary to make it competitive with air travel. To be cost efficient, trips need to be in the 300-500 mile range. Uncertain futures again haunt the aviation forecaster. It is virtually impossible at this point to predict when, if,

TABLE 5 Percent of Total Trips Taken in Last 12 Months (By Age and Income)

Income	18-29	30-39	Age 40-40	50-64	65+	All Ages
$40,000 & over	8	18	20	8	3	57
$25,000-$39,999	3	6	3	3	2	17
$15,000-$24,999	3	2	1	2	3	10
Under $15,000	2	1	1	1	2	8
Undesignated	2	1	3	2	0	8
All Incomes	18	28	28	16	10	100

SOURCE: 1988 ATA Air Travel Survey

NOTE: Eight percent did not designate income.

TABLE 6 Percent Flying in Past Year, By Age and Income

	AGE GROUP				
Family Income	18-29	30-39	40-49	64 & 50-64	Over
$40,000 and up	50	50	51	50	40
$25,000-$39,999	24	30	30	32	40
$15,000- 24,999	21	25	13	21	23
Under $15,000	19	17	13	12	15
All Incomes (Weighed Average)	28	33	33	49	22

Source: ATA Air Travel Survey, 1988

and how maglev might be introduced into the transportation system; nor is it possible to predict what effect maglev might have on air transport.

The prevailing questions are: Who will invest to make this a reality? Is this the appropriate place for the government to be encouraging development through research and development assistance, or should airlines or railway corporations be investing in the new technology?

ADJUSTING LONG - RANGE FORECASTS TO ACCOUNT FOR CHANGES IN DEMOGRAPHICS*

Demographic trends are critical to accurate forecasting in the commercial air transport sector. To airline management demographic trends dictate fleet requirements: the range and capacity of aircraft, the routes the aircraft should be placed, and when the aircraft should be purchased. To government officials, demographic where trends suggest infrastructure needs: where airports should be located, when they should be built, how large they should be, when air traffic control systems should be expanded, where they should be installed.

The number of trips per capita drives demand. It is important, therefore, to identify as specifically as possible the type of person who has a propensity to fly and how frequently that person might fly. Research has identified several factors that affect the propensity to fly: (1) income, (2) age, (3) gender, and (4) geographical location. Data from the 1988 Air Transport Association (ATA) Air Travel Survey indicate that a 45-year-old male who resides in the northeast and earns a minimum annual income of $40,000 is the most likely to fly.

*Summary of presentation by Richard Golaszewski, Gellman Research Associates

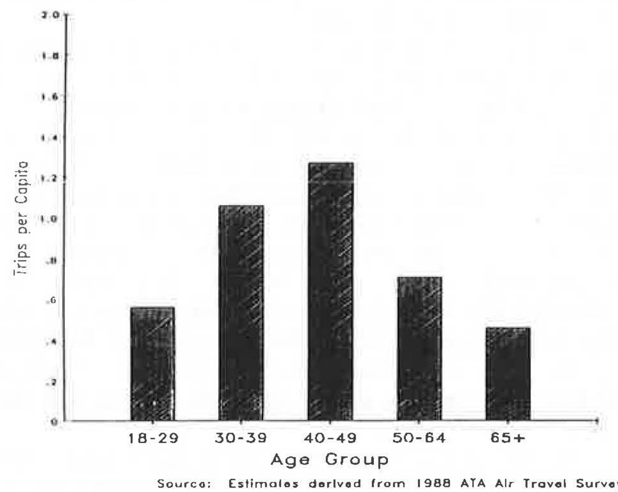

FIGURE 24 Propensity to Fly by Age Group, 1988

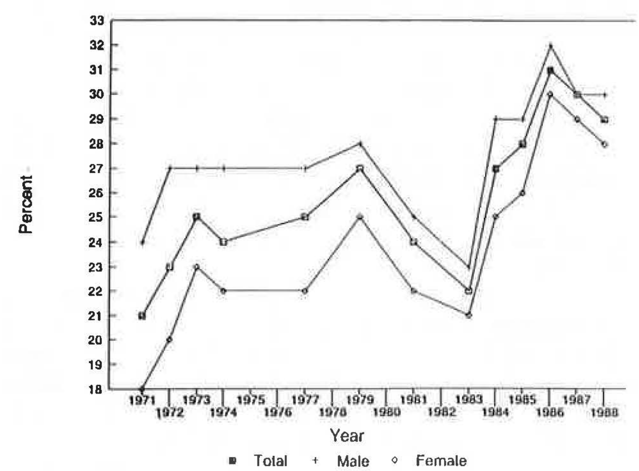

FIGURE 25 Percent of Respondents Who Have Flown in the Past 12 Months (By Gender)

Current methodological sophistication does not permit the multiple-variable analysis that would reveal more precise information. For example, demographic trends indicate that the U.S. population is increasing, especially for persons younger than 18, and that the greatest growth is occurring in the southeastern and southwestern United States. Howwever, per capita personal incomes are highest in the northeast. Current analytical techniques do not allow the forecaster to determine if aviation traffic growth will be greater in the southeast and southwest, due to the increasing numbers of people, or in the northeast where incomes are rising.

Golaszewski has devised an analytical approach which is more sophisticated than that now used by FAA. Amenable to sensitivity analyses, it can be implemented on spreadsheet software. It incorporates economic factors already considered in FAA forecasting methodologies but adds a demographic index derived

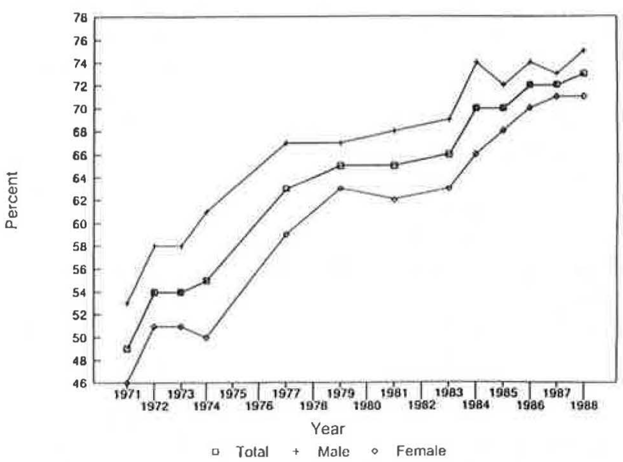

FIGURE 26 Percent of Respondents Who Have Flown in Their Lifetimes (By Gender)

from information about: (1) current propensities to fly by demographic cohorts, (2) present cohort populations, and (3) forecasts of cohort populations. The model generates demographically adjusted forecasts by multiplying FAA forecasts of enplanements by the demographic index. (Details of the forecasting models are provided in Appendix A.)

Using this model and 1988 ATA survey data, Golaszewski discovered that adjusting for population composition--gender, region, and age--to the year 2010 produces only a modest change of 1.55 percent in the FAA enplanement forecast. Two critical variables could not be accommodated in this projection due to lack of information: (1) potential changes in the income

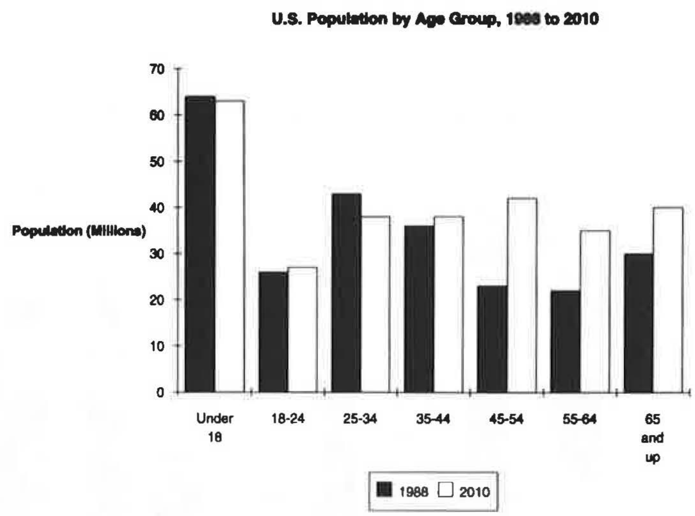

FIGURE 27 U.S. Population by Age Group, 1988 to 2010

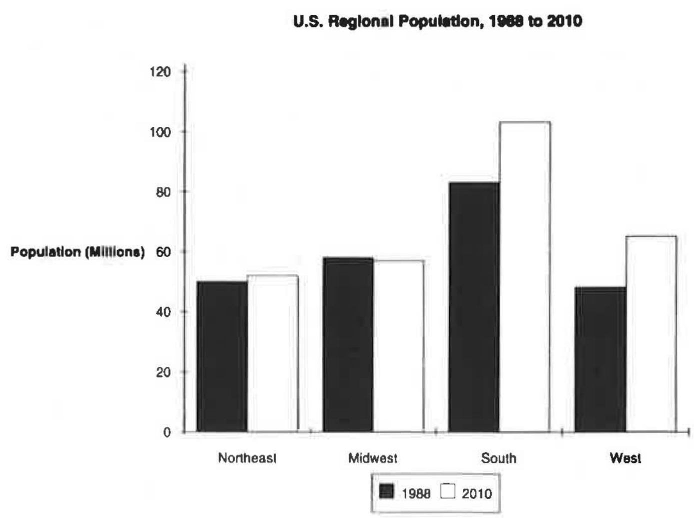

FIGURE 28 U.S. Regional Population, 1988 to 2010

composition of the population and (2) potential changesin the propensity to fly within population cohorts.

Accurate demographic information is crucial because only a 10-percent increase in trips per capita by in all cohorts (gender, region, and age) in 2010 would increase

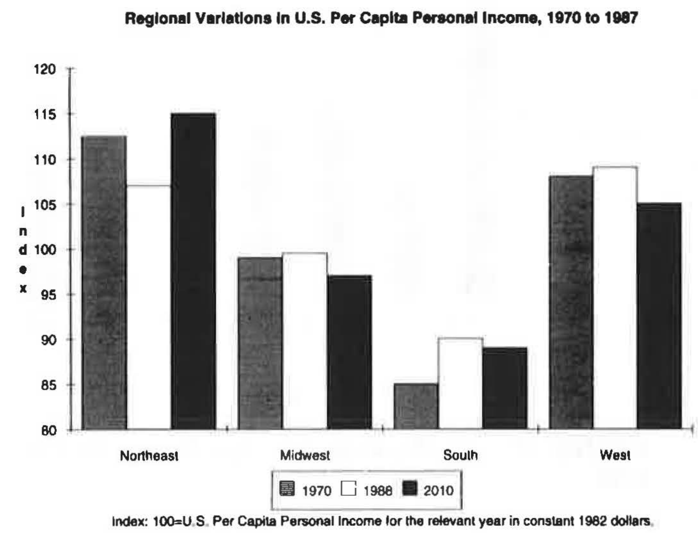

FIGURE 29 Regional Variations in Per Capita Personal Income, 1970 to 1987

enplanements by 11.7 percent over the FAA forecast. Currently, the United States represents a significant untapped market since the typical American adult flies only 0.6 to 0.7 times per year. One quarter of U.S. adults have never flown, and only one-third of the population takes an air trip is any given year. A more systematic collection of data at regular intervals would enhance the quality and quantity of information available to the forecaster. A larger base of comparable data over time would facilitate reliable time series analyses and improve forecasting outcomes.

A central issue is whether Americans have an increasing propensity to fly. Revenue passenger miles (RPMs)[6] have increased steadily over the last decade. While fares have decreased somewhat in real terms, income has remained fairly stable over the last 10 years. This suggests that a new group of people have come to regard to flying as the preferred mode of intercity travel.

Forecasting accuracy would be improved if analysts understood why this trend is occurring. Perhaps overall changes in life style explain traffic increases: people introduced to flying in the early days of economic deregulation when fares dropped dramatically may be more inclined to fly today. Similarly, people introduced to flying in their work may be more likely to fly on leisure trips as well. Families who are geographically dispersed may choose to travel by air for family reunions and holidays. The "graying" population may be more likely to fly as a result of a combination of these factors. Finally, technological advances may have made flying more accessible to would-be travelers. It is easier to buy tickets and arrange package trips--whether for business or pleasure.

Statistics indicate that the most frequent flyer is still the business traveler. Forecasters have been predicting an upsurge in leisure flying for years, but the data suggest this has not occurred. Nevertheless, aviation forecasters are aware of the potential. Better predictors of leisure flying would be a valuable tool.

SUPPLY-SIDE CONSIDERATIONS IN FORECASTING THE U.S. ALL-CARGO EXPRESS INDUSTRY*

In 1988, a study of the U.S. all-cargo industry was sponsored by the 10 leading U.S. carriers.[7] Internal data covering the 10 years following deregulation in 1977 were collected from each sponsor by means of written questionnaires. The results revealed the emergence of a growth industry.

From 1977 to 1988, the all-cargo sector of the industry increased its asset base eightfold to a level of $8 billion, and stockholder equity grew sevenfold to $4.9 billion. The number of shipments jumped 11 times to 414 million air shipments, and revenues increased from $1.1 billion to $9.1 billion. Tonnage carried expanded by more than 400 percent, and employment grew by a factor of 5. The jet fleet expanded from 59 aircraft to 372 (including 17 L-100 large turboprops), while the number of regular air shipper accounts ballooned by 700 percent to more than 4.5 million.

Three factors account for this success. (1) Economic deregulation encouraged private-sector innovation by freeing entry in the domestic arena and eliminating CAB jurisdiction over pricing and new product development. (2) The integrated door-to-door express business, pioneered by Federal Express in 1973, created new primary demand for services. This demand was supported by the creation of the zip code system and the steady deterioration of small package and document services by the Postal Service and the Railway Express Agency. (3) Federal Express's success inspired competitors like Emery, Airborne, UPS, and, more recently, DHL, Burlington Air Express and CF to establish dedicated air systems for the transportation of small packages and heavy-weight freight in the domestic market.

By all important measures, air cargo deregulation has been a success. Consumers enjoy overnight service from any zip code in the country to any other zip code, usually by noon the next day, or earlier. Every consumer typically has a choice of four or more air cargo or air

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* Summary of presentation by Brian Campbell, Leeper, Cambridge & Campbell, Inc.

express competitors offering a variety of price and service options. Relatively few consumer complaints have been registered against this industry. No one is suggesting that the air cargo industry should be regulated.

The growth of all-cargo carriers' has not exacerbated pressures on the airport and airways system. Because they operate most of their flights at night, they complement the passenger system and provide added revenue utilization for the Nation's airport system.

A fairly smooth geometrically increasing curve is generated when historical traffic statistics are plotted. Currently, growth rates are decreasing in the document sector due to widespread use of fax technology. Prediction is difficult, but forecasters anticipate that document movement will continue to be a major part of the industry's high-yield time-definite service.

Unpredictable variables make forecasting difficult. The greatest uncertainty affecting all-cargo forecasts today is airport access restrictions, which are proliferating throughout the country on an ad hoc basis. The associated economic costs are unevenly distributed and threaten the continued growth of this sector in the air transportation system. Sixty-five percent of all domestic shipments of the all-cargo carriers involve next-day service. Carriers must fly between 10:00 p.m. and 7:00 a.m. and use relatively inexpensive aircraft because they only average four hours utilization per day.

Locally imposed airport access restrictions and noise limitations are proliferating throughout the country. This movement toward local regulation, coupled with uncertainty about the costs and timing of Stage 3 conversion, will require forecasters to pay close attention to supply-side elements and to develop forecasts that reflect assumptions about national and local noise policy. Simple time-series forecasts will not work.

Airport access restrictions based on noise impose uneven costs on air carriers. While two-thirds of all-cargo flights occur between 10 p.m. and 7 a.m., only 6-8 percent of passenger flights operate during this period. Nevertheless, according to 1988 figures, passenger airlines operate 22,000 nighttime flights and 211,000 daytime flights compared to 6,200 nighttime and 3,200 daytime all-cargo flights. Restricting airport access for all carriers alike would have a greater negative affect on the all-cargo carriers even though three-fourths of the flights and associated noise is created by passenger airlines, which depend far less on nighttime flying for their profitability.

Restrictions on nighttime flying also affect a broad range of consumers and producers who rely on air express service for product delivery. This is particularly acute for those manufacturers who use just-in-time inventory in their production processes. The loss of one Boeing 727 carrying cargo at night affects 3,000 shippers and 3,000 recipients.

Noting that U.S. regulation of noise is fairly lax when compared to that in Europe and Japan, other ways of dealing with the issue were suggested. Perhaps several 24-hour airports, such as Osaka Kansai Airport being built off the coast of Japan, could be utilized. This would probably involve dual use of military airports or the transition to commercial use only of facilities at former military bases. The notion of "wayports" was not deemed useful, but using existing airports geographically distanced from large population centers appeared to be a sensible solution. The possibility of a more purely economic solution was raised: a "payment" system in which the offender would compensate the offended.

Distributing the costs and benefits of nighttime flying and noise pollution is a complicated process. If carriers pay an increased fee for the privilege of using the airport during nighttime hours, the cost of the service will rise and negatively affect the profitability of the airline and those dependent on the service. If delivery time is increased in order to avoid nighttime flying, those affected will bear asymmetrically high costs related to their time-sensitive production needs.

Slow growth of U.S. economy could be as devastating as uneven application of noise regulations throughout the country. With facsimile technology penetrating the documents sector of the express service sector, carriers are responding by increasing the weight limit they will ship express (as opposed to freight), seeking out new markets, and offering other new express services, such as shipping C.O.D.

Once again, the effects of political decisions can be crucial. To save money, the Postmaster General of the United States has indicated that the Postal Service may return to shipping regular mail by surface transportation and requiring extra fees for air mail. This could shift a lot of traffic to express carriers.

Despite its fairly recent emergence and rapid growth, the all-cargo sector is not yet clearly understood. The variables affecting the industry have not been fully identified, and clearer definitions of activity measures is needed. For example, there is no effective consumer profile; most shipments are made by managers of business and professional organization, but they are usually initiated by secretarial or clerical staff, making it difficult to know where to target sales pitches. Furthermore, it is not clear what might be the most useful unit of measuring activity--ton miles, revenue, or something else--to track growth within the express package and cargo shipping industry.

THE CRAF PROGRAM: IMPACTS ON CIVIL AIR COMMERCE AND FAA ACTIVITY*

The Civil Reserve Air Fleet (CRAF) is a program whereby U.S. civil air carriers commit aircraft and

* Summary of presentation by Gene S. Mercer, Federal Aviation Administration

personnel to the Department of Defense (DOD) to augment U.S. military capability in times of crisis. Although instituted in 1952, the CRAF program had never been activated prior to its Stage I implementation on August 17, 1990.

Through interagency agreements between DOD and the Department of Transportation (DOT) and through contracts with civil air carriers, the CRAF program guarantees DOD a reserve of aircraft to meet national emergency requirements. As an incentive to volunteer for CRAF, air carriers earn entitlement to DOD peacetime airlift augmentation business in direct proportion to the equipment and personnel they contribute to emergency mobilization.

CRAF provides DOD a wide-range of options for responding to various world political and military situations. There are three stages.

Stage I: Carriers provide long-range international aircraft to perform airlift services that cannot be met by the Military Airlift Command (MAC), the DOD airlift manager. The MAC Commander has authority to activate Stage I. Aircraft committed by the carriers must be at their on-load site within 24 hours after mission notification. Currently 18 passenger and 22 cargo aircraft are under contract.

Stage II: This stage provides additional capacity for a major airlift emergency that does not warrant national mobilization. The Secretary of Defense has the authority to activate Stage II. Response time is 24 hours. Long- and medium-range aircraft are used to meet domestic and international route requirements. In total, 187 additional aircraft are committed to Stage II. Together with the Stage I aircraft, the fleet is comprised of 116 long-range aircraft (77 passenger and 39 cargo) and 71 medium-range aircraft (21 passenger and 50 cargo).

Stage III: All passenger and cargo capability contracted in the CRAF program, affecting 11.6 percent of the U.S. commercial jet fleet of 4,017 aircraft, are subject to full activation. Stage III is activated by order of the Secretary of Defense in time of war or during a defense oriented national emergency declared by the President or the U.S. Congress. The response time is 48 hours. In all, 506 aircraft including those activated in Stage I and Stage II are affected by CRAF contracts: 424 long-range aircraft (283 passenger and 141 cargo) and 82 medium range aircraft (32 passenger and 52 cargo).

CRAF program activation varies according to carrier and implementation phase. Appendix B indicates the wide ranging impacts of CRAF implementation and shows the distribution of the U.S. commercial jet fleet by type of aircraft, the number of aircraft committed to CRAF, and the anticipated calendar year (CY) 1990 deliveries. If not voluntarily committed to the CRAF program, the 222 two-engine narrow body aircraft scheduled for delivery in 1990 would be used in domestic service, while the 28 widebody aircraft would be used in international service.

Carriers commit four crew members per crew position for each aircraft supplied to CRAF. Crew members cannot be members of the National Guard or the Air Force reserve units. To meet security clearance requirements crew members must be U.S. citizens.

The short-term impact of Stage I implementation already under way is not significant. Airlines have been able to meet CRAF commitments with only minor schedule changes. CRAF activation is, in fact, benefitting certain carriers with pre-existing financial problems by providing a stable revenue stream.

SUGGESTED IMPROVEMENTS AND ADDITIONS TO FAA FORECASTING

The presentations and discussion at the workshop suggested several ways in which the Federal Aviation Administration might improve its forecasts of commercial aviation activity.

1. Develop and adopt a multiple-variable analytical tool to reveal more precise information about demographic trends, both domestically and internationally.
2. Initiate a data gathering process to capture potential changes in the income composition of the population and potential changes in the propensity to fly within population cohorts.
3. Develop indicators of the potential expansion of leisure air travel.
4. Consider preparing alternative future scenarios as a complementary approach to straightforward forecasting.
5. Consider reframing fundamental questions about air transportation, such as the purpose and function of airlines as providers of transportation services.
6. Assess the supply, access, and cost of energy under a number of different future scenarios to help aviation industry forecasters make realistic judgments about the parameters affecting air travel.
7. Assess the impact of creating new international hubs within the United States.
8. Assess the impact of noise regulations under a number of different scenarios -- ranging from a proliferation of ad hoc standards to a uniform national standard.
9. Assess the impact of imposing various types of user charges to help pay for the capital and operating costs of airports and air traffic control facilities.
10. Examine the viability of new transportation technologies and how their introduction might affect the nation's air transport system.
11. Consider means by which the transportation system could be integrated intermodally.

12. Determine the units of measure that would be most useful in tracking and forecasting growth in the express package and cargo shipping industry.

NOTES

1. The classic definition of a recession is employed here, namely at least two quarters of declining growth.

2. Since its Chapter 11 filing in the early 1980s, Continental has been, until recently, the only carrier consistently willing to keep fares down by means of deep discounts.

3. Cabotage refers to the right of a foreign airline to carry domestic passengers to and from destinations within another country. Currently most bilateral air transport agreements deny this privilege to foreign carriers.

4. While this sounds high, it is comparable to the cost of building a super highway.

5. The guideways, which entail the highest capital cost, would also affect the environment in terms of visibility.

6. A revenue passenger mile is one revenue (fare-paying) passenger transported 1 mile in revenue service.

7. The 10 carriers were Airborne, Burlington Air Express, C F Air Freight, DHL, Emery, Evergreen, Federal Express, Flying Tiger, Southern Air Transport, and UPS. As of 1990, this group has shrunk to eight with Emery's acquisition of C F Air Freight and Federal Express' purchase of Flying Tiger. This group represented about 90-95 percent of the U.S. all-cargo industry.

APPENDIX A
DEMOGRAPHIC FORECASTING MODELS
Richard Golaszewski, Gellman Research Associates

KEY FEATURES OF PROPOSED APPROACH:

- Demographically adjusted forecasts obtained by multiplying FAA forecasts of enplanements by demographic index.
- Accounts for economic factors already considered in FAA model.
- Requires following information:
  - Current (1988) propensities to fly by demographic cohorts.
  - Current cohort populations.
  - Forecasts of cohort populations.
- Approach amenable to sensitivity analyses.
- Can be implemented on spreadsheet software.

NOTATION

Subscripts:

t refers to current year
t' refers to future year
i indexes cohort groups
a refers to demographically-adjusted forecast

Variables: (variables generated from ATA survey in lower case)

ENP = Total enplanements
ei = Propensity to fly for ith cohort
ni = ith cohort population

MODEL I: CONSTANT PROPENSITIES TO FLY

$$ENP_{at'} = DI_{t'} \cdot ENP_{t'}$$

Where

$$DI_{t'} = \left[\frac{\sum_i n_{it'} \cdot e_{it}}{\sum_i n_{it'}}\right] \div \left[\frac{\sum_i n_{it} \cdot e_{it}}{\sum_i n_{it}}\right]$$

NOTE: Model I is based on the assumption that sizes of cohorts change but propensities to fly within cohorts do not.

MODEL II: CHANGING PROPENSITIES TO FLY

$$ENP_{at'} = ADI_{t'} \cdot ENP_{t'}$$

Where

$$ADI_{t'} = \left[\frac{\sum_i n_{it'} \cdot \hat{c}_{it'}}{\sum_i n_{it'}}\right] \div \left[\frac{\sum_i n_{it} \cdot c_{it}}{\sum_i n_{it}}\right]$$

NOTE: Model II is based on the assumption that both sizes of cohorts and propensities to fly change.

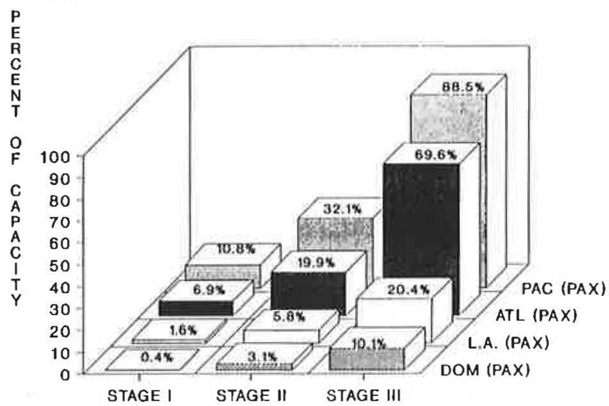
FINDINGS

- Adjusting for population composition--gender, region and age--to the year 2010 produces modest changes in FAA's enplanement forecast: 1.55 percent.
- Two critical variables could not be accommodated in the current effort:
  - Potential changes in the income composition of the population, and
  - Potential changes in the propensity to fly within population cohorts.
- For example, a ten-percent increase in per capita trips in the year 2010 in all cohorts (gender, region and age) would increase enplanements by 11.7 percent over the FAA forecast.

APPENDIX B
CRAF IMPACTS ON COMMERCIAL AVIATION
Gene S. Mercer, Federal Aviation Administration

CRAF impacts are discussed in terms of available seat miles (ASMs) for passenger aircraft and available ton miles (ATMs) for cargo carriers for calendar year 1989. These measures are among the most reliable indicators of air carrier capacity. To determine the impacts, the average daily utilization of the aircraft by type were examined. In 1989, the Majors, Nationals, and other U.S. carriers flew a total of 537.1 billion available seat miles in domestic service and 166.7 billion available seat miles in international service. Systemwide, these airlines flew 703.8 billion ASMs.

A summary of CRAF impacts on U.S. civil aviation passenger capacity, expressed as percentages of total capacity, is shown in Figure B-1. Detailed examination of the stage-by-stage effects is presented in the following sections.



Key: PAC = Pacific Passengers (PAX)
ATL = Atlantic passengers
L.A. = Latin America passengers
DOM = Domestic passengers

FIGURE B-1 Impact of CRAF on U.S. Civil Aviation Passenger Capacity

STAGE I CRAF IMPACTS

Passenger Service

If Stage I of the CRAF program had been in effect for the entire calendar year, the 18 passenger aircraft involved would have represented 13.9 billion ASMs, only 2.0 percent of system capacity. Carriers serving the Pacific and Atlantic markets would have been affected the most; on average, 10.8 percent and 6.9 percent of ASMs would have been withdrawn from the civilian market every day the program remained in effect. Carriers withdrawing more than 10 percent of the international ASMs would have included Continental (13.5 percent) and Tower (33.3) in the North Atlantic, and American (50.0 percent), Continental (10.6 percent) and United Airlines (13.7 percent) in the Pacific. These figures represent maximum effects of Stage I implementation for an entire 12-month period. On a daily or weekly basis, impact would vary according to length and timing of the activation period, ie., peak or off-peak periods of the week or month. (see Tables B-1 and B-2.)

TABLE B-1 STAGE 1 CRAF IMPACT: DOMESTIC PASSENGER AIRCRAFT

Carriers	CY 1989 ASM's (MIL)	No. AC*	% of Fleet (%)	ASM Loss (mil)	% of ASM's (%)
American	98,685	0.6	0.1	370	0.4
America West	13,725	-	-	-	-
Continental	47,953	0.7	0.2	409	0.9
Delta	82,516	-	-	-	-
Eastern	15,528	-	-	-	-
Northwest	15,502	0.3	0.1	196	0.5
Pam Am	11,702	0.5	0.3	371	3.2
Southwest	14,884	-	-	-	-
TWA	35,435	-	-	-	-
United	82,840	0.5	0.1	368	0.4
USAIR	29,004	-	-	-	-
MAJORS	476,774	2.6		1,714	0.4
Air Wisconsin	930	-	-	-	-
Alaska	7,324	-	-	-	-
Horizon	607	-	-	-	-
Aloha	847	-	-	-	-
America Trans Air	2,328	0.5	2.8	171	7.4
Hawaiian	3,624	-	-	-	-
Markair	339	-	-	-	-
Midway	6,158	-	-	-	-
Trump Shuttle	373	-	-	-	-
West Air	854	-	-	-	-
NATIONALS	23,384	0.5		171	0.7
Other Domestic	36,916	-	-	-	-
DOMESTIC PASSENGER	537.074	3.1		1,885	0.4

* Aircraft committed computed on average daily utilization by equipment type, with fleets being used in both domestic and international schedules. For example, Continental in Stage I has two B747 committed--0.7 units in domestic service, 0.5 units in Atlantic service, and 0.8 units in Pacific service.

Cargo Service

Assuming CRAF activation for CY 1989, 14 air carriers with over 13.4 billion available ton miles would have

committed 22 cargo aircraft, diverting nearly 1 billion available ton miles, or 7.1 percent of cargo capacity. The data do not distinguish between domestic and international portions of all-cargo service. However, it is anticipated that the effects would have been felt most severely in the international service from which the long-range cargo aircraft would have been withdrawn. Since additional cargo can be carried in the belly of passenger aircraft, potential CRAF impacts might be mitigated through diversion of some cargo. (See Table B-3.)

STAGE II CRAF IMPACTS

Passenger Service

A total of 94 passenger aircraft would have been committed to the CRAF program under Stage II, resulting in the withdrawal of 52.6 billion ASMs, or 7.5 percent of the total system capacity. The impacts would be felt most dramatically in the Pacific market where 32.1 percent of the capacity would be withdrawn. American Airlines, would have lost 100 percent of its service and United Airlines would have lost 44.8 percent. In the Atlantic market where nearly 20 percent of the ASMs would have been withdrawn, the impacts would have been more evenly distributed among all carriers, ranging from 15.6 percent of the Atlantic capacity for American to 33.3 percent for Tower. Only Delta and USAir would not have been affected. (Tables B-4 and B-5)

Cargo Service

Under Stage II, 93 cargo aircraft would have been committed, diverting nearly 2.2 billion ATMs from civilian service, or nearly 16.2 percent of the total ATMs. Southern Air (100 percent), Air Transport International (40 percent), and Evergreen (35.4 percent) would have been the most severely affected cargo carriers. (TABLE B-6)

STAGE III CRAF IMPACT

Passenger Service

If Stage III of the CRAF program were implemented it would reduce passenger capacity by 23.5 percent (based on calendar year 1989 reported ASMs).

Under Stage III, each of several carriers would lose 10.0 percent or more of their domestic capacity,

TABLE B-2 STAGE I CRAF IMPACT: INTERNATIONAL PASSENGER AIRCRAFT

Carriers	CY 1989 ASM's (MIL)	No. AC	% of Fleet (%)	ASM Loss (MIL)	% of ASM's (%)
American	10,017	0.4	0.1	263	2.6
Continental	4,248	0.5	0.1	573	13.5
Delta	6,681	-	-	-	-
Northwest	5,122	0.3	0.1	168	3.3
Pan AM	26,291	2.0	1.3	1,605	6.1
Tower	2,110	1.0	25.0	703	33.3
TWA	21,996	2.0	1.0	1,986	9.0
USAIR	612	-	-	-	-
ATLANTIC	77,077	6.2		5,298	6.9
American	5,609	-	-	-	-
Continental	3,199	-	-	-	-
Delta	2,713	-	-	-	-
Eastern	3,635	-	-	-	-
Pam Am	8,620	0.5	0.3	376	4.4
USAir	258	-		-	-
L. AMERICA	24,034	0.5		376	1.6
American	912	1.0	0.2	486	50.0
Continental	8,353	0.8	0.3	881	10.6
Delta	1,744	-	-	-	
Hawaiian	1,610	-	-	-	
Northwest	21,443	2.4	0.7	1,755	8.2
United	21,708	3.5	0.8	2,978	13.7
PACIFIC	55,780	7.7		6,070	10.8
OTHER INT'L.	9,844	0.5		229	2.3
INT'L. PASSENGER	166,735	14.9		11,973	7.2
TOTAL PASSENGER	703,809	18.0		13,858	2.0

TABLE B-3 STAGE I CRAF IMPACT: CARGO AIRCRAFT

Carriers	CY 1989 ATM's (000)	No. AC	% of Fleet (%)	ATM Loss (000)	% of ATM's (%)
Air Trans. Int'l.	93,460	1.0	20.0	18,692	20.0
Connie Kalitta	317,456	1.0	7.1	22,675	7.1
Emery/Rosenbal	1,218,275	4.0	9.5	115,736	9.5
Evergreen	840,405	2.0	6.5	81,519	9.7
Express One	49,636	-	-	-	-
Federal Express	7,438,246	8.0	4.6	498,362	6.7
Northern Air	41,586	-	-	-	-
Northwest		2.0	0.6	-	-
Southern Air	504,154	1.0	16.7	84,193	16.7
Sun Country	136,166	-	-	-	-
Trans Cont'l.	147,351	-	-	-	-
United Parcel	2,474,949	2.0	1.9	123,747	5.0
World		1.0	20.0	-	-
Zantop	103,420	-	-		-
ALL CARGO CARRIERS	13,365,104	22.0		949,924	7.1
TOTAL - ALL SERVICES		40.0	1.0		

including Continental, Northwest, Pan Am, TWA, and United among the Majors and America Trans Air and Hawaiian among the Nationals. (Table 7) Conversely, three Majors (America West, Southwest and USAir) would not be affected in their domestic market at all, while Delta would lose only 0.2 percent of its domestic capacity. Given the competitive environment in which carriers operate, it is quite likely that airlines least affected by the activation of Stage III would move aggressively into the most lucrative, but now underserved markets, making it difficult for the previous carriers to recapture these markets. Under these conditions, implementation of CRAF Stage III could have a permanent effect on market share distribution.

TABLE B-4 STAGE II CRAFT IMPACT: DOMESTIC PASSENGER AIRCRAFT

Carriers	CY 1989 ASM'S (MIL)	No. AC	% of Fleet (%)	ASM Loss (MIL)	% of ASM's (%)
American	98,685	15.4	3.0	4,401	4.5
America West	13,725	-	-	-	-
Continental	47,953	2.1	0.7	982	2.1
Delta	82,516	-	-	-	-
Eastern	15,528	-	-	-	-
Northwest	44,502	4.3	1.3	2,017	4.5
Pan Am	11,702	1.7	1.1	1,260	10.8
Southwest	14,884	-	-	-	-
TWA	35,435	6.0	2.9	3,120	8.8
United	82,840	8.0	1.9	4,296	5.2
USAir	29,004	-	-	-	-
MAJORS	476,774	37.5		16,076	3.4
Air Wisconsin	930	-	-	-	-
Alaska	7,324	-	-	-	-
Horizon	607	-	-	-	-
Aloha	847	-	-	-	-
America Trs Air	2,328	3.9	21.7	754	32.4
Hawaiian	3,624	-	-	-	-
Markair	339	-	-	-	-
Midway	6,158	-	-	-	-
Trump Shuttle	373	-	-	-	-
West Air	854	-	-	-	-
NATIONALS	23,384	3.9		754	3.2
Other Domestic	36,916	-	-	-	-
DOMESTIC PASSENGER	537,074	41.4		16,830	3.1

TABLE B-5 STAGE II CRAF IMPACT: INTERNATIONAL PASSENGER AIRCRAFT

Carriers	CY 1989 ATM's (000)	No. AC	% of Fleet (%)	ATM Loss (000)	% of ATM's (%)
American	10,017	2.6	0.5	1,559	15.6
Continental	4,248	1.7	0.5	1,383	32.6
Delta	6,681	-	-	-	-
Nortwwest	5,122	2.3	0.7	1,182	23.1
Pan Am	26,291	6.7	4.2	5,378	20.5
Tower	2,110	1.0	25.0	703	33.3
TWA	21,996	6.0	2.9	5,103	23.2
USAir	612	-	-	-	-
ATLANTIC	77,077	20.3	-	15,308	19.9
American	5,609	1.0	0.2	197	3.5
Continental	3,199	-	-	-	-
Delta	2,713	-	-	-	-
Eastern	3,635	-	-	-	-
Pan Am	8,620	1.6	1.0	1,202	13.9
USAir	258				
L. AMERICA	24,034	2.6		1,399	5.8
American	912	2.0	0.4	912	100.0
Continental	8,353	2.2	0.7	1,831	21.9
Delta	1,744	-	-	-	-
Hawaiian	1,610	-	-	-	-
Northwest	21,443	7.4	2.3	5,410	25.2
United	21,708	13.0	3.0	9,731	44.8
PACIFIC	55,780	24.6		17,884	32.1
Other Intl.	9,844	5.1		1,148	11.6
INT'L. PASSENGER	166,735	52.6		35,739	21.4
TOTAL PASSENGER	703,809	94.0		52,564	7.5

The international passenger market would lose 66.7 percent of its capacity, while the domestic market would lose 10.1 percent. As Table B-8 shows, 88.5 percent of the Pacific market and 69.6 percent of the Atlantic service would be eliminated. All carriers serving these two international markets would be severely affected. In the Latin America market, 20.4 percent of the market would be lost. Pan Am would lose 52.3 percent of its long-range capacity. The loss of capacity by the U.S. international carriers would create opportunities for foreign carriers to increase their market shares temporarily and, perhaps, penetrate new markets not previously served by the individual foreign carrier.

Cargo Service

Under Stage III, 41.6 percent of cargo capacity would be lost (based on calendar year 1989 ATMs).[1] Several carriers (Air Transport International, Connie Kalitta, Emery/Rosenbalm, Evergreen, Southern, and Trans

Continental) would each lose over 50 percent of their all-cargo capacity. It is doubtful that any significant portion of the cargo capacity lost by all-cargo carriers could be diverted to passenger aircraft because, under Stage III, all long-range widebody aircraft would be committed to CRAF. This would virtually eliminate all U.S. international cargo lift capability. Given these conditions, U.S. cargo carriers would likely lose market shares to foreign carriers, particularly in international markets.

NEW AIRCRAFT DELIVERIES

International Service

The FAA forecasts (which incorporate manufacturer's planned delivery schedules) indicate that during 1990 air carriers are expected to accept deliveries of 28 long-range widebody aircraft for international service, adding as much as 16 billion ASMs to international capacity annually. Actual ASMs generated in 1990 would depend on the dates of delivery and the length of time the aircraft are in service. For the purpose of this analysis, the FAA assumed that 14 aircraft were delivered to date, thereby providing 50 percent of the potential new long-range capacity. Under this assumption, fully two-thirds of the long-range capacity withdrawn under Stage I would be replaced.

TABLE B-6 STAGE II CRAF IMPACT: CARGO AIRCRAFT

Carriers	CY 1989 ATM's (000)	No. AC	% of Fleet (%)	ATM Loss (000)	% of ATM's (%)
Air Trans. Int'l.	93,460	2.0	40.0	37,384	40.0
Connie Kalitta	317,456	2.0	14.3	45,396	14.3
Emery/Rosenbalm	1,218,275	7.0	16.7	203,451	16.7
Evergreen	840,405	11.0	35.4	297,503	35.4
Express One	49,636	2.0	18.2	9,033	18.2
Federal Express	7,438,246	14.0	8.1	1,041,354	14.0
Key		4.0	44.4	-	-
Northern Air	41,586	2.0	-	-	-
Northwest		3.0	0.9	-	-
Reeve		2.0	100.0	-	-
Southern Air	504,154	18.0	100.0	504,154	100.0
Sun Country	136,166	-	-	-	-
TPI Int'l.		6.0	-	-	-
Trans Cont'l.	147,351	-	-	-	-
United Parcel	2,474,949	4.0	3.9	24,749	10.0
World		3.0	60.0	-	-
Zantop	103,420	13.0	-	-	-
ALL CARGO CARRIERS	13,365,104	93.0		2,163,024	16.2
TOTAL - ALL PASSENGER AND CARGO SERVICES			187.0	4.5	

Under Stage II of the CRAF, however, the 50 percent capacity expected through new deliveries, would represent only 28.0 percent of the total international passenger ASMs withdrawn. Thus, the mitigating effect of these expected deliveries are not as great as in Stage I.

TABLE B-7 STAGE III CRAF IMPACT: DOMESTIC PASSENGER AIRCRAFT

Carriers	CY 1989 ATM's (MIL)	No. AC	% of Fleet (%)	ATM Loss (MIL)	% of ATM's (%)
American	98,685	33.6	6.6	8,727	8.9
America West	13,725	-	-	-	-
Continental	47,953	12.0	3.7	4,788	10.0
Delta	82,516	0.3	0.1	152	0.2
Eastern	15,528	7.0	4.1	1,263	8.1
Northwest	44,502	16.7	5.1	7,762	17.4
Pan Am	11,702	9.1	5.7	5,261	45.0
Southwest	14,884	-	-	-	-
TWA	35,435	23.8	11.3	8,663	24.5
United	82,840	28.3	6.6	13,043	15.7
USAir	29,004	-	-	-	-
MAJORS	476,774	130.8		49,659	10.4
Air Wisconsin	930	-	-	-	-
Alaska	7,324	-	-	-	-
Horizon	607	-	-	-	-
Aloha	847	-	-	-	-
America Trans Air	2,328	7.4	41.1	2,119	91.0
Hawaiian	3,624	4.3	18.7	2,371	64.8
Markair	339	-	-	-	-
Midway	6,158	-	-	-	-
Trump Shuttle	373	-	-	-	-
West Air	854	-	-	-	-
NATIONALS	23,384	11.7		4,470	19.1
Other Domestic	36,916	-	-	-	-
DOMESTIC PASSENGER	537,074	142.5		54,129	10.1

If Stage III were implemented, the 50 percent capacity expected from new deliveries represents only 7.2 percent of the capacity withdrawn. Even if all of the aircraft were in service, the 16 billion ASMs added would represent 14.4 percent of the total international ASMs withdrawn. Overall, the mitigating effects of additions to the international fleet are significant in Stage II and Stage III, but they are not overwhelming.

Of the 28 aircraft expected to be delivered in 1990, eight B747-400s and six MD-11s are generally earmarked for use in the Pacific Market. These aircraft could provide approximately ten billion ASMs annually in the Pacific. Under the same 50 percent assumption, new aircraft in service would mitigate the effects of Stage I since as much as 82 percent of the ASMs withdrawn would be replaced.

Under Stage II, 50 percent of the expected additional capacity in the Pacific would represent 27.9 percent of the capacity withdrawn. However, if all the aircraft were already delivered before Stage II is implemented, the new deliveries would represent 55.9 percent of the ASMs withdrawn.

Under Stage III, the additional aircraft would represent 10.1 percent of the ASMs withdrawn if 50 percent of the new aircraft earmarked for the Pacific are in service. New deliveries would be 20.2 percent of the ASMs withdrawn if 100 percent new aircraft earmarked for the Pacific are in service.

Domestic Service

The FAA forecasts indicate that during 1990 the domestic passenger air carriers are expected to accept deliveries of 222 aircraft. (Table B-10) Based on average daily utilization, these aircraft could add as much as 40.9 billion ASMs to domestic capacity annually. Actual ASMs in 1990 would depend on the dates of delivery and the length of time the aircraft are utilized. If 50 percent of these aircraft have already been delivered and are able to provide 50 percent of expected capacity, then the relatively small impact of Stage I CRAF discussed previously (119 billion domestic ASMs withdrawn) would be completely offset.

Under Stage II of the CRAF, 50 percent of the expected deliveries of domestic passenger aircraft would represent 122 percent of the capacity withdrawn, thereby completely nullifying the overall effect of the implementation of the CRAF program in the domestic passenger market.

If Stage III were implemented, the addition of 20.5 billion ASMs would represent only 37.9 percent of the capacity withdrawn (54.1 billion ASMs). If all the new domestic aircraft were in service before Stage III is implemented, 75.6 percent of the ASMs withdrawn would be restored. Thus, when the impacts of the delivery of new aircraft are considered, the overall effects of the implementation of the CRAF program on the domestic market are either eliminated completely (Stage I and Stage II) or they are mitigated considerably as in Stage III.

In summary, it appears that only in a Stage III CRAF environment would there be an actual cut in domestic capacity due to withdrawing a aircraft from civilian schedules. In all cases, however, planned schedule increments would be delayed or canceled. In all cases--Stage I, Stage II, and Stage III--international capacity would be reduced.

CRAF PROGRAM IMPACTS ON CIVIL AIR COMMERCE FLIGHT CREWS

CRAF requires carriers to commit four crew members per crew position for each aircraft committed to the program. Crews cannot be members of the National Guard or on reserve duty[2] and, due to security clearance requirements, must be U.S. citizens.

Table B-11 assumes three positions (pilots/co-pilots) per aircraft or 12 crew personnel per aircraft committed to the program. Where data were reported, pilots/co-pilots by airline as of December 31, 1989 have been included. Based on aircraft commitments for each of the three stages, carrier crew liability to the program has been computed. Note that crew liability exceeds current crew staff for some small carriers.

Prior to CRAF implementation, airlines were already facing pilot shortages, and this could very well be the limiting factor in maintaining commercial air service. Under Stage II of CRAF, over 5 percent of the current industry flight crew personnel would be committed to this program, a loss which would be aggravated by the call-up of reserves.

TABLE B-8 STAGE III CRAF IMPACT: INTERNATIONAL PASSENGER AIRCRAFT

Carriers	CY 1989 ATM's (MIL)	No. AC	% of Fleet (%)	ATM Loss (MIL)	% of ATM's (%)
American	10,017	4.4	0.9	2,633	26.3
Continental	4,248	5.0	1.5	4,248	100.0
Delta	6,681	2.5	0.6	1,521	22.8
Northwest	5,122	8.9	2.8	4,555	88.9
Pan Am	26,291	38.7	24.2	24,215	92.1
Tower	2,110	4.0	100.0	2,110	100.0
TWA	21,996	16.2	7.7	14,377	65.4
USAir	612	-	-	-	-
ATLANTIC	77,077	79.7		53,659	69.6
American	5,609	2.0	0.4	393	7.0
Continental	3,199	-	-	-	-
Delta	2,713	-	-	-	-
Eastern	3,635	-	-	-	-
Pan Am	8,620	7.2	4.5	4,510	52.3
USAir	258	-	-	-	-
L. AMERICA	24,034	9.2	-	4,903	20.4
American	912	2.0	0.4	912	100.0
Continental	8,353	9.0	2.8	7,115	85.2
Delta	1,744	1.2	0.3	624	35.8
Hawaiian	1,610	0.7	3.0	513	31.9
Northwest	21,443	26.4	8.2	19,374	90.4
United	21,708	32.7	7.6	20,838	96.0
PACIFIC	55,780	72.0		49,376	88.5
Other Int'l.	9,844	14.6		3,3O5	33.6
INT'L. PASSENGER	166,735	175.5		111,243	66.7
TOTAL PASSENGER	703,809	318.0		165,372	23.5

TABLE B-9 STAGE III CRAF Impact: Cargo Aircraft

Carriers	CY 1989 ATM's (000)	No. AC	% of Fleet (%)	ATM Loss (000)	% of ATM's (%)
Air Trans. Int'l.	93,460	4.0	80.0	74,768	80.0
Aloha		4.0	26.7	-	-
Connie Kalitta	317,456	8.0	57.1	181,267	57.1
Emery/Rosenbalm	1,218,275	22.0	52.4	638,376	52.4
Evergreen	840,405	17.0	54.8	460,541	54.8
Express One	49,636	2.0	18.2	9,033	18.2
Federal Express	7,438,246	40.0	23.3	2,982,736	40.1
Hawaiian		6.0	26.1	-	-
Key		4.0	44.4	-	-
Northern Air	41,586	2.0	-	-	-
Northwest		8.0	2.5	-	-
Reeve		2.0	100.0	-	-
Southern Air	504,154	21.0	100.0	504,154	100.0
Sun Country	136,166	1.0	16.7	44,934	33.0
TPI Int'l.		6.0	-	-	-
Trans Cont'l.	147,351	5.0	83.3	122,792	83.3
United		1.0	0.2	-	-
United Parcel	2,474,949	13.0	12.6	539,538	21.8
World		9.0	100.0	-	-
Zantop	103,420	13.0	-	-	-
ALL CARGO CARRIERS	13,365,104	188.0		5,558,139	41.6
TOTAL - ALL PASSENGERS AND CARGO SERVICES		506.0	12.6		

NOTES

1 Since much of the cargo data are incomplete or, in some cases, non-existent, only carriers with at least one aircraft committed to the CRAF have been included in Table B-9. Therefore, we have not estimated cargo capacity for all carriers. For these reasons, it is anticipated that the impact on the all-cargo carriers could be even more severe than that portrayed by the data in Table B-9.

2 About 10 percent of commercial flight deck crews are members of the reserves.

TABLE B-10 U.S. COMMERCIAL AIR CARRIER JET FLEET

	Fleet as of 12/31/89	Aircraft Committed to CRAF Stage I #	Stage I %	Stage II #	Stage II %	Stage III #	Stage III %	CY 1990 Forecast Deliveries
2 Engine NB								
B-737	754					4	0.5	82
B-757	151					4	2.7	50
DC .	520							
MD-60	398					3	0.8	56
A-320	6							18
BAC-111	26							
F-28	48							
F-100	8							16
Total	1,911					11	0.6	222
3 Engine WB								
B-727	1,185			31	2.6	34	2.9	
4 Engine NB								
B-707	29	1	3.5	1	3.5	4	13.8	
B-720	1							
DC-8	176	8	4.6	17	9.7	67	13.8	
BAE-146	51							
Total	257	9	3.5	18	7.0	71	27.6	
Total Narrowbody	3,353	9	0.3	49	1.5	116	3.5	222
2 Engine WB								
A-300	67							2
A-310	19					21	105.3	1
B-767	111					28	25.2	11
Total	197					49	24.9	14
3 Engine VB								
DC-10	183	5	2.7	32	17.5	97	53.0	
L-1011	100	1	1.0	10	10.0	33	33.0	
MD-11								6
Total	283	6	2.1	42	14.8	130	45.9	6
4 Engine WB								
B-747	184	25	13.6	56	30.4	171	92.9	8
Total Widebody	664	31	4.7	98	14.7	350	52.7	28
Total Jet Fleet	2,050	40	1.0	147	3.7	466	11.6	250
Non-Jet Aircraft				40		40		
Total CRAF Aircraft		40		187		506		

TABLE B-11 THE CRAF PROGRAM IMPACTS ON CIVIL AIR COMMERCE FLIGHT CREWS

Carrier/ Aircraft Type	Total Crew Personnel 12/89	Stage I Planes	Stage I Crew	Stage II Planes	Stage II Crew	Stage III Planes	Stage III Crew
Air Trans Int'l	*		12		24		48
DC 8-60		1		2		4	
American Trans Air	*		12		84		168
B727-100				4		4	
L1011-50		1		3		10	
Aloha	155						48
B737-200C						4	
American	6,089		24		232		504
B727-200				13		13	
B747-SP		1		2		2	
DC10-30		1		6		10	
B767-200						17	
Connie Kalitta	*		12		24		106
DC8-50				1		7	
DC-70		1		1		1	
Continental	3,856		24		72		312
MD-82						3	
B747-100/200/400		2		2		8	
DC10-10				1		7	
DC10-30				3		8	
Delta	*						48
L1011-500						4	
Eastern	849						84
B757-200						4	
B727-200						3	
Express One	*				24		24
B727-100C/F				2		2	
Evergreen	239		24		144		228
B727-100C/F				8		8	
B747-100/200/400				1		2	
DC8-60						1	
DC8-70		1		2		2	
B747-100F						2	
B747-100C						2	
B747-200C		1		1		2	
Emery/Rosenbalm	*		48		84		264
DC8-60						15	
DC8-70		4		7		7	
Federal Express	1,946		96		168		492
B747-100/200/400						1	
DC8-70		1		3		6	
B747-100F				2		8	
B747-200F		4		4		10	
DC10-30C/F		3		5		16	
Hawaiian	258						132
DC8						6	
L1011-50						5	

TABLE B-11 THE CRAF PROGRAM IMPACTS ON CIVIL AIR COMMERCE FLIGHT CREWS *(Continued)*

Carrier/ Aircraft Type	Total Crew Personnel 12/89	Stage I Planes	Stage I Crew	Stage II Planes	Stage II Crew	Stage III Planes	Stage III Crew
Key	85				48		48
B727-100				4		4	
Northern Air Cargo	50				24		24
CV640/DC6				2		2	
Northwest	4,761		60		204		720
B747-100/200/400		3		9		32	
DC10-30				5		20	
B747-200F		2		3		8	
Pan Am	1,350		36		120		660
B747-100/200/400		3		10		16	
A310-200/300						21	
B747-100C						14	
B747-200C						4	
Reeve Aleutian	21				24		24
L188C				2		2	
Southern Air Transport	195		12		216		216
L100				17		17	
B707-300C		1		1		4	
Sun Country	95						12
DC10-40						1	
Trans Continental	*						84
DC8						2	
DC8-50						5	
Trans World	2,091		24		144		480
B747-100/200/400		2		5		15	
L1011-50				3		4	
L1011-100				4		10	
B767-200						11	
Tower	51		12		12		48
B747-100/200/400		1		1		4	
TPI International	*				72		72
L188C				6		6	
United Airlines	4,352		48		252		744
DC8						4	
B747-SP				4		11	
B747-100/200/400		4		9		24	
DC10-10				5		18	
DC10-30				3		4	
DC10-10C/F						1	
United Parcel	825		24		48		156
DC8-70				1		7	
B747-100F		2		3		6	
World	185		12		48		144
DC10-10				1		3	
DC10-30C/F		1		3		9	
Zantop	166				156		156
L188C				12		12	
CV640/DC4				1		1	
TOTAL	43,732**	40	480	187	2,244	506	6,072

* Data not available
** Total number of industry pilots/co-pilots reported by air carriers as of 12/31/89