RESEARCH PAPER P-540

A SURVEY AND ASSESSMENT OF AIR TRAVEL FORECASTING

Janet D. Kiernan

April 1970

IDA
URBAN MASS TRANSPORTATION PROJECT

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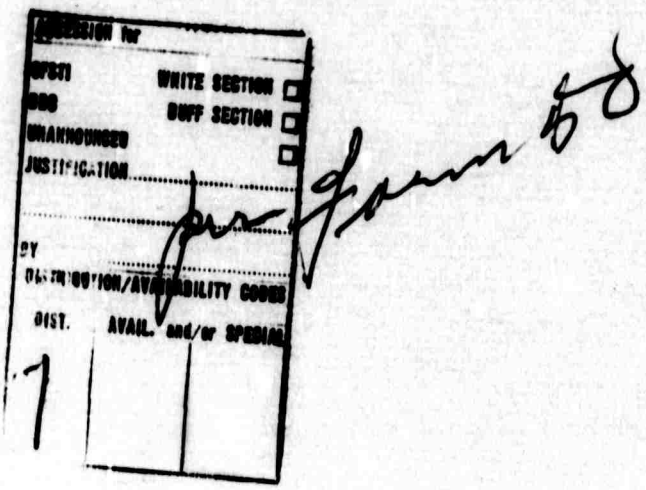

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URBAN MASS TRANSPORTATION PROJECT
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FOREWORD

IDA, under Contract to the Office of Research of the Urban Mass Transportation Administration (UMTA) of the U.S. Department of Transportation, is conducting studies of major activity center circulation transportation systems. One such study addresses intra-airport circulation transportation systems. This paper has been prepared in support of this study and is intended to provide background and information on future air travel demands and insight into the status and accuracy of air travel forecasting. The information and results presented in this paper have been used in IDA Study S-351 entitled, Intra-Airport Transportation Systems: An Examination of Technology and Evaluation Methodology, by Peter G. Freck et al., December 1969, and in IDA Research Paper P-604 entitled Evaluation of Intra-Airport Transportation Concepts for the Dallas-Fort Worth Regional Airport, by Lee Minichiello et al., to be published.

CONTENTS

I. INTRODUCTION

Each year the Federal Aviation Administration (FAA) issues six- to twelve-year annual forecasts of key indicators of aviation activity and of FAA workload for the purpose of meeting both the short-term and long-term planning needs of its various offices and services. Although these estimates are collected in one report to meet one agency's specific needs, they are the most widely referenced projection of future demand for air travel. Consequently, there is significant reliance on these estimates throughout the Government and the aviation comn unity.

This report analyzes, historically, the FAA forecasting effort; it also surveys as a basis of comparison the relevant parallel work of other agencies and organizations. The study analyzes the methodologies and accuracies of each of the various forecasts and compares them for consistency. The purpose of the study is to provide information on future air travel demand as well as some insights into the status and accuracy of air travel forecasting as it might pertain to requirements for airport and air terminal capacities.

II. SUMMARY OF FINDINGS

(1) Forecasting future demand for air travel is done by all major segments of the aviation community to meet a wide variety of planning needs. The notable examples are airlines' requirements for new equipment and personnel; aircraft manufacturers' requirements for anticipating aircraft orders; airport operators' requirements for airfield and terminal capacity expansion; and Civil Aeronautics Board and FAA requirements for route assignments, expansion of air traffic control (ATC) and National Airways System (NAS) facilities, and airport planning and implementation. As a result of this wide variety of requirements, a number of different methodologies, exhibiting varying degrees of sophistication, have been employed by the various organizations.

(2) Essentially, forecasting for all modes of travel is done on three levels: national, regional, and specific facility. For air travel, the generally available data, both historical and projected, are fairly comprehensive on the national level. Projections for regions and specific facilities (as generators of air travel demand), however, are available only as part of special or ad hoc studies and generally do not appear on a consistent basis for any one region or facility. The FAA does not publish regional forecast data but apparently utilizes results of regional analyses as one input to their forecast studies for the airport hubs, i.e., groups of airports associated with metropolitan areas. The hub studies specifically analyze aviation demand and facility requirements for each of the facilities comprising a hub but the published results are grouped in order to represent the needs for the hub as a whole. Consequently, data can be derived for only a few specific facilities, i.e., for some of the large airports. Moreover, publication of the hub studies did not begin until 1967 and this short time period is inadequate for an accuracy assessment of the hub forecasting data in lieu of that of specific facilities.

(3) Due to this unavailability of forecasting data for hubs and for specific facilities, detailed analysis for forecasting accuracy was necessarily limited to the more readily available national estimates of the FAA. These forecasts, updated annually over the 10-year period from 1957 to the present, were consistently accurate on the short-term basis but highly inaccurate for the long-term (5 to 10 years). Furthermore, the error has been that of under-estimation, which is increasing in a linear fashion for the longer term estimates.

(4) A comparison of future air travel projections from eight major forecasting studies showed very little consensus. The projections diverge over a wide range of expectations and in recent years all have proven to be too low when compared with the actual. Moreover, there does not seem to be any significantly better rationale for one methodology over another.

III. THE FAA FORECASTS

Travel forecasting, in general, can be categorized according to three levels: national, regional, and specific facility. The FAA has published annual national forecasts for air travel since the early 1950's, but only recently has it published studies for those airport groups encompassed by the "air traffic hubs."* Because there is insufficient published forecasting data to analyze the hub forecasts for accuracy (as well as an incomplete breakout of individual airports), this analysis will examine the national forecasts. However, it is significant that the FAA bases the hub estimates on the national estimates, i.e., the four hub sizes are determined by each community's percentage share of the national figures for total enplaned passengers (scheduled service of the fixed-wing operations of the domestic certificated route air carriers).** The FAA's expectation for continuation of these ratios in the future is explained in the current large hub forecast report (Ref. 1):

> Since a community's percentage share of the U.S. airline passenger market has proven relatively stable from year to year, and because passenger data are highly correlated with other measures of aeronautical activity such as aircraft operations, the hub structure serves as a valuable stratification method in forecasting local activity trends based on national data.... The forecast data indicate that only a slight

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* An air traffic hub is coextensive with the metropolitan area of a single city, or a Standard Metropolitan Statistical Area (SMSA) as defined by the U.S. Bureau of the Census. An SMSA is a community consisting of at least one city of 50,000 population, or twin cities with a combined population of at least 50,000 plus any contiguous counties that are metropolitan in character and have similar socioeconomic relationships.

** The hubs are classified as large (generating 1 percent or more of the total U.S. enplaned passengers), medium (0.25 to 0.99 percent of the total), small (0.05 to 0.24 percent), and nonhub (less than 0.05 percent).

increase in the percent of the respective U.S. totals will prevail for the Large Hubs in 1980.

The FAA projects a wide variety of aviation activity indicators covering passenger traffic, aircraft utilization and operations, and FAA workload with respect to the ATC and NAS activities. However, the basic planning statistic throughout the industry, and the most often used measure of growth, is the Revenue Passenger-Mile (RPM)—the measure of passengers carried in relation to distance traveled.* Passenger enplanements are also of great importance with respect to demand for airport facilities and services. Therefore, the scope of this analysis includes both the RPM and the passenger enplanement; it also includes both domestic and international segments of the total U.S. scheduled service of the certificated route air carriers.

A. HISTORICAL DATA

In assessing the accuracy of the FAA "official" estimates, it was necessary to survey a series of 15 annual forecast studies beginning with the first report published by the Civil Aeronautics Administration (CAA) of the U.S. Department of Commerce in April 1954. However, the data were reported by calendar year through 1956 and by fiscal year from 1958 to the present (no projections were published in 1957). For this reason, comparison of the forecast results with subsequent actual events will be limited to the 10-year period from fiscal year 1959 through the base year of the present forecast period (FY 1968). The basic format of the reports has remained substantially unchanged since the first report issued after the CAA became the FAA in 1958.

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* One revenue passenger transported one mile in revenue service. Revenue passenger-miles are computed by summation of the products of the revenue aircraft miles flown on each interairport hop multiplied by the number of revenue passengers carried on that hop.

Tables 1 and 2 present the actual data since 1955 for annual volumes and rates of growth of U.S. passenger enplanements and revenue passenger-miles, broken down by the domestic and international operations of the scheduled service of the U.S. certificated route air carriers. The FAA reports these data on a fiscal year basis while the literature of the aviation community reports predominantly on a calendar year basis. For comparison, Table 3 parallels the FAA data by calendar year data (domestic RPM only).

TABLE 1. VOLUME OF U.S. REVENUE PASSENGER ENPLANEMENTS (DOMESTIC AND INTERNATIONAL) AND PERCENTAGE CHANGE, FISCAL YEARS 1955-1968

Fiscal Year	Revenue Passenger Enplanements								
	TOTAL			DOMESTIC			INTERNATIONAL		
	Annual Volume (millions)	Annual Change (millions)	Rate (%)	Annual Volume (millions)	Annual Change (millions)	Rate (%)	Annual Volume (millions)	Annual Change (millions)	Rate (%)
1955	38.5	--	--	35.4	--	--	3.1	--	--
1956	43.7	5.2	13.5	40.0	4.6	13.0	3.7	0.6	19.4
1957	49.1	5.4	12.4	44.9	4.9	12.3	4.2	0.5	13.5
1958	53.2	4.1	8.4	48.7	3.8	8.5	4.5	0.3	7.1
1959	55.7	2.5	4.7	50.7	2.0	4.0	5.0	0.5	11.1
1960	62.2	6.5	11.7	56.6	5.9	11.6	5.6	0.6	12.0
1961	61.8	-0.4	-0.6	55.9	-0.7	-0.1	5.9	0.4	7.1
1962	66.6	4.8	7.8	59.9	4.0	7.2	6.7	0.8	1.6
1963	70.7	4.1	6.2	63.3	3.4	5.7	7.4	0.7	10.4
1964	83.0	2.3	3.3	71.4	11.1	17.5	8.6	1.2	16.2
1965	94.6	11.6	14.0	84.6	10.2	13.8	10.0	1.4	16.3
1966	113.9	19.3	20.4	102.2	17.6	20.8	11.7	1.7	17.0
1967	126.4	12.5	11.0	113.5	11.3	11.1	12.9	1.2	10.3
1968	152.6	26.2	20.7	137.5	24.0	21.1	15.1	2.2	17.0
	1963-1968 (5 yr) Total growth 116 1958-1968 (10 yr) Total growth 187			1963-1968 (5 yr) Total growth 117 1958-1968 (10 yr) Total growth 182			1963-1968 (5 yr) Total growth 104 1958-1968 (10 yr) Total growth 236		

TABLE 2. VOLUME OF U.S. REVENUE PASSENGER-MILES (DOMESTIC AND INTERNATIONAL) AND PERCENTAGE CHANGE, FISCAL YEARS 1955-1968

Fiscal Year	Revenue Passenger-Miles								
	TOTAL			DOMESTIC			INTERNATIONAL		
	Annual Volume (billions)	Annual Change (billions)	Rate (%)	Annual Volume (billions)	Annual Change (billions)	Rate (%)	Annual Volume (billions)	Annual Change (billions)	Rate (%)
1955	22.4	--	--	18.3	--	--	4.1	--	--
1956	25.8	3.4	15.2	21.1	2.8	15.3	4.7	0.6	14.6
1957	29.3	3.5	13.6	23.8	2.7	12.8	5.5	0.8	17.0
1958	31.5	2.2	7.5	25.5	1.7	7.1	6.0	0.5	9.1
1959	33.3	1.8	5.7	26.8	1.3	5.1	6.5	0.5	8.3
1960	38.1	4.8	14.4	30.4	3.6	13.4	7.7	1.2	18.5
1961	38.8	0.7	1.8	30.4	--	--	8.4	0.7	9.0
1962	42.5	3.7	9.5	33.0	2.6	8.6	9.5	1.1	13.1
1963	45.9	3.4	8.0	35.1	2.1	6.4	10.8	1.3	13.7
1964	54.2	8.3	18.0	41.3	6.2	17.7	12.9	2.1	19.4
1965	62.6	8.4	15.4	47.3	6.0	14.5	15.3	2.4	18.6
1966	76.4	13.8	22.0	57.9	10.6	22.4	18.5	3.2	20.9
1967	86.3	9.9	13.0	65.7	7.8	13.5	20.6	2.1	11.4
1968	106.5	20.2	23.4	81.6	15.9	19.5	24.9	4.3	20.9
	1963-1968 (5 yr) Total growth: 132%			1963-1968 (5 yr) Total growth: 133%			1963-1968 (5 yr) Total growth: 131%		
	1958-1968 (10 yr) Total growth: 238%			1958-1968 (10 yr) Total growth: 220%			1958-1968 (10 yr) Total growth: 315%		

TABLE 3. U.S. DOMESTIC REVENUE PASSENGER-MILES AND ANNUAL CHANGE, CALENDAR YEARS 1946-1968

Calendar Year	RPM (billions)	Annual Growth		Five-Year Ave. Annual Growth Rate (%)	Five Year Growth (%)
		RPM (billions)	Rate (%)		
1946	5.9	--	--		
1947	6.1	0.2	3.4		
1948	6.0	-0.1	-1.6		
1949	6.8	0.8	13.3		
1950	8.0	1.2	17.6		
1951	10.6	2.6	32.5	20.0	146.7
1952	12.5	1.9	17.9		
1953	14.8	2.3	18.4		
1954	16.8	2.0	13.5		
1955	19.8	3.0	18.1		
1956	22.4	2.6	13.1	11.6	70.3
1957	25.2	2.8	13.5		
1958	25.2	0.0	0.0		
1959	29.1	3.9	15.5		
1960	30.3	1.2	4.1		
1961	30.8	0.5	1.7	8.9	52.0
1962	33.4	2.6	8.4		
1963	38.3	4.9	14.7		
1964	43.9	5.6	14.6		
1965	51.6	7.7	17.5		
1966	60.3	8.7	16.9	17.7	125.8
1967	75.1	14.8	24.5		
1968	86.5	11.4	15.2		

Inspection of these sets of data shows marked decrease in annual growth as a result of economic growth recessions in 1958 and 1961. One explanation for this phenomenon is offered by Lippke and Stewart in a recent paper on econometric modeling techniques applied to air traffic forecasts (Ref. 2). In referring to an otherwise good fit of a short-term model in terms of quarterly cyclical behavior (using RPM) they note the following:

> The only two short periods of significantly poor cyclical behavior occur at 1959.1 and 1962.2. In 1959.1 the economy was in the very unusual position of an overly fast recovery to the 1958 recession with the government slamming on the brakes with a tight money policy at the same time that back orders and manufacturing hiring were at extreme peaks, thus, quite possibly explaining higher traffic than the model would detect. In 1962.2 the government's strong stand on steel prices produced a unique psychological setback to business as reflected in the stock market. This, together with the nation's shock at the potential threat of World War III by the Kennedy-Khruschev Cuban confrontation may possibly explain some residual loss of domestic travel and the resulting poor fit for several quarters.

In a 1966 analysis of forecasting accuracy for world air transportation, the International Air Transport Association (IATA) made the following observation with regard to historical growth (also using RPM) of U.S. domestic traffic (Ref. 3):

> It should be noted that the growth in U.S. domestic traffic since the end of the Second World War has been very uneven, which does not make the job of the forecaster any easier. An analysis of annual growth shows that a figure of 15% or more was recorded eight times:
>
> | | | | |
> |---|---|---|---|
> | 1949-1950 | + 19 | 1954-1955 | + 18 |
> | 1950-1951 | + 31 | 1958-1959 | + 16 |
> | 1951-1952 | + 19 | 1963-1964 | + 15 |
> | 1952-1953 | + 18 | 1964-1965 | + 18 |
>
> In 1948, on the other hand, traffic declined by 2%; in 1957 it remained stationary and four times growth was under 10%:
>
> | | | | |
> |---|---|---|---|
> | 1946-1947 | + 3 | 1960-1961 | + 1 |
> | 1959-1960 | + 4 | 1961-1962 | + 8 |
>
> It should be stressed that from 1959 to 1962, U.S. domestic traffic rose by only 14.5%, while it rose by over 50% from 1962 to 1965 (54.5%). In terms of passenger-km the 1959 to 1962 increase was under 7,000 million passenger-km, whereas from 1962 to 1965 it came to nearly 30,000 million passenger-km (29,462 million passenger-km), or more than total traffic in 1954 (27,040 million passenger-km).

Examination of the data in Tables 1 and 2, taking into account the past three years, shows that total domestic passenger enplanements in the five-year period since 1963 have more than doubled, increasing 117 percent from 63.3 million in 1963 to 137.5 million in 1968. Domestic RPM's have shown even greater growth, increasing from 133 percent in the same period from 35.1 billion in 1963 to 81.6 billion in 1968. These data also show that for the past 10 years, domestic enplanements have almost tripled (182 percent) and RPM's have more than tripled (220 percent). The current FAA forecast report expects domestic enplanements to more than triple again (213 percent) by 1980. For the same 12-year period, domestic RPM's also are expected to more than triple (253 percent).

B. PROJECTED DATA

The early published FAA forecasts presented only long-term estimates and, in some cases, a range of values for each estimate. However, since the initiation of fiscal year reporting in 1958, the FAA projections have been presented uniformly. (See Tables 4 and 5.) After 1958, each series contains estimates for six consecutive years; some of the more recent series have included an additional longer range estimate. Appendix A is a compilation of the FAA forecast data for total U.S. domestic and international passenger traffic beginning with the first 6-year forecast in 1958. Table 4 presents these data (including earlier estimates from 1954) for the domestic enplanement forecast series; Table 5 shows similar data for RPM's. For purposes of comparison, the historical data and rates of annual change are also shown. Figure 1 plots the RPM data graphically in order to show (1) the consistency of the various forecasts with past trends and (2) realization of the forecasted trends. A cursory inspection of these data shows consistent upward revision for each new forecast period beginning in 1964. That is, the 1963 forecast for 1964 of 38.2 billion RPM's fell 3.2 billion short of the actual figure. Consequently, each year of the entire new forecast series for 1965 was increased as were the years for each subsequent series. However, the effect of this compensation still is not reliable for the long-term results, e.g., compare the following with the 1968 actual data: the 4th year estimate in 1964, the 3rd year estimate in 1965, and the 2nd year estimate in 1966.

TABLE 4. FAA AIR TRAFFIC FORECASTS SINCE 1953 COMPARED WITH ACTUAL DATA–

Revenue Passenger Enplanements by Calendar Year

Base	Actual Volume (millions)	Change From Previous Year, %	FORECASTS (millions) 1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	19
1953	28.7	--		50.0										
1954	32.3	12.5		55.0					68.0 70.0 72.0					
1955	38.0	17.4												
1956	41.9	10.0		60.0 66.0 72.0					80.0 93.0 106.0					10 11 13

Revenue Passenger Enplanements by Fiscal Year

Base Year	Actual Volume (millions)	Change From Previous Year, %	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	19
1958	48.7	--	53.1	59.0	65.0	70.0	75.0	80.0						
1959	50.7	4.1		56.6	61.0	65.5	70.0	74.5	79.0					
1960	56.6	11.6			58.9	64.3	68.5	72.7	76.9	81.0				
1961	55.9	-1.2				58.0	62.5	66.7	71.0	74.0	75.0			
1962	59.9	7.2					63.2	66.2	69.5	73.0	76.0	79.0		85
1963	63.3	5.7						68.0	70.0	73.0	76.0	79.0	82.0	85
1964	74.4	17.5							82.5	87.5	92.0	97.0	102.0	107
1965	84.6	13.7								96.1	104.9	112.9	121.5	130
1966	102.2	20.8									114.8	127.4	138.0	150
1967	113.5	11.1										137.3	151.6	167
1968	137.5	21.1											151.5	164
ACTUAL			50.7	56.6	55.9	59.9	63.3	74.4	84.6	102.2	113.5	137.5		

•Scheduled service of the U.S. certificated route air carriers.

D WITH ACTUAL DATA—MILLIONS OF DOMESTIC REVENUE PASSENGER ENPLANEMENTS*

STS (millions)													
1967	1968	1969	1970	1971	1972	1973	1974	1975	—	1977	—	1979	1980
			100.0 118.0 136.0										

1967	1968	1969	1970	1971	1972	1973	1974	1975	—	1977	—	1979	1980
75.0													
76.0	79.0		85.0					99.2					
76.0	79.0	82.0	85.0					100.0					
92.0	97.0	102.0	107.0										
104.9	112.9	121.5	130.9	140.9									
114.8	127.4	138.0	150.8	167.0	185.5	207.0				317.5			
	137.3	151.6	167.7	184.0	203.0	222.5	244.5					400.0	
		151.5	164.7	181.3	200.0	219.0	241.5	265.0				384.0	420.0
113.5	137.5												

B

TABLE 5. FAA AIR TRAFFIC FORECASTS SINCE 1953 COMPARED WITH ACTUAL D

Revenue Passenger Miles by Calendar Year

Base Year	Actual Volume (billions)	Change From Previous Year, %	FORECASTS (Billio 1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1953	14.8	--		23.8											
1954	16.8	14.0		29.0					35.5 37.0 38.5						
1955	18.3	9.9													
1956	21.1	15.3		32.0 35.0 38.0					42.0 49.0 56.0					52.0 60.0 68.0	

Revenue Passenger Miles by Fiscal Year

Base Year	Actual Volume (billions)	Change From Previous Year, %	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1958	25.5	--	28.2	31.4	34.7	38.0	41.0	44.0							
1959	26.8	5.0		30.1	32.7	35.4	38.1	40.8	43.5						
1960	30.4	13.4			32.0	35.4	38.1	40.8	43.5	46.2					
1961	30.4	--				32.0	35.0	38.0	41.5	44.0	45.0				
1962	33.0	8.5					35.3	37.6	40.0	42.5	45.0	47.0		51.0	
1963	35.1	6.3						38.2	40.0	42.5	45.0	47.0	49.0	51.0	
1964	41.3	17.6							46.0	49.0	52.0	55.0	58.0	61.0	
1965	47.3	14.5								54.2	59.6	64.6	70.0	75.9	82.3
1966	57.9	22.4									66.1	74.0	81.0	89.4	100.0
1967	65.7	13.5										80.2	89.5	100.0	110.0
1968	81.6	19.5											91.2	100.5	111.8
		ACTUAL	26.8	30.4	30.4	33.0	35.1	41.3	47.3	57.9	65.7	81.6			

*Scheduled service of the U.S. certificated route air carriers.

E 1953 COMPARED WITH ACTUAL DATA ON REVENUE PASSENGER MILES*

	FORECASTS (Billions)													
35	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	—	1977	—	1979	1980
5 0 5															
0 0 0					52.0 60.0 68.0										

5	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	—	1977	—	1979	1980
5															
5	46.2														
5	44.0	45.0													
)	42.5	45.0	47.0		51.0					61.0					
)	42.5	45.0	47.0	49.0	51.0					61.0					
)	49.0	52.0	55.0	58.0	61.0										
	54.2	59.6	64.6	70.0	75.9	82.3									
		66.1	74.0	81.0	89.4	100.0	112.0	126.0				200.0			
			80.2	89.5	100.0	110.0	123.0	136.0	151.0					258.0	
				91.2	100.5	111.8	125.0	139.0	155.0	170.0				260.0	288.0
	57.9	65.7	81.6												

B

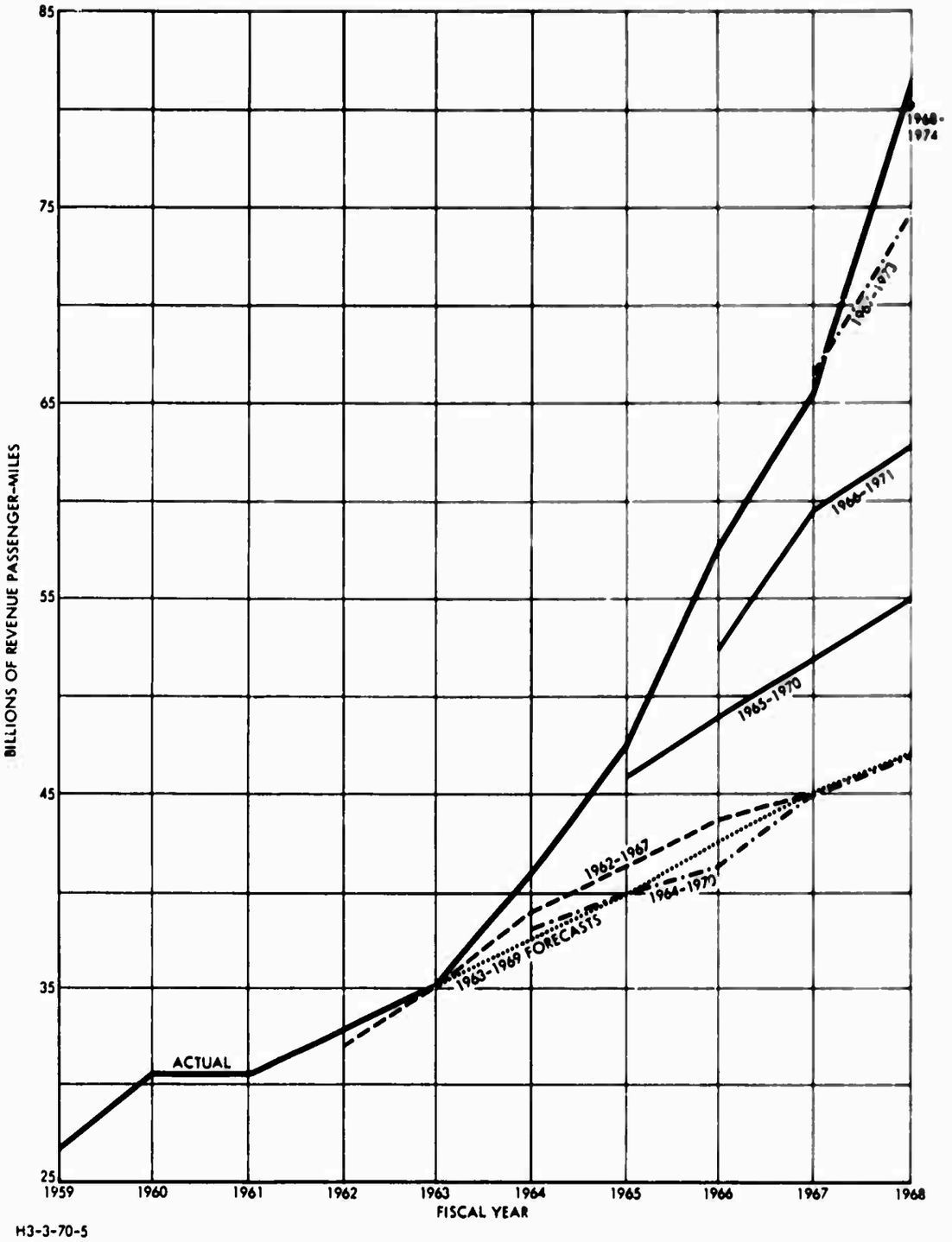


FIGURE 1. FAA Six-Year Forecasts and Actual, Since 1961--Billions of Domestic Revenue Passenger-Miles

Examination of FAA forecasting data over the past few years shows the methodology to be one of heavy reliance on past trends, i.e., essentially a straight-line extrapolation (Tables 4 and 5, and Fig. 1) of growth rates based on statistical analyses of a few economic variables relating to GNP and the air transport industry. As can be seen in Tables 4 and 5 and in Fig. 1, the projections in the early 1960's completely failed to anticipate the tremendous growth in air traffic that lay just ahead: by 1968, the airlines had carried 59 million or 74 percent more passengers than were projected in 1962.

Using the series of past forecast data for enplanements and RPM's (Tables 4 and 5), the percentage deviation of the FAA forecasted values from the actual values was calculated (Tables 6 and 7). The percentage errors for both series range from an average 1 percent, for first year projections, to approximately 19 percent for sixth year projections. The corresponding standard deviations are approximately 4 and 20 percent, respectively. One should note in these tables that the nth year estimated errors are increasing in all cases for the first year estimates out.

Figures 2 and 3 graphically illustrate the degree and trend of underestimation reflected in these percentage error data. Figure 2 points up the long-term underestimation beginning even during the earlier 1958-1960 period of consistent overestimation (baseline equal to 0 percent error). By 1961, all the projections fell short of the actual growth. Figure 3 shows that the mean annual error increases in a linear fashion as a function of the year from the projection base year. Further, the standard deviation of the error about the mean increases as a function of the year from the projection base year.

As indicated by the preceding analysis, the trend of the forecasting error in the FAA case indicates a pattern of rather pronounced long-term underestimation which is increasing in spite of yearly upward revision. The results of an extrapolation of this rate of error, over 12 years hence to 1980, are presented in Table 8. For example, using the average error of 19 percent for 6th year estimates (Table 7) an increase of 57 million enplanements, or approximately 23 percent over the

TABLE 6. PERCENTAGE ERROR (ANNUALLY) FOR EACH OF THE SIX-YEAR FAA DOMESTIC REVENUE PASSENGER-MILE FORECASTS, FISCAL YEARS 1958-1968

Forecast Base Year**	Estimates Percentage Error*					
	1st year	2nd year	3rd year	4th year	5th year	6th year
FY 1958	-5.2	- 3.9	-14.1	-15.2	-16.9	- 6.5
FY 1959	1.0	- 7.6	- 7.3	- 8.5	1.2	8.0
FY 1960	-5.3	- 7.3	- 8.6	1.2	8.0	20.2
FY 1961	3.0	0.3	8.0	12.3	24.0	31.5
FY 1962	-0.6	9.2	15.4	26.6	31.5	42.4
FY 1963	7.5	15.4	26.6	31.5	42.4	--
FY 1964	1.3	15.4	20.9	32.6	--	--
FY 1965	6.4	9.3	20.8	--	--	--
FY 1966	0.6	9.3	--	--	--	--
FY 1967	1.7	--	--	--	--	--
FY 1968	--	--	--	--	--	--
Mean	1.0	4.5	7.7	11.5	15.0	19.1
Standard Deviation	4.2	9.2	15.7	19.5	21.7	19.2

*Percent Error = [(RPM Actual-RPM Forecast) ÷ RPM Actual] X 100.

**Base Year = year prior to forecast period for which current actual data were available.

Note: Minus values represent "overestimation."
Blanks occur for years subsequent to 1968, the last year for which actual data were available.

TABLE 7. PERCENTAGE ERROR (ANNUALLY) FOR EACH OF THE SIX-YEAR FAA DOMESTIC REVENUE PASSENGER ENPLANEMENT FORECASTS, FOR FISCAL YEARS 1958-1968

Forecast Base Year**	Forecasts Percentage Error*					
	1st year	2nd year	3rd year	4th year	5th year	6th year
FY 1958	-4.7	-4.2	-16.3	-16.9	-18.5	-7.5
FY 1959	0.0	-9.1	- 9.3	-10.6	- 0.1	6.6
FY 1960	-5.4	-7.3	- 8.2	2.3	9.1	20.7
FY 1961	3.2	1.3	10.3	16.1	27.6	33.9
FY 1962	0.2	11.0	16.7	28.6	33.0	41.7
FY 1963	8.6	17.3	28.6	33.0	42.5	--
FY 1964	2.5	14.4	18.9	29.5	--	--
FY 1965	6.0	7.6	17.9	--	--	--
FY 1966	-1.1	7.3	--	--	--	--
FY 1967	0.1	--	--	--	--	--
FY 1968	--	--	--	--	--	--
Mean	0.9	4.3	7.3	11.7	15.6	19.1
Standard Deviation	4.3	9.6	16.3	20.3	22.9	20.0

*Percent Error = [(RPM Actual-RPM Forecast) ÷ RPM Actual] X 100.

**Base Year = year prior to forecast period for which current actual data were available.

Note: Minus values represent "overestimation."
Blanks occur for years subsequent to 1968, the last year for which actual data were available.

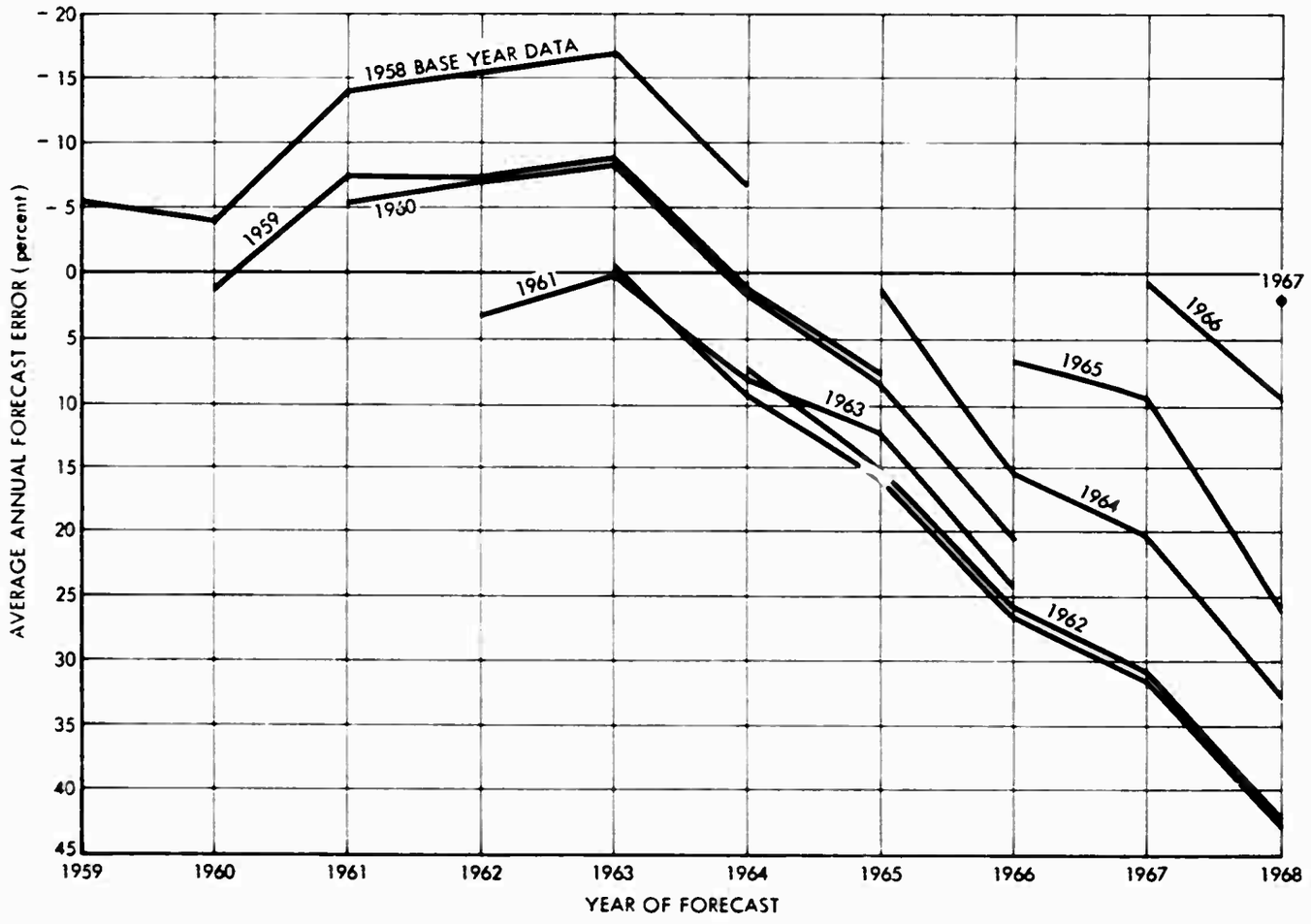
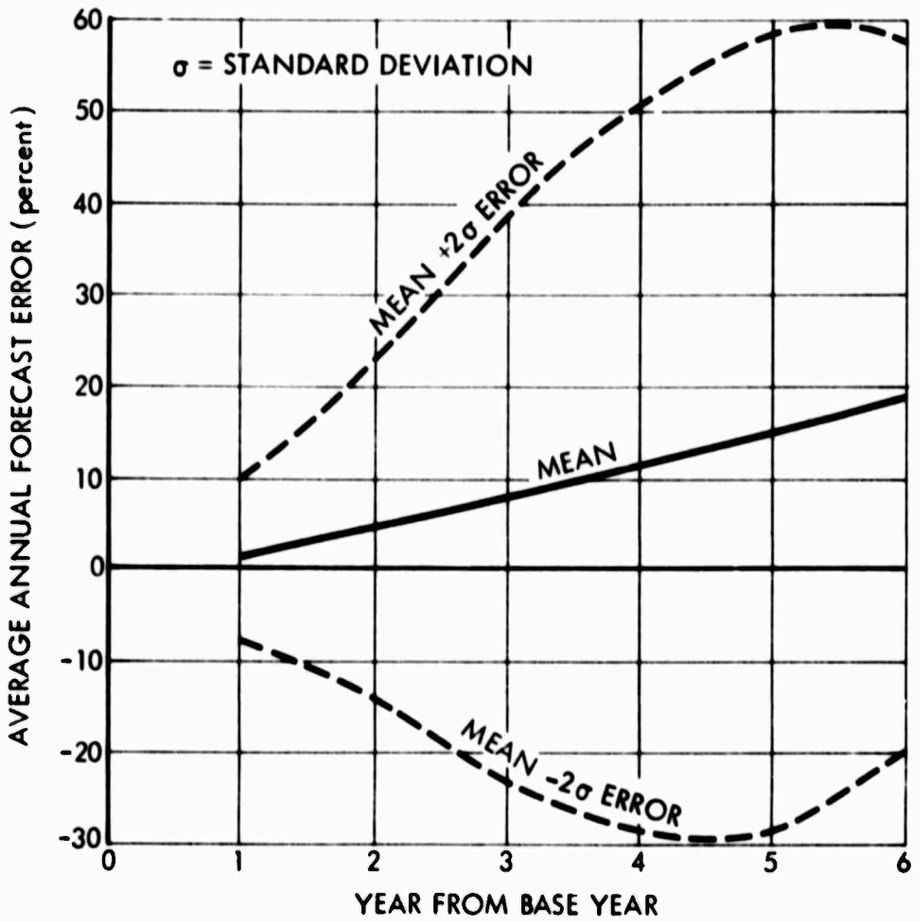


FIGURE 2. Average Annual Error for Projections of RPM's as a Function of Year of Forecast, Base Years FY 1958-1967

forecasted 241.5 million enplanements, could be expected in 1974 if all conditions stay the same. Similarly, an even greater increase over the 1980 forecast could be anticipated, namely, a 70 percent increase (298.1 million) over the forecasted 429 million. Using a standard deviation of the error of 20 percent projected out to the 1980 time period (most likely this is conservative) one might expect with high probability that the actual enplanements will fall somewhere between 558 million and 1 billion.



NOTE:
PLUS VALUES REPRESENT UNDERESTIMATION.

FIGURE 3. Average Annual Error for Projection of RPM's as a Function of Year from Forecast, Base Year

TABLE 8. ADJUSTED 1968 FORECAST SERIES (REVENUE PASSENGER ENPLANEMENTS IN MILLIONS) BASED ON EXTRAPOLATED ERROR

Year	1968 Forecast Series*	Extrapolated Error (%) at 1968	"Adjusted" Forecast**
1969	151.5	0.01	151.5/(1-0.01) = 153.0
1970	164.7	0.04	164.7/(1-0.04) = 171.6
1971	181.3	0.07	181.3/(1-0.07) = 194.9
1972	200.0	0.12	200.0/(1-0.12) = 227.3
1973	219.0	0.16	219.0/(1-0.16) = 260.7
1974	241.5	0.19	241.5/(1-0.19) = 298.1
1979	384.0	0.37***	384.0/(1-0.37) = 609.5
1980	429.0	0.41***	429.0/(1-0.41) = 727.1

* From Table 4.

** Adjusted Forecast = forecast ÷ (1-error).

*** These errors are based on linear extrapolations of the above 1969 to 1974 error rates.

IV. OTHER AVAILABLE FORECASTS

A. GENERAL METHODOLOGY OF AVAILABLE FORECASTS

In his Digest and Assessment of Air Travel Forecasting Techniques (Ref. 4), Ralph A. Calderone summarizes methodology for travel forecasting within the various segments of the air transport complex in the following manner:

> Airline Companies. Generally, airline companies have taken a relatively simple approach to forecasting future passenger traffic, employing one or a combination of three methods: (1) executive judgment, (2) trend and cycle analysis, and (3) correlation analysis. Of these, the first two are used most frequently and, of the two, judgment plays the most prominent role. While the airlines consider a number of factors in preparing their forecasts, they seem to consider that current and anticipated levels of economic activity are of primary importance. They statistically analyze only a few indices, however, and of these the most commonly chosen is GNP.
>
> Government, Trade, and Aircraft Manufacturing Organizations. These organizations usually employ the following techniques: (1) linear or curvilinear projections of historic trends, (2) simple or multiple correlation analysis, (3) executive judgment, (4) economic models, (5) statistical and mathematical formulas, and (6) marketing surveys.

Demand studies made by airlines or aircraft manufacturers fall within distinguishable classifications according to the length of the forecast period.

(1) Short-range predictions of up to one year periods are generally the product of trend projections of passenger and/or revenue growth. Such predictions are made either for a segment of the industry, or for the entire industry, or for some specific airline.

(2) Longer-range predictions always include behavioral analyses of one or a number of general economic activity indices (most frequently GNP, national income, disposable personal income, consumer price level, retail sales, or industrial production). It is assumed that there are some relatively stable relationships between the general economic activity growth and that of transportation (general or air), and therefore population and employment trends are studied. The number and relationship of variables vary, but what is generally used is a combination of traffic trend projections in conjunction with or modified by expected traffic as a function of exogenous national economic indices. The forecasts are usually made for the entire national air travel market. Divisions of total projected traffic among the various airlines are generally predicted or anticipated market shares which are assumed to be functions of pricing, equipment plans, etc.

B. FORECAST COMPARISONS

In 1967, Arizona State University studied the feasibility of establishing a national program for training skilled aviation personnel.* In this connection, the study group undertook a detailed analysis of aviation statistics in order to develop forecasts of the required new hire pilots and mechanics from 1965 through 1980 for the civil air carrier segment of the aviation industry. After extended statistical processing of the available data and subsequent correlation and regression analyses, the problem of projecting overall employment levels was transformed into that of finding an acceptable forecast of aircraft by types over the period under study. All such existing forecasts depended on projections of revenue passenger-miles and cargo ton-miles.** However, differing assumptions regarding new aircraft types and introduction dates caused differences in the forecasts. Consequently, the study reviewed

*The study was a Technical Assistance Project sponsored by the Economic Development Administration of the U.S. Department of Commerce.

**One short ton (2,000 pounds) transported one statute mile (5,280 feet). Ton-miles are computed by multiplying the aircraft miles flown on each interairport hop by the number of tons carried on that flight.

several major forecasting studies, adjusted them for comparability and then formulated a composite projection for the purposes of the study.

The following are brief descriptions of the various forecasting methodologies reviewed by the Arizona study. Since these descriptions have been extracted (in order to illustrate the contrast in scope of the various methodologies), the reader should bear in mind that some of the material is included only to clarify how the Arizona Study made the forecasts comparable (e.g., inclusion of non-U.S. traffic).

1. The Boeing Company

The Boeing forecast [Ref. 5] was divided into U.S. domestic and international traffic to arrive at the total U.S. civil air carrier traffic.* Two projections were made for each of these segments on the basis of different forecast growth rates. A "probable" forecast used growth rates that start at approximately 15 percent in 1966 to 1967 and drop to about 6 percent in the late 1970's. A "possible" forecast was based upon growth rates that vary from approximately 17 percent in 1966 to a little over 8 percent by 1980. To get to total Free World traffic, Boeing added non-U.S. forecasts to these totals. The non-U.S. forecasts were based upon growth rates that vary from about 14 percent to 6 percent for the "probable" level and from 18 percent to 8 percent for the "possible" level. These two levels of forecast comprise the Boeing estimates. The "possible" level was found to be closest to the other forecasts examined.

Boeing checked the consistency of their forecasts with other economic indicators. Specifically, projections of the economic growth rates of the United States and those countries represented in the non-U.S. forecasts were evaluated to determine the ability to support the projected traffic growth. A further check on consistency was made by evaluating the compatibility of the air carrier forecasts with projections for the transportation sector of the overall economy. Although demand elasticities were not used directly in the forecasts, an underlying assumption of moderate fare decreases

*Since this is one of the few forecasts that contains this information directly, it is used for comparison in the discussion of other forecasts.

and continued use of promotional fares was made. They felt that this would be necessary to support even the "possible" level of projected growth. The potential market population was checked against the passengers represented in the forecasts and the results were determined to be consistent with a continued increase in propensity to travel over the time period.

2. Douglas Aircraft Company

The Douglas traffic forecast [Ref. 6] parallels the Boeing forecast approach in the manner of validating their growth extrapolation. Douglas forecasted U.S. domestic air passenger traffic only, so it was adjusted by adding the Boeing forecast for international traffic. Douglas, in comparing the world to the U.S., reached the conclusion that "extensive analysis of the economics of countries other than the United States indicates that the rate of growth of factors contributing to air travel exceed those of the United States." (See Ref. 6, p. 10.) Upon this basis they developed their world forecast. They broke down the world forecast into segments in order to validate the projections for such major categories as North Atlantic traffic and intra-European traffic.

The net result of the Douglas forecast is a growth rate that is slightly less than that for Boeing over the period. Their validations of the forecast involved the same economic factors used by Boeing. In addition, they looked at U.S. intercity common carrier traffic. They compared their forecast for the air share of intercity travel with projections of total common carrier domestic intercity travel to check for consistency. They also looked at personal income and corporate profits as key factors in the support of continued growth of air travel.

3. Federal Aviation Administration

The FAA forecast [Ref. 7] was developed in support of the supersonic transport (SST) investigations. The forecast for the total certificated air carriers was divided into domestic and international passenger-miles; however, the composite forecast was based upon the traffic forecast for the domestic segment adjusted by the historical relationship between domestic and international traffic. It is unique among the forecasts in that the projected growth rates, which start at about 14 percent per year, decline to around 10 percent per year in 1970 and then increase to 12 percent for the remaining years. The reason for this increasing growth rate toward the latter part

of the period is the lower fares occasioned by the introduction of aircraft with lower operating costs during that period.

Other factors included are those related to continued real GNP growth of between 2 to 3 percent per year and continued promotional or reduced fares on currently operating aircraft. The effect of reduced fares on stimulating passenger traffic is still an open question, although estimates of this effect are used explicitly. Some work has been done on trying to estimate the demand elasticity but, as yet, no precise conclusions have been reached [Ref. 8]. The overall effect of this additional growth in the latter years is to make the FAA forecast the highest of those discussed, except Boeing's "possible" forecast.

4. Civil Aeronautics Board

Basically, the CAB forecast [Ref. 9] involved the development of the statistical relationship between economic indicators and passenger traffic. The primary independent variables used were consumer price index, disposable personal income, population, real disposable personal income, fares, and real fares. As in the FAA forecast, an estimate was made of fare elasticity which was included in the forecast equations.

Separate forecasts of the independent variables were developed or obtained from other sources and the dependent variable, revenue passenger-miles, was then determined for each of the ten years of their forecast. Since this forecast was not on a growth projection basis, it is interesting to compare the percentage growth rates as derived by this method with those used in the other forecasts. For the early years in this forecast, the growth rate was 9.3 percent and this declined to a closing growth rate of 7.6 percent per year. This is substantially less than the majority of the growth rates used in the other forecasts.

Since this forecast was developed for the domestic trunk air carriers, domestic operations, scheduled service only, it was necessary to inflate the result in order to equate it to total civil air carriers. Since the relationship between the total industry and the domestic trunk carriers has been reasonably stable over the past, the percentage relationship between those two groups during 1965 was applied to the forecast for the future. This corrected forecast is the lowest of the group for the total air carrier population, which is consistent with the overall lower growth rate which is derived from their forecasts.

5. Air Transport Association

The ATA forecast [Ref. 10] consisted simply of three levels of projected growth rate: 10.8 percent for the low growth rate, 13.5 percent for the average growth rate, and 16.2 percent for the high growth rate. The average growth rate gives a forecast that is approximately equal to the Boeing "probable" forecast in the early years but considerably higher in the later years.

6. Lockheed Aircraft Corporation

Lockheed developed a forecast of air passenger traffic in support of their bid for the SST contract [Ref. 11]. Their forecast was also used as an input to a simulation model of an airline that they use for measuring markets for new aircraft. Their approach to the forecasting problem was to separate and then forecast U.S. domestic and international traffic. For the U.S. domestic market forecast, they used three methods: (1) a market analysis technique, (2) a city-pair analysis, and (3) an economic index (GNP) method. The international traffic forecast was based upon an analysis of the relationship between the U.S. forecast and the trans-Atlantic traffic, plus a trend extrapolation for major market areas of the world.

The basic underlying assumptions of all three approaches in forecasting the domestic traffic include continued growth in the GNP, continued downward pressure on air fares, increasing propensity to fly, and no major economic or political changes in the world situation. Lockheed's overall forecast is a composite of these three techniques. Although showing some differences for some time periods, they tended to support one another. The forecast for domestic scheduled traffic in the U.S. is adjusted in the same manner as for the CAB forecast and results in a total almost identical to the Douglas domestic forecast plus the Boeing international forecast. It is still somewhat lower than the Boeing "probable" forecast.

7. General Electric

The G.E. forecast [Ref. 12] is "about median of the range of opinion from several sources" for the Free World. Their percentage growth rate varies from a little over 10 percent in 1965 to

somewhat less than 9 percent in 1980. Since their U.S. forecast does not include international service, this is corrected by adding the Boeing international forecast to the basic General Electric forecast, yielding a result that is very close to the Boeing "probable" forecast. The validation of this forecast consisted of checking the reasonableness with forecasts from other sources.

8. North American Aviation Company

North American used a simple 10 percent per year annual growth rate (Ref. 13). This gave results which were nearly as low as the CAB forecast for the early years. By 1980 they project revenue passenger-miles of about the same magnitude as Boeing or General Electric. The 10 percent rate was derived by comparing past forecasts of growth rates to actual past growth rates. North American considered that 10 percent would compensate for some of the past errors in projections.

C. CONSISTENCY AMONG THE FORECASTS

In the March 18, 1969, Executive Aviation Report (Ref. 14) a similar comparison of methodology was made using the same 8 sources for the same time period. The report emphasizes the apparent wide variance of the 8 methodologies and therefore the not surprisingly enormous variation in the results—to the point where, in the opinion of the report, forecasting seems meaningless. For example, the RPM's vary in 1980 from 250 billion (CAB extrapolated figure) to over 500 billion (ATA) (Table 9). Figure 4 graphically illustrates the wide variance by comparing the estimates (in the form of "outlyers" and low and high boundaries of a composite) with (1) the available actual data since 1965, and (2) with each other past the year (1967) for which actual data are available. It is pointed out that the trend of the forecasts was substantially too low even in the immediate future (1965 to 1967), and the more optimistic a forecast, the more accurate it proved to be. The report goes on to say that even ATA, which generated the most pessimistic forecast by far, was still too low, as indeed was even Boeing's "possible." This report concludes that since not one of these different methods in 1965 could foreshadow the near-term

upward growth, studies to establish relationships between air transport and published economic diagnostic parameters are needed.

TABLE 9. COMPARISON OF EIGHT MAJOR U.S. FORECASTING EFFORTS—PROJECTIONS FOR TOTAL CIVIL AIR CARRIER REVENUE PASSENGER-MILES (DOMESTIC AND FOREIGN SCHEDULED SERVICE), IN BILLIONS*

Cal. Year	ATA	Boeing "Probable"	CAB	Douglas	FAA	G.E.	Lockheed	North American	Composite	Actual
1965	76	76	76	76	76	76	76	76	76	
1966		90			87				87	
1967		103		99	99				99	111.7
1968		116			108				110	
1969		133		121	119				123	
1970	143	149	116		132	144	134	122	138	
1971		165		145	149				152	
1972		181			165				167	
1973		199		170	181				181	
1974		215							200	
1975	269	232	169	200		224	201	196	218	
1976		250							236	
1977		269		230	246				255	
1978		290							275	
1979		307		262					295	
1980	307	327			379	323	283	314	315	
1985		430			450		400			

*This Table was taken from Ref. 14.

The Air Transport Association (Ref. 15) also notes the consistency in air travel forecasting with respect to underestimation: "The history of air transport over the past two decades shows a pattern, repeated over and over again, of the actual volume of industry traffic significantly exceeding the most carefully drawn forecasts, both government and private." As an example, ATA points out various instances in which actual traffic was well above a preceding FAA forecast made

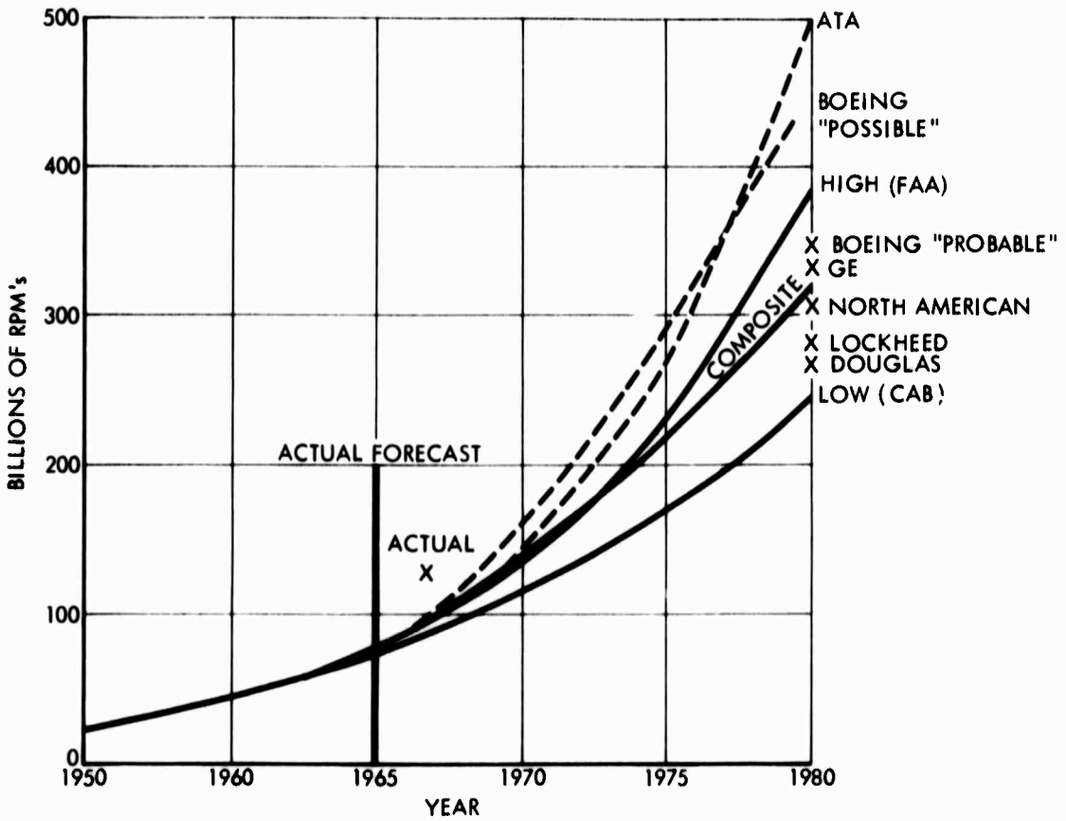


FIGURE 4. Comparison of Eight Major U.S. Forecasting Efforts--Projections for Total Civil Air Carrier Revenue Passenger-Miles (Domestic and Foreign Scheduled Service)

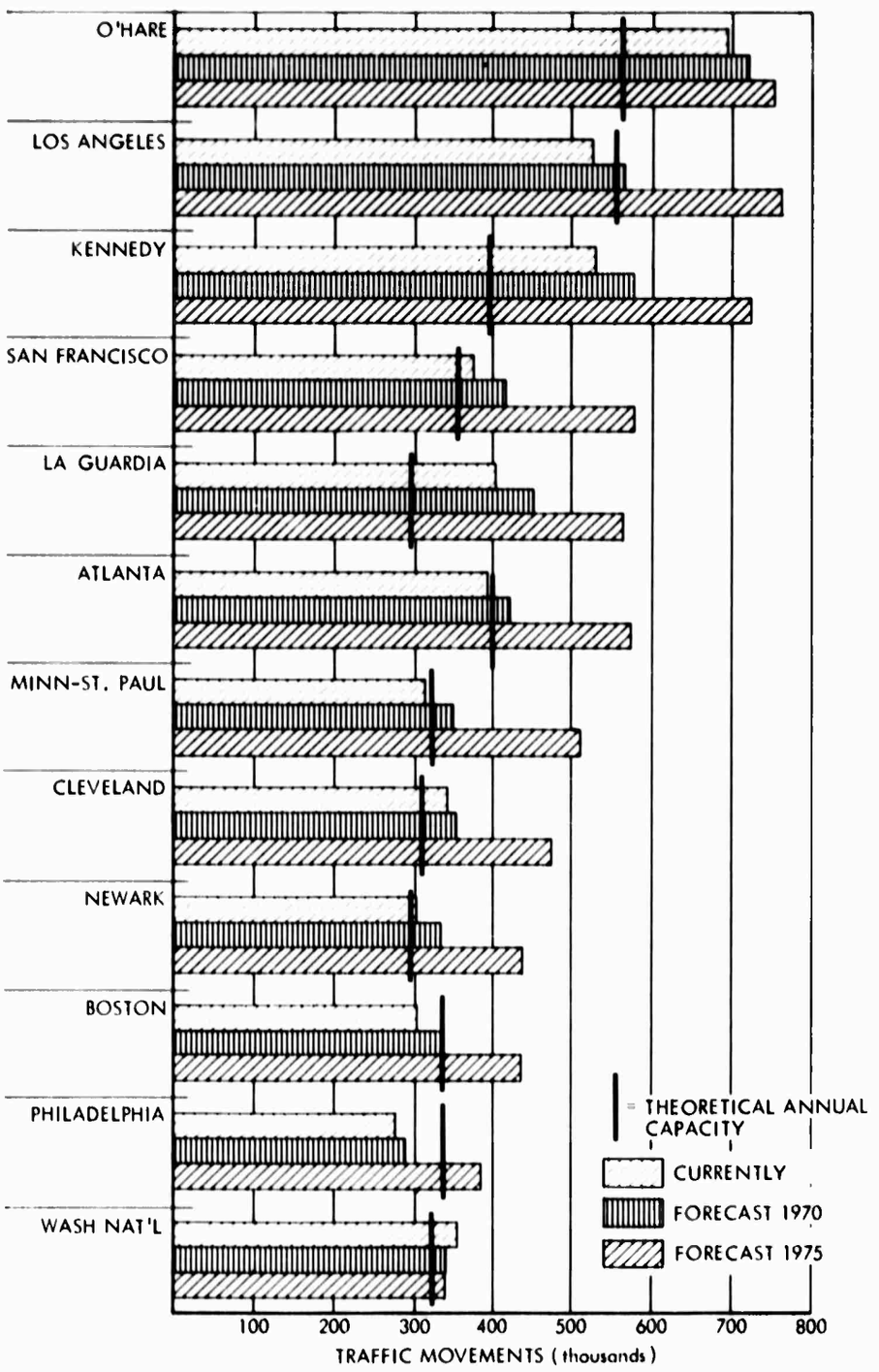
only two years or so earlier. The ATA view of this situation, however, seemingly supports, at least for the short term, the status quo:

> If airline expansion in recent years had been limited to the forecast rate of traffic growth, air transport capacity would have fallen far short of meeting the needs of the traveling public.
>
> Given inherent uncertainties of traffic prediction even for relatively short periods ahead, expansion of capacity should not be expected to proceed in perfect rhythm with demand. Leads and lags in the accommodation of the one to the other are inevitable, and even desirable. The record shows that in the real world of airline industry competition,

> a normalizing force is constantly at work to insure an underlying pattern of harmony between capacity and demand, with comcomitant benefits to the "convenience and necessity" of the traveling public.

In the same vein, the Aviation Report (Ref. 14, p. 1), (in noting the consistent underestimation as a symptom of poor forecasting in general) points out rather tongue-in-cheek that at least the error of underestimation, as opposed to overestimation, is "the safe one," as "underestimating RPM's means higher load factors, improved earnings and/or hasty follow-on orders to the manufacturing industry, which has certainly been noted in the past two years."

On the other hand, the May 1969 issue of Space/Aeronautics (Ref. 16) uses ATA data to illustrate current ATC saturation or near saturation of 12 high-density air carrier airports (Fig. 5) which "in almost all cases, have already reached or gone beyond their theoretical annual capacities." According to the ATA, there will be significant peak hour traffic delays at all 12 airports by the mid-'70s. Thus, one concludes that although underestimation results in higher load factors, improved earnings, and more follow-on manufacturing activity, it unfortunately also results in congestion, inconvenience, and delay for the air traveler due to lack of planning for his needs. It is obvious that continued underestimation to the degree noted above will be critical in its impact on the capability of air terminal and airways facilities to meet the future needs of the air traveler.



Source: Space Aeronautics, May 1969

FIGURE 5. Current and Forecast Aircraft Traffic Movements for High-Density Airports

APPENDIX A

COMPILATION OF PUBLISHED FAA SIX-YEAR FORECASTS, BASED ON FISCAL YEARS 1958-1968, FOR SCHEDULED REVENUE PASSENGER TRAFFIC FOR THE U.S. CERTIFICATED AIR CARRIERS

Fiscal Year	Revenue Passenger Enplanements (Millions)			Revenue Passenger-Miles (Billions)		
	Total	Domestic	International*	Total	Domestic	International*
1958**		48.7			25.5	
1959		53.1			28.2	
1960		59.0			31.4	
1961	-	65.0	-	-	34.7	-
1962		70.0			38.0	
1963		75.0			41.0	
1964		80.0			44.0	
1959**		50.7			26.8	
1960		56.6			30.1	
1961		61.0			32.7	
1962	-	65.5	-	-	35.4	
1963		70.0			38.1	
1964		74.5			40.8	
1965		79.0			43.5	
1960**	61.8	56.6	5.4	38.0	30.4	7.6
1961	65.0	58.9	6.1	40.8	32.0	8.8
1962	71.1	64.3	6.8	45.3	35.4	9.9
1963	75.9	68.5	7.4	59.1	38.1	11.0
1964	80.7	72.7	8.0	52.8	40.8	12.0
1965	85.5	76.9	8.6	56.5	43.5	13.0
1966	90.2	81.0	9.2	60.2	46.2	14.0

*Not included in forecasts before 1960.

**Indicates "base year," i.e., year for which actual data available.

Fiscal Year	Revenue Passenger Enplanements (Millions)			Revenue Passenger-Miles (Billions)		
	Total	Domestic	International*	Total	Domestic	International*
1961**	61.8	55.9	5.7	38.7	30.4	8.2
1962	64.0	58.0	6.0	40.7	32.0	8.7
1963	69.0	62.5	6.5	44.5	35.0	9.5
1964	73.8	66.7	7.1	48.5	38.0	10.5
1965	78.8	71.0	7.8	52.9	41.5	11.4
1966	82.6	74.0	8.6	56.5	44.0	12.5
1967	84.0	75.0	9.0	58.0	45.0	13.0
1962**	66.6	59.9	6.7	42.5	33.0	9.5
1963	70.6	63.2	7.4	45.9	35.3	10.6
1964	74.2	66.2	8.0	49.1	37.6	11.5
1965	78.1	69.5	8.6	52.4	40.0	12.4
1966	82.2	73.0	9.2	55.8	42.5	13.3
1967	85.8	76.0	9.8	59.2	45.0	14.2
1968	89.5	79.0	10.5	62.0	47.0	15.0
1970	96.8	85.0	11.8	68.0	51.0	17.0
1975	114.0	99.2	14.8	82.0	61.0	21.0
1963**	70.7	63.3	7.4	45.9	35.1	10.8
1964	76.1	68.0	8.1	50.2	38.2	12.0
1965	78.7	70.0	8.7	53.0	40.0	13.0
1966	82.4	73.0	9.4	56.4	42.5	13.9
1967	86.0	76.0	10.0	59.7	45.0	14.7
1968	89.6	79.0	10.6	62.5	47.0	15.5
1969	93.2	82.0	11.2	65.3	49.0	16.3
1970	96.8	85.0	11.8	68.0	51.0	17.0
1975	115.0	100.0	15.0	82.0	61.0	21.0
1964**	83.0	74.4	8.6	54.2	41.3	12.9
1965	92.3	82.5	9.8	61.9	46.0	15.0
1966	98.3	87.5	10.8	65.8	49.0	16.8
1967	103.6	92.0	11.6	70.5	52.0	18.5
1968	109.5	97.0	12.5	75.1	55.0	20.1
1969	115.3	102.0	13.3	79.6	58.0	21.6
1970	121.0	107.0	14.0	84.0	61.0	23.0

Fiscal Year	Revenue Passenger Enplanements (Millions)			Revenue Passenger-Miles (Billions)		
	Total	Domestic	International*	Total	Domestic	International*
1965**	94.6	84.6	10.0	62.6	47.3	15.3
1966	107.5	96.1	11.4	72.0	54.2	17.8
1967	117.5	104.9	12.6	79.7	59.6	20.1
1968	126.8	112.9	13.9	87.1	64.6	22.5
1969	136.6	121.5	15.1	95.0	70.0	25.0
1970	147.3	130.9	16.4	103.5	75.9	27.6
1971	158.6	140.9	17.7	112.6	82.3	30.3
1966**	113.9	102.2	11.7	76.4	57.9	18.5
1967	128.0	114.8	13.2	87.5	66.1	21.4
1968	142.2	127.4	14.8	98.4	74.0	24.4
1969	153.9	138.0	15.9	107.7	81.0	26.7
1970	168.0	150.8	17.2	118.8	89.4	29.4
1971	186.0	167.0	19.0	133.0	100.0	33.0
1972	206.5	185.5	21.0	149.0	112.0	37.0
1973	230.0	207.0	23.0	167.5	126.0	41.5
1977	352.0	317.5	34.5	266.0	200.0	66.0
1967**	126.4	113.5	12.9	86.3	65.7	20.6
1968	153.5	137.3	16.2	106.3	80.2	26.1
1969	169.4	151.6	17.8	118.7	89.5	29.2
1970	187.2	167.7	19.5	132.5	100.0	32.5
1971	205.0	184.0	21.0	146.0	110.0	36.0
1972	226.0	203.0	23.0	163.0	123.0	40.0
1973	248.0	222.5	25.5	180.5	136.0	44.5
1974	272.5	244.5	28.0	200.0	151.0	49.0
1979	444.0	400.0	44.0	342.0	258.0	84.0
1968**	152.6	137.5	15.1	106.5	81.6	24.9
1969	168.6	151.5	17.1	119.4	91.2	28.2
1970	183.7	164.7	19.0	132.2	100.5	31.7
1971	202.2	181.3	20.9	147.2	111.8	35.4
1972	223.0	200.0	23.0	164.5	125.0	39.5
1973	244.5	219.0	25.5	183.0	139.0	44.0
1974	269.5	241.5	28.0	204.0	155.0	49.0
1975	296.0	265.0	31.0	226.5	170.0	54.5
1979	429.0	384.0	45.0	342.0	260.0	82.0
1980	470.0	420.0	50.0	379.0	288.0	91.0

REFERENCES

1. Federal Aviation Administration, Aviation Demand and Airport Facility Requirement Forecasts for Large Air Transportation Hubs Through 1980, August 1967.

2. B.R. Lippke and J.S. Stewart, Economic Impact on Domestic Air Traffic, An Econometric Approach, Paper No. 69-113, The Boeing Company, Renton, Washington, p. 1. (Prepared for the 1969 Joint National Meeting of the Operations Research Society of America and the American Astronautical Society, Denver, Colorado, June 1969.)

3. G. Besse and G. Desmas, Forecasting for Air Transport—Methods and Results, ITA, Study 66/7E, 1966.

4. R.A. Calderone, A Digest and Assessment of Air Travel Forecasting Techniques, Graduate Report of Research, Institute of Transportation and Traffic Engineering, University of California, Berkeley, pp. 25-26, August 1967.

5. The Boeing Company, Commerical Airplane Division, Boeing Traffic Forecast, Report S-637, Renton, Washington, 30 January 1967.

6. Douglas Aircraft Company, Measuring the 70's—An Air Travel Market Analysis, Report C1-12/66-423, Long Beach, California, November 1966.

7. Federal Aviation Administration, Aviation Forecasts Fiscal Years 1967-1977, Office of Policy Development, Economics Division, Washington, D.C., January 1967.

8. W.H. Gregory, "Refined Air Elasticity Measure Sought," Aviation Week and Space Technology, pp. 40-43, January 17, 1965.

9. Civil Aeronautics Board, Forecasts of Passenger Traffic of the Domestic Trunk Air Carriers, Domestic Operations, Scheduled Service, 1965-1975, Staff Research Report No. 5, Research and Statistics Division, Bureau of Accounts and Statistics, September 1965.

10. Air Transport Association of America, Air Transport Facts and Figures, 1966, Washington, D.C.

11. Lockheed Aircraft Corporation, Air Traffic Demand 1967-1990, OEA/SST/22, Burbank, California, November 1966.

12. General Electric Company, Commercial Market Profile and Identified Programs, Aircraft Engine Division, Lynn, Mass., February 1967.

13. Conversations with Clayton Clarke of the North American Aviation, Inc., Commercial Marketing Group, Los Angeles, California.

14. Executive Aviation Report, No. 1807, Sussex House, Wimbledon, England.

15. Air Transport Association of America, Air Transport Facts and Figures, 1969, Washington, D.C.

16. Space/Aeronautics, p. 68, May 1969.

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13 ABSTRACT

IDA, under Contract to the Office of Research of the Urban Mass Transportation Administration (UMTA) of the U.S. Department of Transportation, is conducting studies of major activity center circulation transportation systems. One such study addresses intra-airport circulation transportation systems. This paper has been prepared in support of this study and is intended to provide background and information on future air travel demands and insight into the status and accuracy of air travel forecasting. The information and results presented in this paper have been used in IDA Study S-351 entitled, Intra-Airport Transportation Systems: An Examination of Technology and Evaluation Methodology, by Peter G. Freck et al.

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