MANPOWER ADMINISTRATION U.S. DEPARTMENT OF LABOR BUREAU OF LABOR STATISTICS

Pilots and Mechanics in Civil Aviation 1967-77

A STUDY OF MANPOWER REQUIREMENTS

MANPOWER ADMINISTRATION
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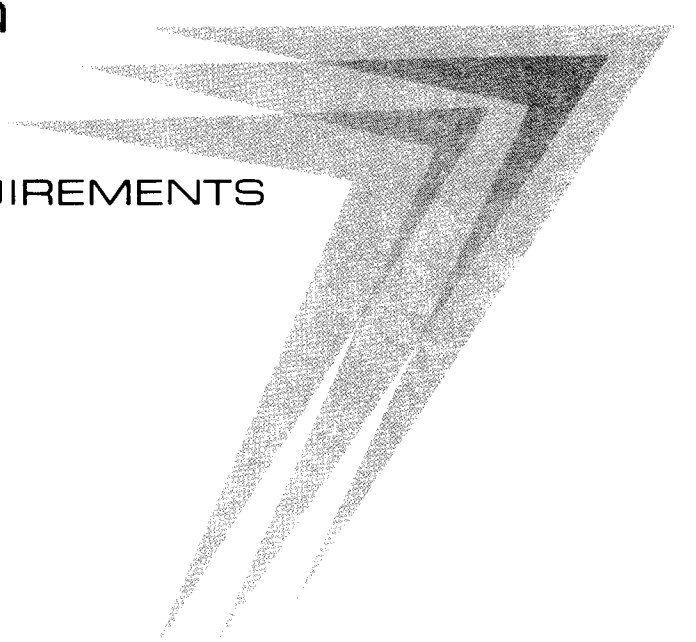

Part I, Current Situation and the Short-Range Outlook (Manpower Administration)

Part II, Long-Range Manpower Requirements (Bureau of Labor Statistics)

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Preface

As a result of the unprecedented expansion in civil aviation during the past few years and the prospect of continuing growth in the 1970's, considerable attention has been focused recently on the current and future supply-demand situation for trained aviation manpower. In recognition of the need for up-to-date comprehensive information on the manpower aspects of the civil aviation industry, the Department of Labor undertook this study designed to appraise current and future requirements and resources for pilots and mechanics in civil aviation. The study was done at the request and with the support of the Federal Aviation Administration and the Department of Defense—the two Federal agencies most concerned with manpower developments in civil aviation.

The study was conducted in two parts: Part I, which was prepared under the direction of the United States Training and Employment Service (USTES) of the Department of Labor's Manpower Administration presents an analysis of current and short-range requirements and resources for pilots and mechanics in each of the principal sectors of civil aviation—both in the airlines and general aviation categories. This analysis is based on a special survey of employers in these industry groups, conducted by USTES in cooperation with affiliated State employment security agencies. Part II, conducted by the Bureau of Labor Statistics (BLS), presents projections of long-range manpower requirements, also by principal sectors of civil aviation, and the methods used to derive these projections.

The Department of Labor is grateful for the assistance and cooperation of the airlines, firms in general aviation, aviation schools, aircraft manufacturers, trade associations, trade unions, government agencies and others who cooperated generously in providing information. We especially would like to acknowledge the cooperation of the Air Transport Association of America, which encouraged all its members in advance to complete and return the questionnaires in a survey of firms in the various sectors of civil aviation. The work of the General Aviation District Offices of the FAA in following up on the nonresponding firms in the air taxi, aerial applicator, aircraft repair stations, and flight and ground schools segments of general aviation, was also very much appreciated.

The analysis of the data in the USTES portion of the study was prepared by Edward D. Hollander and Eleanor F. Silverman of the staff of Robert R. Nathan Associates Inc., under contract with the U.S. Department of Labor. The planning and preparation for the USTES-State employment security agency survey of employers in the civil aviation industry and the assembly of the survey data for analysis were by Robert L. Miller under the supervision of Harold Kuptzin, Chief, Division of Job Market Analysis in the USTES.

The BLS portion of the study was prepared by Richard E. Dempsey, assisted by Kevin Kasunic, LaVerne Lang, and David P. Lafayette. Jerry Kursban assisted in the linear regression analysis used to project manpower requirements. The BLS portion was conducted in the Bureau of Labor Statistics' Division of Manpower and Occupational Outlook, Russel B. Flanders, Chief.

Introduction

The growth of civil aviation during the mid-1960's has been phenomenal—in terms of all major measurements of business activity: revenue, passenger traffic, air cargo carried and size of employment. Revenue passenger miles (including domestic and international) during 1968 passed the 100 billion mark—more than 3 times the record of a decade previous.[1] According to the Federal Aviation Administration (FAA), the 152 million passengers carried in 1968 nearly tripled the number 10 years earlier. By 1980, FAA figures indicate, U.S. airlines are expected to fly a total of 379 billion revenue passenger-miles and carry 470 million passengers in scheduled domestic and international service.

The demand for transportation of cargo by air has also increased sharply in recent years—topping 4.1 billion cargo-ton miles in 1968.[2] By 1970, an all-cargo plane capable of carrying nearly 3 times as much freight as today's largest cargo aircraft will be entering airline fleets.

At the same time, there has been a strong uptrend in all phases of business flying (executive transportation) and other types of general aviation activity, and the outlook for continued growth in the next decade is extremely favorable. The number of active general aviation aircraft rose from 85,000 in 1964 to 114,000 in 1968.[3] The FAA forecast is that the number of these aircraft will nearly double by 1980.

In 1962, the certificated route air carriers employed 17,971 pilots, copilots, flight engineers and navigators. By 1967 this number had reached 30,956.[4] During this same period, the number of mechanics employed by these carriers moved up from 34,925 to 50,016.[4]

The overall expansion of civil aviation activity, coupled with the pending introduction of jumbo and stretched jet transport and new shorthaul aircraft for local service, are expected to result in a further increase in the annual requirements for pilots, mechanics, and other ground service personnel.

The contribution of military training to commercial aviation manpower has always been highly significant. According to a survey conducted by the Air Transport Association in early 1967,[5] two-thirds of all pilots hired during 1966 and two-thirds of those employed at the time of the survey had their principal training in the military services. Military training for pilots, however, is today but a fraction of what it was during World War II and considerably below the peak reached during the Korean conflict.

Projections made as recently as 1964 with respect to manpower needs for pilots and mechanics in 1970 have already been greatly surpassed. The estimates erred on the low side mainly because while increases in productivity due to new equipment were foreseen, no one then anticipated the tremendous growth in passenger miles, hours flown, and the number of aircraft in use which has occurred in the past few years.

The study by the U.S. Training and Employment Service (USTES) and the Bureau of Labor Statistics (BLS) represented a two-pronged approach to manpower analysis as indicated by the different procedures and responsibilities of each. Most of the information for the USTES portion of the study was obtained through a sample survey of firms in the various segments of civil aviation. The questionnaire for the survey was developed with the assistance and cooperation of FAA and DOD. The USTES portion covers the current situation and the short-range growth requirements (to March 1970) for pilots and mechanics, training facilities for these occupations and their potential output, age of employees, and information on pilots with respect to ratings, hours flown, and certification to fly fixed-wing planes and/or helicopters.

The BLS long-range projections of pilot and mechanic requirements through 1972 and 1977, were based on an in-depth analysis of historical trends of the factors affecting manpower requirements in the various sectors of civil aviation. The basic data used in developing estimates and projections of manpower requirements came from FAA, including forecasts of future aviation activity. Information on manpower utilization and expected developments in civil aviation, including the impact of technology on manpower requirements, were analyzed and incorporated. Much of the information was developed through discussions with and data obtained from civil aviation officials representing management, labor and government.

The coverage of the USTES and BLS portions of the study also differ in some other respects. The USTES portion covers civilian pilots and mechanics employed by the Army, Navy, and Air Force and the nonmilitary Federal agencies; the BLS portion excludes those civilian pilots and mechanics employed in the Army, Navy, and Air Force. The USTES portion includes in general aviation the pilots and mechanics employed by State and local governments; the BLS portion includes these workers in the government sector.

[1] *Aviation Forecasts,* Fiscal years 1969-80, Federal Aviation Administration, January 1969.
[2] *1969 Air Transport Facts and Figures,* Air Transport Association of America.
[3] *Aviation Forecast,* op. cit.
[4] *1968 Air Transport Facts and Figures,* Air Transport Association of America.
[5] *Scheduled Airline Industry Pilot Requirements,* Report by Air Transport Association, February 1967.

Part I
Current Situation and the Short-Range Outlook

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Pilots

Of the nearly 67,000 pilots employed in civil aviation in the spring of 1968, 34,500 worked for air carriers, 31,800 were employed in general aviation activities, and about 550 were civilian employees of the Department of Defense.

All three divisions of the industry planned to continue to expand their pilot work forces through 1970, although to varying degrees. The largest and most rapid growth was scheduled for general aviation, where employers contemplated reaching an estimated pilot em ployment level of 38,000 in spring 1970, about 11,000 above spring 1967.[6] Air carriers expected to add only 4,300 during this 3-year period, an estimated prospective increase of only about 1,500 pilots a year. This would represent a considerable slowing down and leveling off in the sharp uptrend which characterized the carriers' employment growth in the years from 1964 to 1967. Reported Department of Defense civilian pilot employment expansion needs were negligible.

No shortage of pilots to meet the estimated short-term growth requirements was experienced or anticipated by employers in the spring of 1968, with the possible exception of pilots with specialized skills and experience, such as agricultural pilots. Both major sources of pilot supply—those with military-training and those with civilian-training backgrounds—were being drawn upon. Civilian training facilities for pilots are adequate in number, highly elastic in response to increases in demand, and well dispersed geographically. Government aid to student pilots in the form of veteran's benefits is exceptionally generous. All sectors of the industry provide on-the-job training.

Of the approximately 34,500 pilots and copilots employed by civil air carriers in spring 1968, about 1,250 or 3.5 percent were flight instructors, according to estimates based on the U.S. Training and Employment Service (USTES) survey. In addition, about 4,000 pilots were engaged in providing instruction in flying at general aviation flight and ground schools. Both major divisions of the industry contemplated increases in their flight instructor employment and expected no difficulty in meeting their needs.

Nearly a third of all pilots and copilots, excluding flight instructors, employed by route air carriers in spring 1968 were also qualified flight engineers, and no change in this proportion was contemplated during the period under review.

More than 92 percent of all employed civil aviation pilots were certified to fly fixed-wing aircraft only. The proportion was about 97 percent for route airlines and 87 percent in general aviation, where the remainder were certified to fly helicopters only or both fixed-wing aircraft and helicopters. Some increase by peak 1970 in the proportions of fixed-wing pilots employed was expected in all sectors except industrial/special flying.

Airline transport ratings were held by nearly 43 percent of all employed civil aviation pilots in the spring of 1968—about 49 percent of those on carriers and about 36 percent of those employed in general aviation. Nearly 87 percent of all employed pilots whose highest rating was commercial were also instrument-rated.

About 11 percent of all employed pilots were 50 years of age or over in the spring of 1968. The proportion for route airlines, where the compulsory retirement age is 60, was 9.4 percent. For general aviation firms it was 12.6 percent.

Approximately 32,355,000 flight hours were logged by professional civilian pilots in the year ending April/May 1968, of which route airlines accounted for about half. Annual hours flown per pilot averaged 512 for the entire industry, with route airline pilots (excluding flight instructors) flying an average of 522, and all general aviation pilots combined, an average of 509 hours. There was wide variation among general aviation sectors in the average hours flown by pilots annually, ranging from 166 in industrial/special flying to 763 in air taxi operations.

Mechanics

Employment of civilian aircraft mechanics in the spring of 1968 totaled 144,000, more than twice the number of pilots. Air carriers employed 51,000; general aviation, which includes all independent repair stations, engaged 54,800; and 38,400 were civilian mechanics employed by the Department of Defense.

The carriers and general aviation firms expected to continue to augment their mechanic work forces

[6] Expansion plans of general aviation firms, particularly those in the executive transportation and air taxi sectors, may be adversely affected by the FAA's new flight-rationing regulation limiting IFR (Instrument Flight Rules) nonairline flying at five airfields serving Washington, New York, and Chicago. The rule went into effect on June 1, 1969.

through 1970, but the Defense Department planned a small reduction. As in the case of pilots, the bulk of the increase was scheduled for general aviation with an estimated spring 1970 mechanic employment level of 62,800, more than 11,000 above spring 1967. Air carriers expected to raise their mechanic employment by only 6,000 to a total of 55,000 during this period. By 1970, Defense Department employment was expected to total several hundred below the 1967 level, after reaching a high of 39,500 in 1969, according to plans reported to the USTES in the spring of 1968.

Many reports, from both general aviation firms and air carriers, indicated a rising and crucial need for mechanics skilled in certain occupational specialties. These included airplane electricians and electronic, radio, and instrument mechanics, as well as avionic technicians. The need for all-around airframe and engine mechanics appeared to be falling off, but remained at a substantial level. Job opportunities in general aviation were best for certificated airframe and powerplant (A&P) mechanics who could also function as pilots.

About 15 percent of all aircraft mechanics employed in civil aviation, excluding the Department of Defense, in the spring of 1968, were 50 years of age or over, according to estimates based on the USTES survey of employers. The proportion was only about 12 percent for air carriers, but close to 17.5 percent in general aviation. There is no compulsory retirement age for aircraft mechanics.

Some tightness in the supply of mechanics, particularly of those with certain special technical skills, appeared to be developing in the spring of 1968. Half of the 28 labor areas surveyed by the USTES survey reported stringencies ranging from slight to critical. Employers complained of shortages of fully qualified and certificated airplane electricians, electronic and instrument mechanics, and radio and avionic technicians, as well as of airframe and engine mechanics.

Aircraft mechanic schools are much less numerous and less well dispersed geographically than are training facilities for pilots. Graduates of many of these schools, the great majority of which are public institutions at vocational high school or technical trade school levels, can qualify only as trainees or apprentices ready for on-the-job training. The same is true of most aircraft mechanics with military-service training backgrounds only. In contrast to the situation for pilots, no special VA benefits beyond the standard ones are available to veterans who might wish to study for aircraft mechanic jobs. While all sectors of the industry were providing on-the-job training in 1968, many employers felt that they would nevertheless probably be unable to meet all anticipated short-run growth and replacement needs in this way, especially for mechanics with highly developed specialized skills.

Expansion of apprenticeship and other formal on-the-job training programs, planned sufficiently in advance of expected needs, might ease this problem in the future. More generous government student aid grants or benefits might encourage enrollment of veterans and others in the better equipped private schools and universities.

Pilots and mechanics employed by the Department of Defense

Very few civilian pilots—550 in all—but more than 38,000 civilian aircraft mechanics were employed by the Defense Department in 1968. The civilian mechanic work force, on the basis of plans existing in the summer of that year, was expected to drop by more than 2,000 between 1969 and 1970, almost entirely as a result of employment reductions contemplated by the Air Force.

While the bulk of Defense Department civilian aircraft mechanic employment is in the Air Force, the Navy accounted for a substantial proportion—about 14,600, or 38 percent—in 1968, and expected to add about 1,000 between 1968 and 1970. The Army, with 850 civilian aircraft mechanics, primarily helicopter mechanics, in 1968, contemplated an increase of about 200.

Chapter I. Pilots and Mechanics

There are more than twice as many civilian mechanics as pilots employed in aviation activities,[7] and mechanics greatly outnumber pilots in each of the three major divisions of the industry (table 1). Air carriers employed three mechanics for every two pilots in 1967. In general aviation, which includes all aircraft repair stations, the ratio of mechanics to pilots was even higher. All but a handful of the civilian aviation employees of the military services were mechanics.

About 49,000, or 35.5 percent of all civilian aviation mechanics employed in 1967, worked for air carriers; about 51,500, or 37.3 percent, were in general aviation, mainly at repair stations; and the remainder, nearly 38,000, or more than 27 percent of the total, were civilian employees of the Department of Defense (table 2). At the 1970 peak of mechanic employment of 168,500, according to estimates based on employer anticipations, the air carriers will account for nearly 60,000, or 35.5 percent of the total, the same proportion as in 1967. General aviation will account for more than 71,000, or about 42 percent, while Defense Department civilian mechanic employment will drop to roughly 37,000, or 22 percent of the total.

The distribution of civilian pilot employment is quite different from that of mechanics. Air carriers employ more pilots than does the general aviation division of the industry, and the Department of Defense employs very few. In the spring of 1967, about 33,000, or 54.6 percent of the total of nearly 60,700 employed pilots, worked for carriers, and 27,000 or 44.5 percent, for general aviation firms. However, these proportions were expected to be nearly reversed by 1970. According to estimates based on employers' hiring plans as reported to the USTES survey in the spring of 1968, pilot employment at the peak of 1970 will total 82,200, of which 39,400 or 48 percent will be on air carriers, and 42,200 or more than 51 percent in general aviation. Defense Department civilian pilot employment was expected to increase very slightly by peak 1970, and to remain at less than 1 percent of total civilian pilot employment.

The two major occupational groups under review—civilian pilots and mechanics—differ sharply in their job content and qualifications as well as their labor market situations. In the sections which follow, they are, therefore, considered separately. Moreover, the civilian pilots and mechanics employed by the Defense Department are considered separately from those employed by the two other major components of the civil aviation industry—air carriers and general aviation. The divisions and sectors of the civil aviation industry are described in appendix A.

PILOTS AND MECHANICS

Table. 1. All civil aviation, including Department of Defense employment trends, 1967-70

Date	Number employed			
	Total	Air carriers	General aviation	Dept. of Defense[1]
	Pilots[2]			
Spring of:				
1967	60,670	33,100	27,000	570
1968	66,860	34,500	31,800	560
1969 (est.)	71,700	36,000	35,100	600
1970 (est.)	76,020	37,400	38,000	620
Peak of:				
1967	66,580	34,900	31,100	580
1968 (est.)	71,220	36,300	34,300	620
1970 (est.)	82,220	39,400	42,200	620
	Mechanics[3]			
Spring of:				
1967	138,200	49,000	51,500	37,700
1968	144,200	51,000	54,800	38,400
1969 (est.)	152,900	53,000	60,400	39,500
1970 (est.)	155,100	55,000	62,800	37,300
Peak of:				
1967	150,000	53,300	58,000	38,700
1968 (est.)	157,900	55,400	62,500	40,000
1970 (est.)	168,500	59,800	71,400	37,300

[1] Civilian Aviation employees only.
[2] Includes pilots, copilots, pilot/flight engineers, and flight instructors.
[3] Includes aircraft mechanics and instructors only; excludes maintenance workers such as carpenters and electricians.
SOURCE: See appendix C. *Air Carriers* — USTES survey data inflated to national totals and adjusted on basis of relationship between FAA total employment and survey sample data for 1967 and 1968. *General Aviation* — USTES survey data inflated to national totals on basis of relationship between BLS employment estimates and survey sample data for 1967. Not adjusted. *Department of Defense* — National totals reported by Army, Navy, Air Force.

PILOTS AND MECHANICS

Table 2. All civil aviation, including Department of Defense percentage distribution of employment, 1967-70

Date	Percentage distribution of employment			
	Total	Air carriers	General aviation	Dept. of Defense
	Pilots			
Spring of:				
1967	100.0	54.6	44.5	0.9
1968	100.0	51.6	47.6	.8
1969 (est.)	100.0	50.2	49.0	.8
1970 (est.)	100.0	49.2	50.0	.8
Peak of:				
1967	100.0	52.4	46.7	.9
1968 (est.)	100.0	51.0	48.2	.9
1970 (est.)	100.0	47.9	51.3	.8
	Mechanics			
Spring of:				
1967	100.0	35.5	37.3	27.3
1968	100.0	35.4	38.0	26.6
1969 (est.)	100.0	34.7	39.5	25.8
1970 (est.)	100.0	35.5	40.5	24.0
Peak of:				
1967	100.0	35.5	38.7	25.8
1968 (est.)	100.0	35.1	39.6	25.3
1970 (est.)	100.0	35.5	42.4	22.1

SOURCE: Based on table 1.

[7] All civil aviation, including civilian employees of the Department of Defense.

Employment trends

About 60,000 pilots[8] were employed in civil aviation[9] in the spring of 1967. By the spring of 1968, about 6,200, or 10.3 percent, had been added. At that time, however, a slowing down in the rate of employment expansion over the following 2 years was contemplated. Spring 1969 pilot employment is estimated, on the basis of the USTES sample survey,[10] at about 71,000, roughly 4,800 or 7.2 percent above spring 1968, and spring 1970 pilot employment at 75,400, about 4,300 or 6.0 percent above spring 1969 (tables 3 and 4). If the hiring schedules anticipated by employers in the spring of 1968 are realized, pilot employment will total an estimated 81,600[11] at the peak of 1970, about 15,600 or nearly 25 percent above the 1967 peak, and will represent an average increase of about 5,200 pilots a year for the 3-year period. Most of the contemplated increase is attributable to the expansion plans of the general aviation division of the industry.

The air carriers' pilot work force increased only about 1,400, or 4.5 percent, between 1967 and 1968. Similar annual increases of 1,400 to 1,500, or about 4.0 percent a year, in 1969 and 1970 are estimated. Peak 1970 employment of pilots on all civil air carriers is estimated at 39,400, about 13 percent above the peak of 1967, and would require the net addition of about 4,500 pilots (1,500 a year) over the 3-year period. All but a couple of hundred of these would be for certificated route carriers.

PILOTS

Table 3. Civil aviation, employment trends, all pilots, by industry division, 1967-70

Date	Total	Air carriers		General aviation
		All	Certificated route	
	Number employed			
Spring of:				
1967	60,100	33,100	31,100	27,000
1968	66,300	34,500	32,500	31,800
1969 (est.)	71,100	36,000	33,900	35,100
1970 (est.)	75,400	37,400	35,300	38,000
Peak of:				
1967	66,000	34,900	32,800	31,100
1968 (est.)	70,600	36,300	34,200	34,300
1970 (est.)	81,600	39,400	37,100	42,200
	Percentage distribution			
Spring of:				
1967	100.0	55.1	51.7	44.9
1968	100.0	52.0	49.0	48.0
1969 (est.)	100.0	50.6	47.7	49.4
1970 (est.)	100.0	49.6	46.8	50.4
Peak of:				
1967	100.0	52.9	49.7	47.1
1968 (est.)	100.0	51.4	48.4	48.6
1970 (est.)	100.0	48.3	45.5	51.7

SOURCE: See table 1.

Historical data on the employment of pilots and other flight personnel by certificated route air carriers indicate that the prospective annual increases of 1,400 to 1,500 a year for the 1967-70 period would represent both a sharp slow-down and a leveling out in the very rapid employment expansion which had been going on since 1964. As shown in the following tabulation, such an annual increase would be less than half the size of that which occurred between 1966 and 1967, and about a fourth of the 1965-66 increment of more than 5,800. On the other hand, it would greatly exceed the annual growth rate prevailing in the early 1960's.

Changes in employment of pilots, copilots, flight engineers, and navigators by certificated route air carriers[1]

Years	
1960-61	750
1961-62	-125
1962-63	340
1963-64	1,240
1964-65	2,420
1965-66	5,835
1966-67	3,150

[1] FAA, *Statistical Handbook of Aviation,* and Air Transport Association of America, *Air Transport Facts and Figures.*

Since 1967,[12] general aviation firms have been augmenting their pilot work forces at a much faster rate than the carriers, and are expected to continue to do so, according to estimates based on the USTES survey. Employing 27,000 pilots in the spring of 1967, they had added 4,800 (a 17.8-percent increase) by spring 1968, and planned to add an additional 3,300 (or 10.4 percent more) by the spring of 1969, and 2,900 (or 8.3 percent more) between 1969 and 1970, to bring their total pilot employment up to about 38,000, or 41 percent above spring 1967. Plans through peak 1970 called for an estimated pilot work force of more than 42,000, about 11,000 or nearly 36 percent above peak 1967, compared

[8] The term "pilot" as used in this survey includes pilots, copilots, pilot/flight engineers, and flight instructors, unless otherwise specified. Each occupation is described in Appendix B.

[9] Air carriers and general aviation, excluding civilian employees of the Department of Defense, who are considered in Section IV, but including nondefense government employees.

[10] Manpower Administration, U.S. Training and Employment Service, April/May 1968, see Appendixes B and C.

[11] This estimate was made before United Airlines was required, by union agreement, to have three pilots instead of two on its two-engine Boeing 737's. This will add 400 to pilot requirements.

[12] Earlier figures are not available.

with an estimated increase of 4,500 or 13 percent for air carriers. To reach this estimated peak 1970 employment level, general aviation firms would have to add an average of nearly 3,700 pilots a year during the 3-year period from peak 1967 to peak 1970.

If all contemplated employment growth is realized, there will be a continued change in the distribution of pilot employment between the two major components of the civil aviation industry. By the spring of 1968, general aviation firms had already increased their share of total pilot employment[13] to 48 percent from 45 percent in the previous spring. At the estimated peak 1970 employment level, this proportion would rise to nearly 52 percent, while the proportion for air carrier pilot employment would decline from 55 percent in 1967 to 48 percent.

In summary, net 1967-70 requirements of the civil aviation industry for pilots, for purposes of growth only and not including replacements, are estimated at around 5,200 a year, on the basis of employer plans reported in spring 1968. Over the 3-year period, it is estimated that air carriers would require an average of roughly 1,500 pilots a year, and general aviation firms an average of about 3,700 pilots a year, to reach estimated peak 1970 staff levels.

Air carrier pilots, by type. The USTES survey of spring 1968 provided a breakdown, for air carriers only, of pilot employment by type, from which it was possible to estimate the varying prospective employment trends during the 1967-70 period under review for: All pilots and copilots, including flight instructors; pilots and copilots, excluding flight instructors; flight instructors; and pilots and copilots, excluding flight instructors, who are also flight engineers (tables 5, 6, 7, and 8).

Table 4. Civil aviation, increases in employment over specified periods, by industry division, 1967-70

Date	Total	Air carriers		General aviation
		All	Certificated route	
	Employment increases			
Spring of:				
1967-68	6,200	1,400	1,400	4,800
1968-69 (est.)	4,800	1,500	1,400	3,300
1969-70 (est.)	4,300	1,400	1,400	2,900
1967-70 (est.)	15,300	4,300	4,200	11,000
Peak of:				
1967-68 (est.)	4,600	1,400	1,400	3,200
1968-70 (est.)	11,000	3,100	2,900	7,900
1967-70 (est.)	15,600	4,500	4,300	11,100
	Percentage increases			
Spring of:				
1967-68	10.3	4.2	4.5	17.8
1968-69 (est.)	7.2	4.3	4.3	10.4
1969-70 (est.)	6.0	3.9	4.1	8.3
1967-70 (est.)	25.5	13.0	13.5	40.7
Peak of:				
1967-68 (est.)	7.0	4.1	4.3	10.3
1968-70 (est.)	15.6	8.5	8.5	23.0
1967-70 (est.)	23.6	12.9	13.1	35.7

SOURCE: Based on table 3.

Table 5. Civil air carriers employment trends, by type of pilot, 1967-70

Date	Number employed		
	Pilots and copilots		Flight instructors
	Including flight instructors	Excluding flight instructors	
	All air carriers		
Spring of:			
1967	33,100	31,910	1,190
1968	34,500	33,255	1,245
1969 (est.)	36,000	34,700	1,300
1970 (est.)	37,400	36,050	1,350
Peak of:			
1967	34,900	33,655	1,245
1968 (est.)	36,300	35,000	1,300
1970 (est.)	39,400	38,000	1,400
	Certificated route air carriers only		
Spring of:			
1967	31,100	29,980	1,120
1968	32,500	31,330	1,170
1969 (est.)	33,900	32,680	1,220
1970 (est.)	35,300	34,030	1,270
Peak of:			
1967	32,800	31,620	1,180
1968 (est.)	34,200	32,970	1,230
1970 (est.)	37,100	35,770	1,330

SOURCE: Total employment as shown in table 3 distributed on basis of USTES survey sample data.

Of the 33,100 pilots and copilots employed by all civil air carriers in spring 1967, 1,190 (or 3.6 percent) were flight instructors. Estimates indicate that employers expected to add about 160 by the spring of 1970, and that peak 1970 flight instructor employment would be 155 above the peak of 1967. The expansion of flight instructor employment was expected to proceed at about the same rate as that for all other pilots as table 7 shows.

Nearly a third (31 percent) of all pilots and copilots, excluding flight instructors, employed by route air carriers in spring 1968 were also qualified flight engineers. The figures in table 8 reflect fairly accurately a cockpit manning pattern consisting of a crew of three pilots, of whom at least one is also a flight engineer. No change in the ratio of pilot/flight engineers (or second officers, as they are sometimes called) to all pilots was contemplated by route carriers throughout the 1967-70 period under review.

Route airlines employed 9,420 pilot/engineers in the spring of 1967 and expected to add an estimated 1,230 by spring 1970. At the estimated peak of pilot employ-

[13] Excluding civilian employees of the Department of Defense.

Table 6. Civil air carriers, changes in employment over specified periods, by type of pilot, 1967-70

Date	Increases in number employed		
	Pilots and copilots		Flight instructors
	Including flight instructors	Excluding flight instructors	
	All air carriers		
Spring of:			
1967-68	1,400	1,345	55
1968-69 (est.)	1,500	1,445	55
1969-70 (est.)	1,400	1,350	50
1967-70 (est.)	4,300	4,140	160
Peak of:			
1967-68 (est.)	1,400	1,345	55
1968-70 (est.)	3,100	3,000	100
1967-70 (est.)	4,500	4,345	155
	Certificated route air carriers only		
Spring of:			
1967-68	1,400	1,350	50
1968-69 (est.)	1,400	1,350	50
1969-70 (est.)	1,400	1,350	50
1967-70 (est.)	4,200	4,050	150
Peak of:			
1967-68 (est.)	1,400	1,350	50
1968-70 (est.)	2,900	2,800	100
1967-70 (est.)	4,300	4,150	150

SOURCE: Based on table 5.

ment during 1970, a total of approximately 10,650 pilot/flight engineers, or 1,290 more than at peak 1967, would be employed. This would represent an average annual increase of about 400 over the 3-year period.

Several major airlines reported that they engaged professional flight engineers or flight navigators who were not qualified pilots.

General aviation pilots, by industry sector. Nearly 44 percent of the estimated 31,800 professional pilots employed in the general aviation division of the civil aviation industry in 1968 were engaged in executive transportation activities (table 9). Air taxi operations accounted for about a fourth (24 percent) and instructional activities at pilot flight and ground schools for 13 percent. Firms engaged in aerial application, such as crop dusting, and in industrial/special activities, such as pipeline patrolling, each employed about 5 percent of all general aviation pilots. State and local government and nondefense Federal agency flying activities accounted for more than 2,000 pilots, or nearly 7 percent of the total. Repair stations engaged 650, or 2 percent of the estimated total, for checking out and testing aircraft.

Sharp employment increases to peak 1970, assuming the availability of pilots for jobs in general aviation, were planned by all sectors. All general aviation firms combined hoped to expand their pilot work forces by an estimated 11,000, or more than a third, between peak 1967 and peak 1970 (table 10). Numerically, the greatest increases were scheduled for executive transportation, pilot schools, and air taxi operations, many of which also double as schools. Contemplated increases for other general aviation sectors, while relatively small in number, represented substantial proportional expansion. Industrial/special operators, for example, expected to add an estimated 660, for a more than 40-percent increase in pilot employment. The contemplated addition of roughly 150 to 550 pilots by peak 1970 in each of the other general aviation sectors would represent about a one-fourth increase in each pilot work force above peak 1967.

Rough estimates of the average annual growth requirement for pilots in each of the general aviation sectors, for the 3 peak years 1967-70, based on employers' reports, indicate that about 2,500 of the estimated total demand of 3,700 a year would arise from the expansion plans of executive transportation and air taxi operations combined. The next largest requirement, 600 a year, would be for pilot instructors at schools. A summary tabulation follows:

General aviation industry sector	*Estimated average annual requirement for contemplated expansion of pilot employment, 1967-70*
Executive transportation	1,300
Air taxis	1,200
Flight and ground schools	600
Industrial/special	220
Government (nonmilitary)	190
Aerial application	160
Repair stations	60
Total	3,730

Not all sectors, of course, would require the same kinds of pilots. As executive transportation and air taxi operators increase their use of larger and more sophisticated aircraft, they will need more pilots trained on this kind of equipment. On the other hand, a good part of the demand in industrial/special work, for example, would be for helicopter pilots, and aerial application companies would need specialized pilots well-trained in agricultural flying activities.

Pilot certification to fly specified types of aircraft

Of the total of 66,260 pilots employed in the civil aviation industry in the spring of 1968, 61,255, or 92.4 percent, were certified to fly fixed-wing aircraft only; 815, or 1.2 percent, were certified to fly helicopters

only; and 4,190, or 6.3 percent, were certified to fly both fixed-wing aircraft and helicopters, according to estimates based on the USTES survey of employers (table 11). More than 97 percent of the pilots employed by air carriers had fixed-wing certification only, while the corresponding proportion for general aviation firms was about 87 percent, with 2.5 percent certified to fly helicopters only, and about 10 percent certified to fly both fixed-wing aircraft and helicopters.

There was considerable variation among the sectors of the general aviation division of the industry in the type of certification held by employed pilots. The proportions of pilots with only fixed-wing certification ranged from around 90 percent in executive transportation, pilot schools, and nonmilitary government agencies, down to 40 percent in industrial/special activities, of which about 28 percent were certified to fly helicopters only, and 32 percent to fly both fixed-wing aircraft and helicopters. In no other sector did helicopter-only certification bulk nearly so large, ranging from 0.7 percent in nonmilitary government to 3 percent in repair stations. However, in all other general aviation sectors, sizable proportions of all pilots (ranging from 7 to 12 percent) were certified to fly both fixed-wing aircraft and helicopters.

Asked to estimate the distribution of their anticipated peak 1970 employment as between fixed-wing and helicopter pilots, civil aviation firms as a whole placed fixed-wing pilots at 95 percent of the prospective total and helicopter pilots at 5 percent (table 12). Route carriers, of which only a few are helicopter airlines, expected to have about 200 helicopter pilots out of an estimated total pilot employment of approximately 37,000. The employment of helicopter pilots in general aviation, on the other hand, was expected to total an estimated 4,000, or 9.5 percent of a prospective 42,000, at peak 1970. The executive transportation and air taxi sectors each anticipated having about 900 helicopter pilots on their payrolls, and industrial/special companies expected that about 1,500, or two-thirds, of their employed pilots would be qualified to fly helicopters, according to estimates based on the survey sample.

More detailed breakdowns, by type of pilot as well as by type of certification, are available from the survey for air carriers only (tables 13 and 14). They indicate that, both in 1968 and at estimated prospective peak employment in 1970, there is virtually no difference between flight instructors and all other pilots in the distribution of employees by type of certification. In the spring of 1968, of 33,255 noninstructor pilots and copilots employed by air carriers, 97.3 percent were certified to fly fixed-wing aircraft only, 0.1 percent were certified to fly helicopters only, and 2.6 percent were certified to fly both fixed-wing aircraft and helicopters. The corresponding proportions for flight instructors were almost

Table 7. Civil air carriers, percentage change in employment over specified period, by type of pilot, 1967-70

Date	Percent change in employment		
	Pilots and copilots		Flight instructors
	Including flight instructors	Excluding flight instructors	
	All air carriers		
Spring of:			
1967-68	4.2	4.2	4.6
1968-69 (est.)	4.3	4.3	4.4
1969-70 (est.)	3.9	3.7	3.8
1967-70 (est.)	13.0	13.0	13.4
Peak of:			
1967-68 (est.)	4.0	4.0	4.4
1968-70 (est.)	8.5	8.6	7.7
1967-70 (est.)	12.9	12.9	12.4
	Certificated route air carriers only		
Spring of:			
1967-68	4.5	4.5	4.5
1968-69 (est.)	4.3	4.3	4.3
1969-70 (est.)	4.1	4.1	4.1
1967-70 (est.)	13.5	13.5	13.4
Peak of:			
1967-68 (est.)	4.3	4.3	4.2
1968-70 (est.)	8.5	8.5	8.1
1967-70 (est.)	13.1	13.1	12.7

SOURCE: Based on table 5.

Table 8. Civil air carriers, ratio of pilot/flight engineers to all pilots, 1967-70

Date	Pilots and copilots, excl. flight instructors–		
	Total number	Who are also flight engineers	
		Number	Percent of total
	All air carriers		
Spring of:			
1967	31,910	9,540	29.9
1968	33,255	9,940	29.9
1969 (est.)	34,700	10,360	29.9
1970 (est.)	36,050	10,790	29.9
Peak of:			
1967	33,655	10,040	29.8
1968 (est.)	35,000	10,460	29.9
1970 (est.)	38,000	11,350	29.9
	Certificated route air carriers only		
Spring of:			
1967	29,980	9,420	31.4
1968	31,330	9,815	31.3
1969 (est.)	32,680	10,230	31.3
1970 (est.)	34,030	10,650	31.3
Peak of:			
1967	31,620	9,920	31.4
1968 (est.)	32,970	10,330	31.3
1970 (est.)	35,770	11,210	31.3

SOURCE: Total employment as shown in table 3 distributed on basis of USTES survey sample data.

identical. By peak 1970, air carriers expected that 99.4 percent of their projected total noninstructor pilot complement would consist of fixed-wing pilots and that 0.6 percent would be helicopter pilots. The corresponding proportions for instructors were, again, almost identical.

Ratings held by pilots

Airline transport ratings (ATR's) were held by 43 percent of all employed civil aviation pilots in the spring of 1968, while for 56 percent the highest rating held was commercial (table 15). The proportion of pilots holding ATR's was considerably higher for carriers—49 percent—than for general aviation—about 36 percent. Conversely, about half of all air carrier pilots had ratings no higher than commercial. These were, presumably, functioning as copilots or second officers. The proportion of commercial rating holders in general aviation was 62 percent, with 2 percent of the total having other ratings, mainly helicopter or instructor, as their highest.

Variations among general aviation sectors in the proportion of employed pilots with ATR's was extremely wide, ranging from 2 percent in aerial application to 57.5 percent in executive transportation, a higher proportion than that reported for carriers, as might be expected where there is frequently only one pilot in the cockpit. Roughly 80-90 percent of pilots employed in air taxi, aerial application, industrial/special, and instructional activities held no more than a commercial certificate, as did 58 percent of nonmilitary government pilots.

Viewed another way, as in table 16, about 60 percent of the 28,360 ATR's employed in 1968 worked for civil air carriers, with more than 56 percent of the total employed by certificated route airlines. General aviation activities employed 40 percent of all employed ATR's, with executive transportation accounting for 28 percent of the civil aviation total.

Of the 37,250 employed pilots whose highest rating was commercial, 47 percent were employed by carriers of all types and about 44 percent by certificated route airlines. About 16 percent were engaged in the air taxi business, more than 15 percent in executive transporta-

Table 9. General aviation, employment trends and percentage distribution, by industry sector, 1967-70

Date	Total	Executive transportation	Air taxi	Aerial application	Industrial/ special	Flight and ground schools	Government 1/	Repair stations
	Number employed							
Spring of:								
1967	27,000	11,900	6,200	1,500	1,500	3,300	2,000	600
1968	31,800	13,900	7,640	1,750	1,620	4,100	2,140	650
1969 (est.)	35,100	14,770	9,110	1,900	1,680	4,600	2,300	710
1970 (est.)	38,000	15,520	9,970	2,110	2,070	5,200	2,400	730
Peak of:								
1967	31,100	13,400	7,500	1,880	1,630	3,950	2,100	640
1968 (est.)	34,300	14,200	8,680	2,020	1,770	4,570	2,350	710
1970 (est.)	42,200	17,230	11,070	2,350	2,300	5,780	2,660	810
	Percentage distribution							
Spring of:								
1967	100.0	44.1	23.0	5.5	5.5	12.2	7.4	2.2
1968	100.0	43.7	24.0	5.5	5.1	12.9	6.7	2.0
1969 (est.)	100.0	42.1	26.0	5.4	4.8	13.1	6.6	2.0
1970 (est.)	100.0	40.8	26.2	5.6	5.4	13.7	6.3	1.9
Peak of:								
1967	100.0	43.1	24.1	6.0	5.2	12.7	6.8	2.1
1968 (est.)	100.0	41.4	25.3	5.9	5.2	13.3	6.9	2.1
1970 (est.)	100.0	40.8	26.2	5.6	5.5	13.7	6.3	1.9

1/ Excluding Department of Defense.
SOURCE: See table 1.

Table 10. General aviation, increases in employment over specified periods, by industry sector, 1967-70

Date	Total	Executive transportation	Air taxi	Aerial application	Industrial/ special	Flight and ground schools	Government[1/]	Repair stations
	Increase in number employed							
Spring of:								
1967-68	4,800	2,000	1,440	250	120	800	140	50
1968-69 (est.)	3,300	870	1,470	150	60	500	160	60
1969-70 (est.)	2,900	750	860	210	390	600	100	20
1967-70 (est.)	11,000	3,620	3,770	610	570	1,900	400	130
Peak of:								
1967-68 (est.)	3,200	800	1,180	140	130	610	250	70
1968-70 (est.)	7,900	3,030	2,390	330	530	1,210	310	100
1967-70 (est.)	11,100	3,830	3,570	470	660	1,820	560	170
	Percentage increase							
Spring of:								
1967-68	17.8	16.8	23.2	16.6	8.0	24.2	7.0	8.3
1968-69 (est.)	10.4	6.3	19.2	8.6	3.7	12.2	7.5	9.2
1969-70 (est.)	8.3	5.1	9.4	11.1	23.2	13.4	4.3	2.8
1967-70 (est.)	40.7	30.4	60.8	40.7	38.0	57.6	20.0	21.7
Peak of:								
1967-68 (est.)	10.3	6.0	15.7	7.4	8.6	15.7	11.9	10.9
1968-70 (est.)	23.0	21.3	27.5	16.3	29.9	26.5	13.2	14.1
1967-70 (est.)	35.7	28.6	47.6	25.0	41.1	46.3	26.7	26.6

SOURCE: Based on table 9.

tion, 8.6 percent in instructional flying, and 3-4 percent in each of the other sectors of general aviation, except repair stations where the proportion was lower.

All but a few of the 650 employed pilots whose highest rating was other than airline transport or commercial (mainly instructor or helicopter) were in general aviation, with 25 percent of the total in air taxi operations, about 22 percent in aerial application, 18.5 percent in executive transportation, and 14 percent in both flight and ground schools and nonmilitary government.

The USTES April/May 1968 survey of employers also gathered information on the number of employed pilots whose highest rating was commercial who also held instrument ratings. Estimates based on the survey sample are shown in table 17. According to these estimates, for all civil aviation activities combined, close to 32,300 pilots out of a total of 37,250 whose highest rating was commercial, or nearly 87 percent, also held instrument ratings. Virtually all carrier pilots whose highest rating was commercial, whether these are considered to include or exclude flight instructors, also held instrument ratings. The corresponding proportion for all general aviation pilots was 75 percent. It was 75 percent or more in each sector of general aviation except aerial application and industrial/special where, presumably, an instrument rating is less essential for the work performed.

More detailed estimates, for air carriers only, in which the highest ratings held are related to the various types of pilots employed, are shown in table 18. From this it may be seen, for example, that an estimated 49 percent of the 31,330 pilots and copilots, excluding flight instructors, employed in the spring of 1968 by certificated route carriers held air transport ratings, whereas for 51 percent the highest rating held was commercial. The distribution of flight instructor employment by type of rating held was virtually the same as that for all other pilots. Of the 31,330 route carrier pilots and copilots who were not flight instructors, about 9,800 were pilot/flight engineers (second officers). Nearly half of these held air transport ratings.

Pilots age 50 years and over

The age of employed pilots is one of the significant factors to be considered in estimating the probable level of new pilot hires to be required as the result of attrition

through retirement or death. Most air carrier pilots aged 50 and over are approaching retirement age, since Federal Aviation Administration Regulation 121, Part 383, stipulates that the use of the services of pilots who have reached their 60th birthday is not permitted on scheduled air carriers. Moreover, most airline pilots have the option to choose early retirement at age 55. No age limitations are imposed by the Federal Government on pilots employed by nonscheduled air carriers or by general aviation firms.

It is estimated that about 11 percent of all pilots employed in the civil aviation industry in the spring of 1968 were 50 years of age or over (table 19). The preference of air carriers, as distinguished from the general aviation division of the industry, for younger pilots, as well as the effect of the airlines' early retirement provisions, are reflected in the figures. Only 9.4 percent of carrier pilots were in the 50-years-or-over category, compared with 12.6 percent in general aviation. Among the general aviation industry sectors, the use of older pilots ranged from 7.4 percent of all those employed in industrial/special flying to 18.7 percent in nonmilitary government.

Of the 7,265 employed pilots aged 50 years and over in the spring of 1968, about 3,260 were employed by carriers and about 4,000 were in general aviation. Carriers accounted for 52 percent of all the pilots employed in civil aviation in the spring of 1968, but for only about 45 percent of those aged 50 and over. Route carriers, with 49 percent of all pilots, employed 42 percent of the older ones. General aviation employed 48 percent of all civil aviation pilots, but 55 percent of

PILOTS

Table 11. All civil aviation, number and percentage distribution of employed pilots certified to fly specified types of aircraft, by industry division and sector, spring 1968

Industry division/sector	All pilots and copilots[1/]	Certified to fly--		
		Fixed-wing only	Helicopter only	Fixed-wing and helicopter
	Number employed			
Grand total	66,260	61,255	815	4,190
Civil air carriers, total	34,500	33,555	35	910
Certificated route	32,500	31,610	35	855
Others	2,000	1,945	(2/)	55
General aviation, total	31,760	27,700	780	3,280
Executive transportation	13,880	12,680	140	1,060
Air taxi	7,640	6,660	80	900
Aerial application	1,750	1,510	30	210
Industrial/special	1,620	640	460	520
Flight and ground schools	4,080	3,680	40	360
Government	2,140	1,980	15	145
Repair stations	650	550	20	80
	Percentage distribution			
Grand total	100.0	92.4	1.2	6.3
Civil air carriers, total	100.0	97.3	0.1	2.6
Certificated route	100.0	97.3	0.1	2.6
Others	100.0	97.3	–	2.8
General aviation, total	100.0	87.2	2.5	10.3
Executive transportation	100.0	91.4	1.0	7.6
Air taxi	100.0	87.2	1.0	11.8
Aerial application	100.0	86.3	1.7	12.0
Industrial/special	100.0	39.5	28.4	32.1
Flight and ground schools	100.0	90.2	1.0	8.8
Government	100.0	92.5	0.7	6.8
Repair stations	100.0	84.6	3.1	12.3

1/ Including flight instructors.
2/ Fewer than 5.
SOURCE: Total employment as shown in tables 3 and 9 distributed on basis of USTES survey sample data.

those in the 50-years-and-over age bracket. A fourth of the 7,265 older civil pilots were engaged in executive transportation and about an eighth in air taxi activities.

Hours flown by pilots

Pilots and copilots employed in the civil aviation industry flew an estimated total of 32,355,000 hours in the year ending April/May 1968 (see table 20). For the entire industry combined, this amounted to an average of 512 flight hours per pilot.

Air carriers accounted for 17.4 million, or about 54 percent, of the estimated total number of hours flown. Approximately 16.4 million hours, or just half of the grand total, were flown by route airline pilots, whereas nearly 15 million hours, or 46 percent of the grand total, were logged by general aviation pilots. Executive transportation and air taxi pilots combined flew more than 10 million hours, nearly a third of the total for all civil aviation.

Pilots and copilots employed by certificated route air carriers, where maximum monthly flight time per pilot is regulated by both the FAA and union agreements, flew, on the average, 515 hours during the year. If flight instructors are eliminated from the total for route carriers, the average for the remaining pilots rises to 522 hours. Flight instructors employed by route carriers flew an average of only 344 hours, indicating perhaps that much of the on-the-job flight instruction was given on the ground.

All general aviation pilots combined averaged 509 flight hours during the year, but there was extremely wide variation among the component sectors of the industry division. Average utilization of pilot time appeared to be much higher in the air taxi industry (763 hours flown per pilot) and in the flying schools (708 hours), than in executive transportation (407 hours), or in any of the other general aviation sectors, in which average annual hours flown ranged downward to 208 in nondefense government activities and 166 in industrial/special operations. Only in air taxi and flying school activities and at repair stations did the average annual hours flown exceed the average for pilots and copilots employed by route carriers. But the excess, for the first two of these sectors, was very large—40 to 50 percent.

Pilot supply

Evaluation of the supply of pilots available to the civil aviation industry may be considered from various viewpoints—in terms of supply available to each of the two major divisions of the industry (airlines and general aviation), in terms of the output of the two major sources of supply (civilian and military), or in terms of the type of pilot involved (sophisticated aircraft, light aircraft, helicopter, etc.). Supply in the context of each of these approaches is discussed briefly below.

Table 12. All civil aviation, number and percentage distribution of fixed-wing and helicopter pilots, by industry division and sector, anticipated employment at peak 1970

Industry division/sector	Anticipated employment at peak 1970		
	All pilots and copilots[1/]	Fixed-wing pilots	Helicopter pilots
	Number of employees		
Grand total	81,600	77,380	4,215
Civil air carriers, total	39,400	39,180	215
Certificated route	37,100	36,910	205
Others	2,300	2,270	10
General aviation, total	42,200	38,200	4,000
Executive transportation	17,230	16,350	880
Air taxi	11,070	10,160	910
Aerial application	2,350	2,120	230
Industrial/special	2,300	760	1,540
Flight and ground schools	5,780	5,580	200
Government	2,660	2,520	140
Repair stations	810	710	100
	Percentage distribution		
Grand total	100.0	94.8	5.2
Civil air carriers, total	100.0	99.4	0.5
Certificated route	100.0	99.5	0.6
Others	100.0	98.7	0.4
General aviation total	100.0	90.5	9.5
Executive transportation	100.0	94.9	5.1
Air taxi	100.0	91.8	8.2
Aerial application	100.0	90.2	9.8
Industrial/special	100.0	33.0	67.0
Flight and ground schools	100.0	96.5	3.5
Government	100.0	94.7	5.3
Repair stations	100.0	87.7	12.3

[1/] Including flight instructors.
SOURCE: Total employment as shown in tables 3 and 9 distributed on basis of USTES survey sample data.

The airlines prefer to hire military trained, young pilots (under 35 years of age) who have had considerable experience in flying heavy aircraft and, secondarily, apt, civilian-trained, young, commercial-rated pilots who have logged at least 1,000 flight hours, preferably on heavy equipment. Hiring specifications in regard to physical condition and educational achievement are very high. Because of union seniority rules, both types of recruit are started at the bottom of the promotional ladder, no matter what their previous experience, and are assigned, at the beginning, to the lightest, cheapest, and least sophisticated aircraft. Reportedly, training (largely orientation) of these types of pilots for these entry jobs, which is provided by the airlines, requires only a few months or less, whether the pilot has a military or a civilian background.

General aviation sectors with relatively high proportions of heavy and sophisticated equipment, such as executive transport and air taxis, also look to the military and to qualified civilian-trained pilots, but are

Table 13. Civil air carriers, number and percentage distribution of employed pilots certified to fly specified types of aircraft, by industry division, spring 1968

Industry division	Total pilots	Certified to fly--		
		Fixed-wing only	Helicopter only	Fixed-wing and helicopter
	Number employed			
All civil air carriers				
All pilots and copilots	34,500	33,555	35	910
Pilots and copilots, except flight instructors	33,255	32,345	35	875
Flight instructors	1,245	1,210	(1/)	35
Certificated route carriers				
All pilots and copilots	32,500	31,610	35	855
Pilots and copilots, except flight instructors	31,330	30,470	35	825
Flight instructors	1,170	1,140	(1/)	30
	Percentage distribution			
All civil air carriers				
All pilots and copilots	100.0	97.3	0.1	2.6
Pilots and copilots, except flight instructors	100.0	97.3	0.1	2.6
Flight instructors	100.0	97.2	–	2.8
Certificated route carriers				
All pilots and copilots	100.0	97.3	0.1	2.6
Pilots and copilots, except flight instructors	100.0	97.3	0.1	2.6
Flight instructors	100.0	97.4	–	2.6

1/ Fewer than 5.
SOURCE: Total employment as shown in table 3 distributed on basis of USTES survey sample data.

willing to hire older men, and hiring specifications are lower. Sectors using light equipment hire any qualified pilot, particularly if he is trained in a desired specialty such as, for example, crop dusting.

Viewed another way, young pilots released from the military services and young civilian commercial pilots with heavy aircraft experience are the major sources of supply for the airlines. Older military-trained pilots and civilian commercial pilots with adequate or specialized training, not necessarily on heavy equipment, are the major sources for general aviation.

In terms of pilot type, those with training, experience, and skill in flying heavy equipment come primarily from the military services; those with training and skill in flying light equipment, or in providing specialized flying services of some kind, come either from the older military or from civilian training facilities. Helicopter pilots, for both airlines and general aviation, are an exception; the military will continue to provide almost all of the helicopter pilots for civil aviation, as it always has. Flight instructors at schools are, for the most part, a transient civilian-trained group seeking to log a sufficient number of flying hours for possible advancement to jobs on airlines or elsewhere in general aviation. They are readily available.

Adequacy of supply. The relationship of probable pilot supply to prospective demand may be viewed from the same three viewpoints. The overall supply is and promises to be quite adequate, at least in the short run. No airline reported a scarcity of qualified pilot recruits in the USTES survey. General aviation companies, as a whole, were similarly having no trouble hiring. Some, however, complained of retention problems. They were losing their company-trained pilots to the airlines or to government jobs as soon as they had acquired the requisite number of flight-hours and training. Others could not provide their pilots with full-time, steady

employment and, consequently, competitive annual earnings. Some solved this problem by using their pilots as mechanics or to give flying instruction, as in many small taxi operations, in slack periods. Most general aviation companies, however, were finding it possible to hire and retain a sufficient number of qualified pilots who did not meet the high personnel standards of the airlines and were, perforce, content with general aviation jobs. A few, notably some of those engaged in aerial application activities such as crop dusting, were encountering a stringency in the supply of pilots with the necessary special qualifications for their particular type of work.

The supply of pilots with the desired background of military training appeared to be adequate for current and short-range future needs. Similarly, civilian training facilities appeared to be generating a sufficient number of professional pilots to keep the civil aviation pipeline filled with prospective recruits.

Pilot schools. Civilian pilot training facilities, except on heavy aircraft, are numerous and widely available. As of January 1, 1968, more than 1,700 flight and ground schools offered FAA-approved instruction programs to potential pilots. In addition, there were perhaps as many as 1,500 noncertificated pilot schools whose course content and standards met FAA requirements. Many small general aviation companies, such as air taxis, teach flying in addition to their other activities, but do not consider that they are running "schools," and so are not counted as such.

The 1,720 FAA-certificated pilot schools as of January 1968 represented, as table 21 shows, a substantial increase in number over the 1,182 in December 1965,[14] and there is every indication that this growth is continuing to the present time. Certification by FAA depends not on the size of the school, but on quality of curriculum, including actual course content, facilities, and equipment, as well as on qualification of instructors. Approved schools range from operations with one part-time teacher to universities offering professional pilot courses entailing 4 years of intense study and flight training. By January 1, 1968, there were 65 FAA-approved schools being operated by, or in conjunction

[14] There were 953 FAA-approved schools offering flight training in 1963, and 994 in 1964, according to FAA, "Project Long Look," op. cit., p. 94.

Table 14. Civil air carriers, number and percentage distribution of fixed-wing and helicopter pilots, by industry division, anticipated employment at peak 1970

Industry division	Anticip. empl. at peak 1970		
	Total pilots	Fixed-wing pilots	Helicopter pilots
	Number of employees		
All civil air carriers			
All pilots and copilots	39,400	39,185	215
Pilots and copilots, except flight instructors	38,000	37,790	210
Flight instructors	1,400	1,395	5
Certificated route carriers			
All pilots and copilots	37,100	36,895	205
Pilots and copilots, except flight instructors	35,780	35,580	200
Flight instructors	1,320	1,315	5
	Percentage distribution		
All civil air carriers			
All pilots and copilots	100.0	99.5	0.5
Pilots and copilots, except flight instructors	100.0	99.4	0.6
Flight instructors	100.0	99.6	0.4
Certificated route carriers			
All pilots and copilots	100.0	99.4	0.6
Pilots and copilots, except flight instructors	100.0	95.9	0.5
Flight instructors	100.0	99.6	0.4

SOURCE: Total employment as shown in table 3 distributed on basis of USTES survey sample data.

with, an accredited college or university. About 185 schools had attained sufficient stature to be granted examining authority. But the vast majority were small enterprises with a few pupils, conducted on a part-time basis at small fields in relatively light aircraft, frequently in conjunction with other commercial operations which constituted the main business.

Flight and ground training for pilots at certificated schools is widely available on a geographic basis, as shown in table 22. California had the largest number (235) in any one State in January 1968, with Texas second (142), and New York third (80). But each of the other 47 States and the District of Columbia had a substantial number in relation to its size, ranging from 2 in the District of Columbia to 66 in Pennsylvania. All 27 labor areas for which the USTES received reports in the spring of 1968 indicated that they had adequate training facilities for pilots.

The schools offered a broad range of instruction, from elementary flight and ground courses through programs for flight instructors and commercial flying with instruments, as table 22 also shows. Altogether, a total of 7,025 instruction programs were authorized for the 1,720 certificated schools. About 1,600 of these FAA authorizations, or ratings, applied to basic and advanced ground school programs; 2,864 to primary and commercial airplane flying programs; 1,108 to instrument flying programs; and 1,257 to flight instructor

PILOTS

Table 15. All civil aviation, number and percentage distribution of employed pilots by highest rating held, by industry division and sector, spring 1968

Industry division/sector	All pilots and copilots	Pilots and copilots whose highest rating was--		
		Airline transport	Commercial	Other rating[1/]
	Number employed			
Grand total	66,260	28,360	37,250	650
Air carriers, total	34,500	16,990	17,510	(2/)
Certificated route	32,500	16,000	16,500	(2/)
Others	2,000	990	1,010	(2/)
General aviation, total	31,760	11,375	19,740	645
Executive transportation	13,880	7,980	5,780	120
Air taxi	7,640	1,360	6,120	160
Aerial application	1,750	35	1,570	145
Industrial/special	1,620	310	1,300	10
Flight and ground schools	4,080	770	3,220	90
Government	2,140	800	1,250	90
Repair stations	650	120	500	30
	Percentage distribution			
Grand total	100.0	42.8	56.2	1.0
Air carriers, total	100.0	49.2	50.8	–
Certificated route	100.0	49.2	50.8	–
Others	100.0	49.5	50.5	–
General aviation, total	100.0	35.8	62.2	2.0
Executive transportation	100.0	57.5	41.6	0.9
Air taxi	100.0	17.8	80.1	2.1
Aerial application	100.0	2.0	89.7	8.3
Industrial/special	100.0	19.1	80.3	0.6
Flight and ground schools	100.0	18.9	78.9	2.2
Government	100.0	37.4	58.4	4.2
Repair stations	100.0	18.5	76.9	4.6

1/ Mainly instructor or helicopter.
2/ Fewer than 5.
SOURCE: Employment totals as shown in tables 3 and 9 distributed on the basis of USTES survey sample data.

Table 16. All civil aviation, percentage distribution of airline transport rated and commercial rated pilots, by industry division and sector, spring 1968

Industry division/sector	All pilots and copilots	Pilots and copilots whose highest rating was--		
		Airline transport	Commercial	Other rating
Grand total	100.0	100.0	100.0	100.0
Air carriers, total	52.1	59.9	47.0	0.8
Certificated route	49.0	56.4	44.3	–
Others	3.0	3.5	2.7	–
General aviation, total	47.9	40.1	53.0	99.2
Executive transportation	20.9	28.1	15.5	18.5
Air taxi	11.5	4.8	16.4	24.6
Aerial application	2.6	0.1	4.2	22.3
Industrial/special	2.4	1.1	3.5	1.5
Flight and ground schools	6.2	2.7	8.6	13.8
Government	3.2	2.8	3.4	13.8
Repair stations	1.0	0.4	1.3	4.6

SOURCE: Based on table 15.

programs. Very few schools offered approved training related to glider and helicopter flying. As previously noted, the civilian aviation industry depends almost entirely on the military for its supply of helicopter pilots because of the high cost of such training. More importantly, very few schools have or are able to offer training on jets or other types of heavy, sophisticated equipment which are used by air carriers, in some executive flying, and by some air taxis. Where they do offer this type of training, it is usually by special tie-in arrangement with companies owning the necessary aircraft and the runways on which to operate them.

Government aid. The recent sharp increase in the number, and, in many instances, the capacity of FAA-certificated flight schools received its major impetus from the provisions of the Veterans Pension and Readjustment Assistance Act of 1967 (Public Law 90-77), effective October 1, 1967. This Act approved financial assistance by the Veterans Administration for ex-servicemen who are qualified to take flight training leading to a commercial pilot's license. The benefits are quite liberal–90 percent of established tuition and fee charges for a period up to 36 months.[15]

The 1967 GI benefit law represented a drastic change from the provisions of its 1966 counterpart. The 1966 Act contained a clause specifying that flight training would be paid for only if it were part of an accredited college course leading to a degree. The 1967 Act relaxed the college-course provisions of the 1966 Act, but substituted others. To qualify for benefits under PL 90-77, a veteran must have been in the military service for more than 180 days, already possess a private pilot's license or the equivalent number of flight hours to earn such a license, pass a Class II medical examination, and must take advanced flight training in an FAA-certificated school and only for the purpose of seriously preparing for a career in civil aviation with, at least, a commercial pilot's license. The Act covers an 8-year period ending August 31, 1975.

The response by veterans to the opportunity to undertake serious career flight training with VA reimbursement has been enormous. Many additional schools have applied for and been granted FAA certification to become eligible under the program. Moreover, since the 1967 Act became effective, the content of the approved programs has been enlarged to include special courses for additional pilot ratings, as well as proficiency courses in agricultural and specialized helicopter operations for which no ratings are given. Under amendments to the regulations governing certification of pilot schools (Part 141 of the Federal Aviation Regulations), FAA will now approve courses for aircraft class and type ratings, and for preparation for airline transport pilot certificates, agricultural flying, and special operations involving external loads on helicopters, as well as courses leading

[15] In addition, the U.S. Office of Education will lend up to $1,000 for students taking flight training at certificated schools. The loan program is open to all students, including those who cannot fully meet VA criteria.

Table 17. All civil aviation, employed pilots whose highest rating was commercial who also held instrument ratings, spring 1968

Industry division/sector	Commercial rated pilots		
	Total number	Instrument rated	
		Number	Percent of total
Civil aviation, total	37,250	32,275	86.6
All carriers	17,510	17,485	99.9
Excluding flight instructors	16,880	16,855	99.9
Flight instructors	630	630	100.0
Certificated route carriers	16,500	16,466	99.8
Excluding flight instructors	15,900	15,875	99.8
Flight instructors	600	590	98.3
General aviation, total	19,740	14,790	74.9
Executive transportation	5,780	4,745	82.1
Air taxi	6,120	4,800	78.4
Aerial application	1,570	535	34.1
Industrial/special	1,300	605	46.5
Flight and ground schools	3,220	2,675	83.1
Government	1,250	1,055	84.4
Repair stations	500	375	75.0

SOURCE: Employment totals as shown in tables 3 and 9 distributed on the basis of USTES survey sample data.

to a certificate as a commercial pilot, flight instructor, or instrument-rated pilot.

By the end of February 1969, according to a VA survey,[16] about 29,400 veterans had completed flight training of some kind, and 21,370 were enrolled at flight schools. Schools were enlarging their capacity in anticipation of further increases in enrollments of veterans.

School graduates as source of supply. Evaluation of flying school graduates as additions to the professional pilot labor supply involves consideration of two aspects—numbers and qualifications. Unfortunately, there are no comprehensive FAA data on the number who graduate each year with at least a commercial license, or, more importantly, on the number of these who enter and remain in the civil aviation industry as professionals. While estimates based on the USTES spring 1968 survey of employers show that about 56,000 students were expected to be graduated from flight and ground schools in 1968, there is every indication that this figure is highly inflated to the extent that surveyed schools reported total enrollment rather than prospective graduates. Moreover, there was no indication of what type of pilot training these students had undertaken, for which licenses they were qualifying, nor whether they expected to make a career of aviation or were simply taking instruction for their private use or pleasure.

It is quite clear that not all flight school training is to be construed as adding to the civil aviation industry's professional pilot supply. Many students start training but drop out before completion. A great many others study only long enough to obtain a private license. Still others are already licensed commercial pilots merely seeking additional type or class ratings. For example, one large school reported in the USTES survey that, out of 600 pilots to be trained in 1968, 50 sought additional ratings, 540 sought check outs in various aircraft models, and only 10 were training for new licenses. It remains to be seen whether the new VA-supported school program, oriented as it is toward serious preparation for a civil aviation career, will eventually produce substantial numbers of additional qualified professional pilots.

On-the-job training. Some on-the-job training of pilots was going on in every sector of the civil aviation industry in 1968. It is estimated, on the basis of employer reports made in the spring of 1968, that about 25,000 pilots would complete formal company training programs of some kind during the year. Most of this was orientation, refresher, upgrading, class, or type training of experienced pilots. About 5,700 pilots were being trained by carriers and the remainder by general aviation firms,[17] primarily those in executive transportation and air taxi operations, many of which provide flight instruction as a sideline. Some of the training of general aviation pilots on the larger and more sophisticated aircraft which were coming into increasing use, especially in corporate or executive flying, was being provided by contract with airlines. Some aircraft manufacturers were also providing training of employed pilots on new generations of aircraft as they were put to use.

Conclusions

The potential supply of qualified professional pilots appears to be quite adequate for the overall needs of the civil aviation industry, at least for the short-run period under review. No shortage existed or was contemplated in employer reports.

School facilities are numerous and widespread. Unusually good VA benefits are available to veterans who qualify and are willing to undertake schooling leading to a professional pilot's career, and thousands have taken advantage of the opportunity. Companies are providing on-the-job training to meet their own particu-

[16] Veterans Administration, Department of Veterans Benefits, unpublished data.

[17] Not including flight and ground schools.

Table 18. Civil air carriers, number and percentage distribution of employed pilots by highest rating held, by industry division, spring 1968

Industry division	All pilots and copilots	Pilots and copilots, excluding flight instructor--		Flight instructors
		Total	Who were also flight engineers	
	Number employed			
All carriers, total	34,500	33,255	9,940	1,245
Airline transport	16,990	16,375	4,895	615
Commercial	17,510	16,880	5,045	630
Instrument rated	17,485	16,855	n.a.	630
Certificated route carriers, total	32,500	31,330	9,815	1,170
Airline transport	16,000	15,430	4,835	570
Commercial	16,500	15,900	4,980	600
Instrument rated	16,465	15,875	n.a.	590
	Percentage distribution			
All carriers, total	100.0	100.0	100.0	100.0
Airline transport	49.2	49.2	49.2	49.4
Commercial	50.8	50.8	50.8	50.6
Instrument rated	50.7	50.7	n.a.	50.6
Certificated route carriers, total	100.0	100.0	100.0	100.0
Airline transport	49.2	49.2	49.3	48.7
Commercial	50.8	50.8	50.7	51.3
Instrument rated	50.7	50.7	n.a.	50.4

SOURCE: Employment totals as shown in table 3 distributed on the basis of USTES survey sample data.

lar standards and requirements, and there is no lack of recruits from among either releasees from the military services or from the civilian labor force.

Although general aviation companies were reportedly suffering from turnover resulting from the competition of the airlines for the cream of the trained pilot supply, this situation promised to ease as airline growth requirements tapered off to a plateau through 1970. General aviation's ability to hire and retain pilots will depend on the terms of employment being offered. Airlines have proven that they can attract the kind of pilot they desire. An airline pilot career is a desirable one, with provision for advancement on a seniority basis, and from the smaller, slower aircraft to the largest and fastest, with concomitant pay increases and other benefits. General aviation companies will have to take these factors into account in seeking to solve their turnover problems.

Employment trends

A total of 100,500 aircraft mechanics[18] were employed in civil aviation[19] in the spring of 1967. By the spring of 1968, about 5,300 or 5.3 percent more had been added to payrolls and estimates based on employer anticipations at that time indicated a prospective even sharper employment rise of 7,600, or 7.2 percent, by spring 1969 (tables 23 and 24). The 1969-70 increase, however, was expected to drop to 4,400, or 3.9 percent. If reported hiring schedules materialize as planned, spring 1970 mechanic employment will be an estimated 17,300, or 17.2 percent above spring 1967, and peak 1970 mechanic employment will be approximately 20,000, or 18 percent above the 1967 peak. This would represent an average 3-year requirement of roughly 6,700 a year for expansion purposes alone, not including the need for replacement of workers who leave the industry for one reason or another.

As in the case of pilots, the major part of the demand for additional mechanics is attributable to the anticipated growth requirements of general aviation companies. Aircraft mechanic employment in general aviation totaled 51,500 in spring 1967. By spring 1968 this total had risen by 3,300, or 6.4 percent, to 54,800. Employers expected it to rise 5,600, or about 10 percent more, to 60,400 by the spring of 1969. Although between 1969 and 1970 the demand for general aviation aircraft mechanics was expected to be less than half that of the previous year, dropping to 2,400 or 4.0 percent, spring 1970 employment was expected to total 62,800, about 11,300 or 22 percent above spring 1967, according to estimates based on employers' reports to the USTES. The peak 1967 to peak 1970 growth requirements estimate was even higher—13,400 or 23 percent over the 3-year period. On the basis of these estimates, the average annual 1967-70 demand for aircraft mechanics by the general aviation industry for expansion purposes alone appears to be in the neighborhood of 4,500 a year.

Air carrier demand was expected to be less than half of this. Carriers employed 49,000 mechanics in spring 1967, had added 2,000 (or 4 percent) by spring 1968, and expected to continue to add about 2,000 (or roughly 4 percent) a year through 1970, for a total expansion of 6,000, or about 12 percent over the 3-year period. At peak 1970, air carrier mechanic employment was expected to total approximately 60,000, and to be only 6,500 or 12.2 percent above peak 1967.

Route airlines, both scheduled and nonscheduled, accounted for 96 percent of all air carrier mechanic employment and for virtually all of the estimated prospective employment increases. Other types of carriers (supplemental and commercial operator) expected to add only about 200 mechanics between peak 1967 and peak 1970.

While strictly comparable historical data are not available, closely related figures, including maintenance workers as well as mechanics, which are compiled each year by the Federal Aviation Administration,[20] indicate that the prospective 2000-a-year growth requirement for aircraft mechanics by certificated route airlines in 1969 and 1970 would represent a continued leveling off in the rapid employment expansion which had been going on since 1964. The 1963-64 increase in the employment of mechanics and maintenance workers was 4,900. Comparable year-to-year changes for the years through 1968 were approximately as follows: 1964-65, 2,300; 1965-66, 3,660; 1966-67, 4,700; 1967-68, 2,000.

If all plans for the expansion of mechanic employment through 1970 are realized, the general aviation division will employ, at that time, an even larger proportion of the total civilian aircraft mechanic force[21] than it did in 1967. In spring 1967, general aviation mechanics accounted for 51.2 percent of a total of 100,500 employed aircraft mechanics. Attainment of the spring 1970 employment levels, estimated on the basis of the anticipations reported in the USTES survey sample, by all civil aviation employers would raise general aviation's share to 53.3 percent. General aviation firms would have 7,800 more mechanics on their payrolls than did air carriers; the difference was 2,500 in 1967.

Air carrier mechanics, by occupation. The U.S. Training and Employment Service survey of the air carrier industry yielded a breakdown on the basis of which it was possible to estimate both current and

[18] Only aircraft mechanics are included in this survey. Maintenance workers, such as carpenters and electricians, are excluded. Each of the mechanic occupations covered is described in Appendix B.

[19] Air carriers and general aviation, excluding civilian employees of the Department of Defense, who are considered in Section IV.

[20] FAA, *Statistical Handbook of Aviation,* and Air Transport Association of America, *Air Transport Facts and Figures.*

[21] Excluding the Department of Defense.

PILOTS

Table 19. All civil aviation, number and percentage distribution of employed pilots aged 50 years and over, spring 1968

Industry division/sector	Pilots		
	Total	Aged 50 years and over	Aged 50 years and over as percentage of total
	Number employed		
Grand total	66,260	7,265	11.0
Air carriers, total	34,500	3,255	9.4
Certificated route	32,500	3,065	9.4
Others	2,000	190	9.5
General aviation, total	31,760	4,010	12.6
Executive transportation	13,880	1,830	13.2
Air taxi	7,640	900	11.8
Aerial application	1,750	230	13.1
Industrial/special	1,620	120	7.4
Flight and ground schools	4,080	445	10.9
Government	2,140	400	18.7
Repair stations	650	85	13.1
	Percentage distribution		
Grand total	100.0	100.0	
Air carriers, total	52.1	44.8	
Certificated route	49.0	42.2	
Others	3.0	2.6	
General aviation, total	47.9	55.2	
Executive transportation	20.9	25.2	
Air taxi	11.5	12.4	
Aerial application	2.6	3.2	
Industrial/special	2.4	1.7	
Flight and ground schools	6.2	6.1	
Government	3.2	5.5	
Repair stations	1.0	1.2	

SOURCE: Employment totals as shown in tables 3 and 9 distributed on the basis of USTES survey sample data.

prospective employment of mechanics in specific occupations; i.e., certificated aircraft and engine mechanic,[22] certificated airplane electrician, electronic mechanic, and "other" types of mechanic, which includes certificated radio, instrument, propeller, and specialized services mechanic. Each of these occupations, or occupational categories, is described in Appendix B. A similar breakdown by specific mechanic occupation was not obtained for the general aviation industry.

About half of all mechanics employed by civil air carriers in the spring of 1968 were aircraft and engine mechanics certificated by the FAA, according to estimates based on employer reports, and about two-fifths were in the "other" category (table 25). Airplane electricians and electronic mechanics each constituted 5-6 percent of the total.

Air carriers employed about 25,300 certificated aircraft and engine mechanics (also known as licensed airframe and powerplant mechanics) in the spring of 1968, both on the line and in overhaul and maintenance bases. Spring 1968 employment was about 1,500 above spring 1967, but carriers expected to add only about 900 in the following 2 years. The overall 3-year estimated demand for licensed airframe and powerplant (A&P) mechanics, measuring from spring 1967 to spring 1970, totaled somewhat more than 2,400, of which more than half had apparently already been met by spring 1968.

The estimated 3-year growth requirement for the miscellaneous group of "other" mechanics, which embraces a variety of very specialized and highly skilled workers, was somewhat higher, totaling approximately 2,800. About 20,000 of these specialized mechanics worked for air carriers in spring 1968, only 220 more than in spring 1967. But the demand was increasing sharply. Employers hoped to hire an additional 2,600 by spring 1970, and to have nearly 3,600 more on their payrolls at peak 1970 than they had at peak 1967.

Roughly 2,800 airplane electricians and 2,800 electronic mechanics were in the employ of civil air carriers in the spring of 1968. Estimates based on reported employer anticipations indicated a need for an additional 250 electricians and 270 electronic mechanics in the ensuing 2 years. By peak 1970, employment in each of these occupations was estimated to total around 3,350, requiring the net addition of about 400 of each

[22] The title "aircraft and engine" mechanic and "airframe and powerplant (A&P)" mechanic are interchangeable.

PILOTS

Table 20. All civil aviation, total and average annual hours flown by pilots, year ending April/May 1968

Industry division/sector	All pilots and copilots	Pilots and copilots excluding flight instructors	Flight instructors
	Total hours flown (thousands)		
Grand total	32,355.1		
Civil air carriers, total	17,415.1	16,977.0	438.1
Certificated route	16,390.4	15,996.9	393.5
Other	1,024.7	980.1	44.6
General aviation, total	14,940.0		
Executive transportation	5,241.8		
Air taxi	5,280.9		
Aerial application	791.2		
Industrial/special	259.1		
Flight and ground schools	2,612.6		
Government	430.8		
Repair stations	323.6		
	Average annual hours flown per pilot		
Grand total	512		
Civil air carriers, total	515	521	360
Certificated route	515	522	344
Other	512	508	615
General aviation, total	509		
Executive transportation	407		
Air taxi	763		
Aerial application	487		
Industrial/special	166		
Flight and ground schools	708		
Government	208		
Repair stations	519		

SOURCE: USTES survey sample data for total hours flown by pilots inflated to national totals by same factor as used to inflate 1967 survey employment data. Average annual hours flown per pilot computed by dividing total hours flown by average of employment in spring of 1967 and spring of 1968.

type of mechanic above peak 1967. Air carrier needs for licensed airplane electricians and electronic mechanics were relatively small in number, but reportedly crucial to operations.

General aviation mechanics, by industry sector. While about three-fourths of the nearly 55,000 general aviation aircraft mechanics were in repair stations in the spring of 1968, some were employed in each of the other sectors, according to estimates based on employers' reports to the USTES survey (table 26). About 6,000, or 11 percent of the total, were engaged in maintaining and repairing aircraft used in executive transportation; close to 2,600, or nearly 5 percent of the total, were employed by air taxi operations; and more than 3,000, or close to 6 percent, were at schools, both teaching and maintaining equipment. State and local governments and Federal Government nonmilitary agencies employed about 1,000. Approximately 900 were employed by firms engaged in industrial/special activities, and 700 were in the aerial/application sector.

Not all of these mechanics were full-time or certificated or licensed, but most were all-around mechanics. The general aviation industry is characterized by small establishments, frequently with no more than one or two aircraft to maintain. If a mechanic is employed, he must be able to do all the work. In many one-man operations, particularly in the aerial/application and industrial/special sectors of the industry, the pilot, who is also frequently the owner-operator, is a qualified airframe and engine mechanic as well, and performs the maintenance function on a when-needed basis. Operators who do not employ their own mechanics, or whose repair needs are beyond the abilities of their staffs, have their work done at repair stations or at the overhaul and maintenance bases of air carriers.

Repair stations employed about 39,000 mechanics and repairmen in 1967, and estimates based on the USTES sample of firms indicate a peak 1967 to peak 1970 need for about 8,300 or 19 percent more (table 27). An expansion of more than 1,800, or 31 percent, was planned by companies providing executive transportation. The sharpest relative increase was contemplated by schools and by air taxis. Both mechanic schools and air taxi operations hoped to have roughly 45 percent more mechanics on their payrolls at peak 1970 than they had at peak 1967. Each of the other general aviation sectors also planned to expand its mechanic work force well above previous levels.

Table 21. Number of FAA-certificated flight and ground schools for pilots, by type of school, 1965-68

Type of school	Number of certificated schools for pilots		
	Dec. 31, 1965	Dec. 31, 1966	Jan. 1, 1968
Combined flight and ground	402	505	813
Flight only	734	773	780
Ground only	46	74	127
Total	1,182	1,352	1,720

SOURCE: U.S. Department of Transportation, Federal Aviation Administration, *Statistical Handbook of Aviation,* 1966 and 1967 editions, for 1965 and 1966 data. January 1, 1968 data compiled from FAA:AC No. 140-2 D.

Mechanics age 50 years and over

Age is less of an employment barrier for mechanics than for pilots. There are no FAA retirement age regulations for mechanics employed by air carriers, as there are for pilots or in general aviation firms, and a good number are in the upper age brackets.

Estimates based on the USTES survey indicate that about 15 percent of the 105,800 mechanics employed in civil aviation in spring 1968, excluding civilians employed by the Department of Defense, were 50 years of age and over (table 28). Older mechanics accounted for 12 percent of the total number employed by air carriers and for 17 percent of all mechanics employed in general aviation, reflecting again the preference of carriers for younger workers.

Although mechanic employment was divided fairly evenly between the carriers and general aviation in 1968, the carriers employed slightly less than 40 percent of the 15,800 older mechanics; about 60 percent were employed in general aviation, with 47 percent of the 15,800 at repair stations.

Mechanic supply

The major sources of supply for mechanics in recent years have been, and continue to be, graduates of public and private vocational institutions and veterans who have had some aircraft mechanic training and experience in the armed forces. Each of these sources, as well as the extent of on-the-job training being provided by employers, is evaluated below, within the framework of available information.

Aircraft Mechanic Schools. As of mid-January 1969, a total of 106 aviation mechanic schools had been certificated by the FAA. Altogether these schools offered: 86 programs in powerplant mechanic skills, 82 programs in airframe mechanic skills, and 75 programs in

Table 22. FAA-certificated pilot flight and ground schools, by state and certificated program (rating)
January 1, 1968

Region[1] and State	Number of certificated programs (ratings)[2]											Total number	
	B	A	P	C	PG	CG	PH	CH	F	FH	I	Schools	Ratings
Total, U.S., Territories, and Europe	869	733	1,518	1,346	17	8	93	69	1,257	7	1,108	1,720	7,025
North East:													
New England	39	17	74	60	2		2		55		49	82	298
Maine	7	1	10	8					8		7	10	41
New Hampshire	5		7	5					3		5	8	25
Vermont	3		8	5	1				6		3	10	26
Massachusetts	16	9	29	23	1		1		21		19	33	119
Rhode Island			6	6			1		6		3	7	22
Connecticut	8	7	14	13					11		12	14	65
Middle Atlantic	97	68	148	131	3		12	5	111	1	105	177	681
New York	49	32	60	52	3		5	3	43		42	80	289
New Jersey	14	13	27	27			3		21		20	31	125
Pennsylvania	34	23	61	52			4	2	47	1	43	66	267
North Central:													
East North Central	130	109	231	207	3	1	11	6	196	1	174	256	1,069
Ohio	23	17	46	41	1		1	1	39		39	48	208
Indiana	20	14	30	25	1		3	2	24		18	38	137
Illinois	41	40	65	58	1	1	5	1	53		50	74	315
Michigan	40	32	59	56			2	2	55	1	49	64	296
Wisconsin	6	6	31	27					25		18	32	113
West North Central	89	74	165	145			11	8	140		110	179	742
Minnesota	24	21	34	31			4	4	31		25	38	174
Iowa	7	4	22	20			1	1	20		15	24	90
Missouri	20	19	29	25			2	2	26		23	32	146
North Dakota	14	9	15	13					14		10	15	75
South Dakota	9	6	12	10					8		7	15	52
Nebraska	6	4	21	17			2	1	16		9	23	76
Kansas	9	11	32	29			2		25		21	32	129
South:													
South Atlantic	110	110	189	170	2	2	7	6	156		138	217	890
Delaware	2	1	3						3		3	4	15
Maryland	6	4	13	13					9		10	15	55
Dist. of Col.	2	1	2	2					1		1	2	9
Virginia	7	7	20	18					16		13	21	81
West Virginia	2	1	8	7					6		3	8	27
North Carolina	10	13	25	22					22		22	26	114
South Carolina	13	10	20	15	1	1	2	2	15		10	25	89
Georgia	26	21	37	30					27		26	40	167
Florida	42	52	61	60	1	1	5	4	57		50	76	333

See footnotes at end of table.

Table 22. FAA-certificated pilot flight and ground schools, by state and certificated program (rating) January 1, 1968—Continued

Region[1] and State	Number of certificated programs (ratings)[2]											Total number	
	B	A	P	C	PG	CG	PH	CH	F	FH	I	Schools	Ratings
East South Central	53	42	88	78			2	2	77	1	66	92	409
Kentucky	14	12	16	15			1	1	15		15	19	89
Tennessee	17	9	28	25			1	1	24	1	24	29	130
Alabama	12	12	20	17					17		13	20	91
Mississippi	10	9	24	21					21		14	24	99
West South Central	141	126	214	181	3	3	13	11	168	1	156	232	101
Arkansas	7	6	18	15					13		11	19	70
Louisiana	14	11	28	23			4	2	23		21	29	126
Oklahoma	25	18	36	28	1	1	1		24		25	42	159
Texas	95	91	132	115	2	2	8	9	108	1	99	142	662
West:													
Mountain	43	41	124	114	2	2	13	13	104	1	86	134	543
Montana	15	14	27	24			2	2	26		16	28	126
Idaho			13	11			1	1	12		9	13	47
Wyoming		1	4	3					2		1	4	11
Colorado	11	6	24	25	1	1	1	1	23		21	26	114
New Mexico	6	8	14	14			2	2	12		10	15	68
Arizona	7	5	20	20			3	3	14	1	15	25	88
Utah	4	3	13	9	1	1	2	2	8		8	14	51
Nevada		4	9	8			2	2	7		6	9	38
Pacific	160	139	280	256	2		22	18	247	2	222	344	1,348
Washington	22	19	50	47	1		3	3	47	1	38	58	231
Oregon	7	7	25	23			2	2	24		18	31	108
California	116	99	187	170	1		16	12	164		153	235	918
Alaska	11	10	11	11			1	1	9	1	10	13	65
Hawaii	4	4	7	5					3		3	7	26
Territories:													
Puerto Rico	5	5	3	2					2		1	5	18
Guam	1	1	1	1								1	4
Europe:													
Antwerp	1	1	1	1					1		1	1	6

[1] Regional distribution has been converted from FAA to Labor Department pattern.

[2] Key to ratings:

B — Basic Ground School; A — Advanced Ground School; P — Primary Flying School - Airplane; C — Commercial Flying School - Airplanes; PG — Primary Flying School - Glider; CG — Commercial Flying School - Glider; PH — Primary Flying School - Helicopter; CH — Commercial Flying School - Helicopter; F — Flight Instructor School; CH — Commercial Flying School - Helicopter; F — Flight Instructor School; FH — Flight Instructor School - Helicopter; I — Instrument Flying School.

SOURCE: Derived from U.S. Department of Transportation, Federal Aviation Administration, *List of Certificated Pilot Flight and Ground Schools*, January 1, 1968, AC 140-2D, pp. 1-46.

Table 23. All civil aviation, employment trends, all mechanics,[1] by industry division, 1967-70

Date	Total	Air carriers		General aviation
		Total	Certificated route	
	Number employed			
Spring of:				
1967	100,500	49,000	47,000	51,500
1968	105,800	51,000	49,000	54,800
1969 (est.)	113,400	53,000	51,000	60,400
1970 (est.)	117,800	55,000	53,000	62,800
Peak of:				
1967	111,300	53,300	51,100	58,000
1968 (est.)	117,900	55,400	53,300	62,500
1970 (est.)	131,200	59,800	57,600	71,400
	Percentage distribution			
Spring of:				
1967	100.0	48.8	46.8	51.2
1968	100.0	48.2	46.3	51.8
1969 (est.)	100.0	46.7	45.0	53.3
1970 (est.)	100.0	46.7	45.0	53.3
Peak of:				
1967	100.0	47.9	45.9	52.1
1968 (est.)	100.0	47.0	45.2	53.0
1970 (est.)	100.0	45.6	43.9	54.4

[1]/Aircraft mechanics only; does not include maintenance workers.
SOURCE: See table 1.

combined airframe and powerplant mechanic skills (table 29).

Both the number of schools and the number of certificated programs being offered have increased rapidly since the middle of 1967. FAA-certificated aviation mechanic schools totaled 69 in 1963,[23] 10 were added in the 4½ years between then and July 1, 1967, but 27 more were brought into the program in the ensuing year and a half to reach the total of 106 on January 15, 1969.[24] During the same 18-month period, the total number of FAA-approved courses given by these schools also increased sharply, from 192 to 243.

In table 30, all certificated aviation mechanic school programs offered during the period August 1966 to January 1969 have been grouped according to the regions and labor areas in which they were located. From this it may be seen that, in January 1969, more than three-fifths of all approved programs were being offered in the North Central and Western States. Nine States[25] and the District of Columbia had no approved programs at all. Indeed, location of the certificated schools appears to bear only a minor relationship to probable concentrations of demand for graduates. Thus, there are only three schools in the New York metropolitan area, of which only one is a major supplier; only three schools in the Chicago area, of which none is a major supplier; and no school at all in Nashville, Tenn., a medium-sized hub. On the other hand, aviation mechanics graduated from the major supplier in Pittsburgh, Pa., have to leave the area to find jobs; there is always a local surplus.

Comprehensive data on total enrollment and sizes of the annual graduating classes of certificated aviation mechanic schools are not readily available, since FAA does not require the schools to maintain or report such records. However, information gathered as a by-product of the two formal FAA school inspections which are made each year gives some clues. On this basis, as well as on the basis of data reported in the USTES 1968 survey, it is estimated that between 12,000 and 13,500 students were enrolled in FAA certificated aviation mechanic schools in 1968 (compared with 8,000 in 1963),[26] and that the total number of prospective graduates in 1968 was in the neighborhood of 4,000 to 5,000. The number of graduates per school per year varies widely, ranging between 2 to 5 and 500 to 600. Only seven schools are "major suppliers" of aviation mechanics. In addition to those mentioned above in the New York and Pittsburgh areas, major suppliers are located in Teterboro, New Jersey; Daytona Beach, Florida; Tulsa, Oklahoma; Lexington, Massachusetts; and Inglewood, California.

The great majority of aviation mechanic schools are public institutions at vocational high school and tech-

[23] FAA, "Project Long Look," op. cit., p. 69.

[24] There are, in addition, an unknown but undoubtedly large number of noncertificated schools that have, for one reason or another, not sought or been granted certification.

[25] Delaware, Kentucky, Maine, New Hampshire, Rhode Island, Tennessee, Vermont, Virginia, West Virginia.

[26] FAA, "Project Long Look," op. cit., p. 69.

Table 24. All civil aviation, increases in employment over specified periods, by industry division, 1967-70

Date	Total	Air carriers		General aviation
		Total	Certificated route	
	Employment increases			
Spring of:				
1967-68	5,300	2,000	2,000	3,300
1968-69 (est.)	7,600	2,000	2,000	5,600
1969-70 (est.)	4,400	2,000	2,000	2,400
1967-70 (est.)	17,300	6,000	6,000	11,300
Peak of:				
1967-68 (est.)	6,600	2,100	2,200	4,500
1968-70 (est.)	13,300	4,400	4,300	8,900
1967-70 (est.)	19,900	6,500	6,500	13,400
	Percentage increases			
Spring of:				
1967-68	5.3	4.1	4.3	6.4
1968-69 (est.)	7.2	3.9	4.1	10.2
1969-70 (est.)	3.9	3.8	3.9	4.0
1967-70 (est.)	17.2	12.2	12.8	21.9
Peak of:				
1967-68 (est.)	5.9	3.9	4.3	7.8
1968-70 (est.)	11.3	7.9	8.1	14.2
1967-70 (est.)	17.9	12.2	12.7	23.1

SOURCE: Based on table 23.

nical trade school levels; only 16 are private schools, and only 14 are part of public or private universities or colleges, not including junior colleges. The University of Illinois, San Jose, Purdue, Oklahoma State, Idaho State, Utah State, Southern Illinois, and Western Michigan are examples of colleges and universities which offer approved courses for aviation mechanic certification.

Government aid. A major impetus to the recent large increase in the number of aviation mechanic schools seeking FAA certification is the Federal aid offered to such schools through the U.S. Office of Education under the Smith-Hughes Act and under Title 3 of the George-Barden Act. Under these Acts, certificated schools are receiving both financial aid and surplus equipment for use in training aviation mechanics. Federally guaranteed loans for students are also available under the auspices of the U.S. Office of Education, as they are for pilots.

Unlike flight school attendance, attendance at an approved mechanic school of any type has always qualified a veteran for benefits under the "G.I. Bill of Rights." Aviation mechanics, however, are blanketed in with all other types of mechanics under the Veterans Educational Assistance Program and receive no special

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Table 25. Civil air carriers, employment trends, by type of mechanic,[1] 1967-70

Date	Total	Type of mechanic			
		Aircraft and engine mechanics	Airplane electricians	Electronic mechanics	Other mechanics
	Number employed				
Spring of:					
1967	49,000	23,770	2,720	2,700	19,810
1968	51,000	25,300	2,860	2,810	20,030
1969 (est.)	53,000	25,880	2,900	3,000	21,220
1970 (est.)	55,000	26,210	3,110	3,080	22,600
Peak of:					
1967	53,300	26,390	2,960	2,950	21,000
1968 (est.)	55,400	27,540	3,060	3,040	21,760
1970 (est.)	59,800	28,500	3,380	3,350	24,570
	Increases in number employed				
Spring of:					
1967-68	2,000	1,530	140	110	220
1968-69 (est.)	2,000	580	40	190	1,190
1969-70 (est.)	2,000	330	210	80	1,380
1967-70 (est.)	6,000	2,440	390	380	2,790
Peak of:					
1967-68 (est.)	2,100	1,150	100	90	760
1968-70 (est.)	4,400	960	320	310	2,810
1967-70 (est.)	6,500	2,110	420	400	3,570
	Percentage distribution				
Spring of:					
1967	100.0	48.5	5.6	5.5	40.2
1968	100.0	49.6	5.6	5.5	39.3
1969 (est.)	100.0	48.8	5.5	5.7	40.0
1970 (est.)	100.0	47.7	5.7	5.6	41.1
Peak of:					
1967	100.0	49.5	5.6	5.5	39.4
1968 (est.)	100.0	49.7	5.5	5.5	39.3
1970 (est.)	100.0	47.7	5.7	5.6	41.1

[1] Aircraft mechanics only; does not include maintenance workers.

SOURCE: Employment totals as shown in table 23 distributed on the basis of USTES survey sample data.

benefits such as pilots do. Allowances are nominal and are not related to school tuition and fee charges, as are those for pilots. The cost of a mechanic trainee's education may be nothing or much more than his allowance, but this cost is not taken into account in determining the amount of money he receives, nor are any incentives offered to induce him to undertake aviation mechanic schooling rather than any other kind. A veteran attending mechanic school full time receives $130 a month if he has no dependents, $165 a month if he has one dependent, $175 if he has two dependents, and $10 a month more for each dependent above two. Allowances for part-time school attendance are proportionately less.

The latest available Veterans Administration survey indicates that cumulatively through June 30, 1968, a total of only 7,327 men had undergone training as aircraft mechanics with VA benefits[27] (compared with 29,400 pilots). Of these, 7,310 had received their training in school and 17 on the job. Only about 2,300 of the school trainees had attended a vocational school or technical post-high school; the rest, about 5,000, had attended vocational or technical schools which did not require a previous high school education. No information is available as to how many of these 7,300 veteran-trainees had actually sought or found jobs as aircraft mechanics in the civil aviation industry.

School graduates as source of supply. It is said of public aviation mechanic schools that many enroll, few graduate. Moreover, not all graduates, by any means, find their way into jobs in the aviation industry. A graduate of a public school of high school level may have become adept at mechanical skills, but will still require 3 to 4 years of arduous on-the-job training under close supervision before he is ready to undergo FAA examination and fill a licensed aircraft mechanic's position. Many never reach this stage. Upon graduation, they tend to seek mechanic jobs in aircraft manufacturing or outside of the aviation industry where licensing is not required. Perhaps as many as half of them are thus lost to the civil aviation industry.

The quality of education offered in this field in public institutions, many of which are operating at or near capacity, is generally not of the best nor the most up-to-date. A very large amount of space is needed and

[27] Veterans Administration, Department of Veterans Benefits, unpublished data.

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Table 26. General aviation, employment trends and percentage distribution, by industry sector, 1967-70

Sector	Spring of--				Peak of--		
	1967	1968	1969 (est.)	1970 (est.)	1967	1968 (est.)	1970 (est.)
	Number employed[1/]						
General aviation, total	51,500	54,800	60,400	62,800	58,000	62,500	71,400
Executive transportation	5,020	6,090	6,430	6,870	5,960	6,560	7,810
Air taxi	2,290	2,590	3,170	3,530	2,700	3,140	4,000
Aerial application	680	710	810	980	790	810	1,110
Industrial/special	900	910	960	990	960	960	1,130
Mechanic schools	2,490	3,120	3,680	3,880	3,050	3,550	4,400
Government	1,100	1,120	1,150	1,150	1,120	1,160	1,200
Repair stations	39,020	40,260	44,200	45,400	43,420	46,320	51,750
	Percentage distribution						
General aviation, total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Executive transportation	9.8	11.1	10.6	10.9	10.3	10.5	10.9
Air taxi	4.4	4.7	5.2	5.6	4.6	5.0	5.6
Aerial application	1.3	1.3	1.3	1.6	1.4	1.3	1.6
Industrial/special	1.8	1.7	1.6	1.6	1.6	1.5	1.6
Mechanic schools	4.8	5.7	6.1	6.2	5.3	5.7	6.2
Government	2.1	2.0	1.9	1.8	1.9	1.9	1.7
Repair stations	75.8	73.5	73.2	72.3	74.9	74.1	72.5

[1/] Aircraft mechanics only; does not include maintenance workers.
SOURCE: See table 1.

Table 27. General aviation, changes in employment, by industry sector, 1967-70

Sector	Spring of--				Peak of--		
	1967-68	1968-69 (est.)	1969-70 (est.)	1967-70 (est.)	1967-68 (est.)	1968-70 (est.)	1967-70 (est.)
	Increases in number employed						
General aviation, total	3,300	5,600	2,400	11,300	4,500	8,900	13,400
Executive transportation	1,070	340	440	1,850	600	1,250	1,850
Air taxi	300	580	360	1,240	440	860	1,300
Aerial application	30	100	170	300	20	300	320
Industrial/special	10	50	30	90	0	170	170
Mechanic schools	630	560	200	1,390	500	850	1,350
Government	20	30	0	50	40	40	80
Repair stations	1,240	3,940	1,200	6,380	2,900	5,430	8,330
	Percentage increases						
General aviation, total	6.4	10.2	4.0	34.2	7.8	14.2	23.1
Executive transportation	21.3	5.6	28.1	36.9	10.1	19.1	31.0
Air taxi	13.1	22.4	38.4	64.1	16.3	27.4	48.1
Aerial application	4.4	14.1	21.0	44.1	2.5	37.0	40.5
Industrial/special	1.1	5.5	3.1	10.0	0	17.7	17.7
Mechanic schools	25.3	17.9	5.4	55.8	16.4	23.9	44.3
Government	1.8	2.7	0	4.5	3.6	3.4	7.1
Repair stations	3.2	9.8	2.7	16.4	6.6	11.7	19.2

SOURCE: Based on table 26.

often not available. At Aviation High School in Long Island City, New York, the largest aviation mechanic school in the country, for example, 2,400 day students and 525 evening students were enrolled in the spring of 1968, but there were only 2,000 bench spaces. The school was operating above capacity by using extended sessions, but the Board of Education planned no facilities expansion at that time. It is perhaps unreasonable to expect public high schools to be equipped with adequate supplies of materials and sophisticated tools and equipment, or with expensive airframes and jet engines for students to learn on. Only the basics can be taught at most public schools; the practical, real-world training and keeping abreast of the latest developments must take place where the equipment is, i.e., on the job.

Except for graduates of universities and the better private schools who have been certificated or licensed and choose to make a career of aeronautical mechanics, graduates of aviation mechanic schools are generally hired as trainees or apprentices. They are preferred over completely untrained men. As trainees or apprentices, they are in great demand, and it appears that the number that may become available for such work in the civil aviation industry as a whole in the next couple of years may be insufficient to meet the need.

Military-trained mechanics. Although aircraft mechanics trained in the military services are also an important source of manpower supply for civil aviation, employers in both the air carrier and general aviation divisions of the industry reported to the USTES, in the spring of 1968, that men who had received military training only were "severely restricted for immediate placement in the civilian aircraft maintenance industry as full-functioning mechanics" because of their limited work experience. They tend to be specialized, either on one system of one type of airplane, or on some type of aircraft which does not exist in the civilian economy. Like public school graduates, they are generally hired as trainees or apprentices only. Reportedly, they not only require technical retraining, but their general job knowledge must be increased.

Military-service-trained aircraft mechanics, no matter how adequate a source of good prospects for entry occupations, cannot meet civil aviation's short-range need for fully qualified licensed mechanics of various types. Some of the necessary training may be obtained by veterans who seek further instruction at well-equipped schools. But the bulk of it must be obtained on the job.

Table 28. All civil aviation, number and percentage distribution of employed mechanics aged 50 years and over, spring 1968

Industry division/sector	Mechanics1/		
	Total	Aged 50 years and over	Aged 50 and over as percentage of total
	Number employed		
Grand total	105,800	15,775	14.9
Air carriers, total	51,000	6,225	12.2
Certificated route	49,000	5,865	12.0
Others	2,000	360	18.0
General aviation, total	54,800	9,550	17.4
Executive transportation	6,090	930	15.3
Air taxi	2,590	305	11.8
Aerial application	710	115	16.2
Industrial/special	910	100	11.0
Aviation schools	3,120	420	13.5
Government	1,120	205	18.3
Repair stations	40,260	7,470	18.6
	Percentage distribution		
Grand total	100.0	100.0	
Air carriers, total	48.2	39.5	
Certificated route	46.3	37.2	
Others	1.9	2.3	
General aviation, total	51.8	60.5	
Executive transportation	5.8	5.9	
Air taxi	2.4	1.9	
Aerial application	0.7	0.7	
Industrial/special	0.9	0.6	
Aviation schools	2.9	2.7	
Government	1.1	1.3	
Repair stations	38.1	47.4	

1/Aircraft mechanics only; does not include maintenance workers.

SOURCE: Employment totals as shown in tables 23 and 26 distributed on basis of USTES survey sample data.

On-the-job training. As of January 1, 1969, a total of about 1,000 trainees were enrolled in 3- or 4-year registered apprenticeship programs leading to licensing as aircraft mechanics.[28] The programs were being conducted mainly by airlines, but some general aviation firms, even very small ones, and some manufacturers were also participating. Most of the apprentices were preparing for certification as A&P mechanics or airplane electricians, but the list of occupations for which on-the-job apprenticeship training under registered programs was being provided by employers includes the following occupations as well: aircraft assembly mechanic, accessories mechanic, aircraft mechanic, engine mechanic, helicopter mechanic, instrument mechanic, line service mechanic, propeller mechanic, radio mechanic, aircraft machinist, and sheet metal mechanic.

It is estimated from the spring 1968 USTES survey data that nearly 12,000 aviation mechanics would complete formal company on-the-job training programs of some kind during 1968. Civil air carriers accounted for about 3,500 of this total, and general aviation companies,[29] mainly repair stations, for the rest.

The USTES questionnaire asked civil air carriers to report the number of workers "expected to complete training in 1968 for *promotion* to each of the specified occupations", i.e., certificated aircraft and engine mechanic, certificated airplane electrician, electronic mechanic, and "other" mechanics (see appendix B). Estimates based on the responses indicate the following breakdown:

	Number of aircraft mechanics to be trained in 1968
All mechanics, total	3,530
Aircraft and engine mechanics	2,450
Airplane electricians	250
Electronic mechanics	160
Other mechanics	670

No such occupational breakdown is available for general aviation where employers were simply asked to report the total number of mechanics expected to complete formal company training programs in 1968. The total number for general aviation is estimated, on the basis of these reports, at 8,300, of which 6,500 were in repair stations and nearly 1,000 in executive transportation. Some training of mechanics was going on, however, in each of the other sectors of the industry.

Interpretation of the figures reported to the USTES on the number of mechanics to be trained on the job must be tempered with caution. There is substantial evidence that they are heavily overstated to the extent that many employers included in their reports all mechanics undergoing training of any kind—orientation, refresher, upgrading, apprenticeship, etc.—rather than only those who would, upon completion of their training courses, be ready in 1968 for promotion to the position of a fully qualified and certificated mechanic of the type specified.

But even these highly inflated figures fall short of the estimated annual combined replacement and growth needs for fully qualified mechanics by both air carriers and general aviation firms in the short-term future. The discrepancy between on-the-job training and probable needs is most marked in regard to airplane electricians, electronic mechanics, and "other" mechanics, which includes radio, instrument, propeller, and such highly specialized mechanics as avionic technicians.[30]

28 U.S. Department of Labor, Bureau of Apprenticeship and Training, unpublished data. The term "aircraft mechanic," as used here, encompasses all of the occupations listed in the paragraph.

29 Not including mechanic schools.

30 Avionic technicians check, repair, and install aircraft communication/navigation and control equipment.

Table 29. Number of FAA-certificated schools and approved programs (ratings) for mechanics, by type, 1966-69

Program (rating)	Number of certificated schools for mechanics			
	Aug. 1, 1966	July 1, 1967	July 15, 1968	Jan. 15, 1969
Total schools	78	79	97	106
Number of approved programs (ratings) for:				
Combined airframe and powerplant mechanic	59	60	71	75
Airframe mechanic only	66	64	77	82
Powerplant mechanic only	68	68	80	86
Total Number of approved programs (ratings)	193	192	228	243

SOURCE: Derived from U.S. Department of Transportation, Federal Aviation Administration, *Advisory Circulars* AC147-2B, AC147-2C, AC147-2D, and AC147-2E.

Conclusions

A tightness in the overall supply of aircraft mechanics in relation to the estimated demand seems to be developing. Of the 27 labor areas surveyed by the USTES in the spring of 1968, half reported stringencies in the supply of aircraft mechanics varying from slight to critical. Employers complained of shortages of fully qualified and certificated airplane electricians, electronic and instrument mechanics, and radio and avionic technicians, as well as of airframe and powerplant mechanics.

Graduates of most, though not all, aviation mechanic schools, and mechanics released from the armed forces cannot meet the need; they are not experienced with sophisticated modern civilian aircraft and can qualify only as trainees or apprentices. There is insufficient incentive for them to enter the long road through training to FAA certification when alternative job opportunities at good pay are available. While all route carriers and many other civil aviation companies, as well as some manufacturers of aircraft, are providing on-the-job training, it is inadequate for all expected replacement and growth needs in the short-run future, especially in the most highly skilled and specialized occupations where the stringency already seems to be acute.

General aviation firms are at a particular disadvantage in hiring and retaining fully qualified mechanics of the types they need. Many of them complain that they cannot hold mechanics after they have spent a great deal of time and money training them because, once trained, they leave for better paying and more stable government or airline jobs. A very common practice among general aviation companies to meet this problem is to hire only certificated airframe and engine mechanics who are also pilots and can, therefore, justify higher and steadier pay by doing everything. In very small companies, the pilot/mechanic is frequently the employer himself.

It is clear that all demands for fully qualified and certificated aircraft mechanics and specialized technicians of various kinds cannot be met by recruitment in the open market. Expanded formal company on-the-job training programs, especially apprenticeship programs, planned sufficiently in advance of anticipated needs, appear to offer one practical approach to the problem. Study at the better equipped private schools might be encouraged through more generous government student aid grants or benefits under the Veterans Educational Assistance Program. If small general aviation firms are to compete in the labor market for a limited mechanic supply, they may have to offer inducements in the form of an adequate guaranteed annual wage or something similar.

Table 30. FAA-certificated mechanic schools, by labor area and certificated program (rating), 1966-69

Region and labor area[1]	Number of certificated programs (ratings)[2]											
	August 1, 1966			July 1, 1967			July 15, 1968			Jan. 15, 1969		
	A	P	C	A	P	C	A	P	C	A	P	C
Total U.S. and Territories	66	68	59	64	68	60	77	80	71	82	86	75
North Eastern States	12	13	11	11	12	10	11	12	12	12	13	12
New England	3	3	3	3	3	3	3	3	3	3	3	3
Boston, Mass.	2	2	2	2	2	2	2	2	2	2	2	2
Danielson, Conn.	1	1	1	1	1	1	1	1	1	1	1	1
Middle Atlantic	9	10	8	8	9	7	8	9	9	9	10	10
Buffalo, N.Y.	1	1	1	1	1	1	1	1	1	1	1	1
New York, N.Y.	2	3	1	2	3	1	2	3	2	2	3	2
Utica-Rome, N.Y.	1	1	1	0	0	0	0	0	1	1	1	2
Newark, N.J.	1	1	1	1	1	1	1	1	1	1	1	1
Paterson-Clifton-Passaic, N.J.	1	1	1	1	1	1	1	1	1	1	1	1
Pittsburgh, Pa.	1	1	1	1	1	1	1	1	1	1	1	1
Philadelphia, Pa.	1	1	1	1	1	1	1	1	1	1	1	1
Williamsport, Pa.	1	1	1	1	1	1	1	1	1	1	1	1
North Central States	14	14	14	13	13	16	19	19	20	21	20	22
East North Central	9	9	9	8	8	12	9	8	12	9	8	12
Columbus, Ohio	0	0	0	1	1	0	1	1	0	1	1	0
Lafayette, Ind.	1	1	0	0	0	1	0	0	1	0	0	1
Vincennes, Ind.	0	0	1	0	0	1	0	0	1	0	0	1
Chicago, Ill.	2	2	3	2	2	3	2	2	3	2	2	3
St. Louis, Mo.-Ill.	1	1	1	0	0	1	0	0	1	0	0	1
Carbondale, Ill.	1	1	1	1	1	1	1	1	1	1	1	1
Champaign-Urbana, Ill.	1	1	1	1	1	1	1	1	1	1	1	1
Detroit, Mich.	1	1	0	1	1	1	1	1	1	1	1	1
South Haven, Mich.	0	0	0	0	0	0	1	0	0	1	0	0
Kalamazoo, Mich.	0	0	1	0	0	1	0	0	1	0	0	1
Milwaukee, Wis.	1	1	0	1	1	1	1	1	1	1	1	1
Beloit, Wis.	1	1	1	1	1	1	1	1	1	1	1	1
West North Central	5	5	5	5	5	4	10	11	8	12	12	10
Thief River Falls, Minn.	1	1	1	1	1	1	1	1	1	1	1	1
Minneapolis-St. Paul, Minn.	1	1	0	1	1	0	1	1	0	1	1	0
Kansas City, Kans./Mo.	1	1	1	1	1	1	2	3	2	2	2	2
Salina, Kans.	0	0	0	0	0	0	1	1	1	1	1	1
Topeka, Kans.	0	1	0	0	1	0	0	1	0	0	1	0
Wichita, Kans.	0	0	0	0	0	0	0	0	0	1	1	1
Des Moines, Iowa	0	0	1	0	0	1	0	0	1	0	0	1
Ottumwa, Iowa	0	0	0	0	0	0	0	0	1	0	0	1
Waterloo, Iowa	0	0	0	0	0	0	1	1	1	1	1	1
Fargo-Moorhead, N.D.	1	1	1	1	0	0	1	0	0	1	0	0
Sioux Falls, S.D.	0	0	0	0	0	0	0	0	0	1	1	0
Watertown, S.D.	1	0	0	1	1	0	1	1	0	1	1	0
Omaha, Nebr.-Iowa	0	0	0	0	0	0	1	1	1	1	1	1
Lincoln, Nebr.	0	0	1	0	0	1	0	0	1	0	0	1
Sidney, Nebr.	0	0	0	0	0	0	1	1	0	1	1	0
Southern States	12	12	13	13	13	13	16	17	16	17	19	17
South Atlantic	6	6	7	7	7	7	8	8	8	8	9	8
Baltimore, Md.	0	0	1	0	0	1	0	0	1	0	0	1
Winston-Salem, N.C.	0	0	0	1	1	1	1	1	1	1	1	1
Florence, S.C.	1	1	1	1	1	0	1	1	0	1	1	0
Americus, Ga.	1	1	1	1	1	1	1	1	1	1	1	1
Atlanta, Ga.	0	0	0	0	0	0	1	1	1	1	1	1
Miami, Fla.	2	2	2	2	2	2	2	2	2	2	2	2
St. Petersburg, Fla.	0	0	0	0	0	0	0	0	0	0	1	0

See footnotes at end of table.

Table 30. FAA-certificated mechanic schools, by labor area and certificated program (rating), 1966-69—Continued

Region and labor area[1]	Number of certificated programs (ratings)[2]											
	Aug. 1, 1966			July 1, 1967			July 15, 1968			Jan. 15, 1969		
	A	P	C	A	P	C	A	P	C	A	P	C
South Atlantic—Cont.:												
Daytona Beach, Fla.	1	1	1	1	1	1	1	1	1	1	1	1
Tallahassee, Fla.	1	1	1	1	1	1	1	1	1	1	1	1
East South Central	1	1	1	1	1	1	2	3	2	2	3	2
Jackson, Miss.	0	0	0	0	0	0	0	1	0	0	1	0
Ozark, Ala.	1	1	1	1	1	1	1	1	1	1	1	1
Hamilton, Ala.	0	0	0	0	0	0	1	1	1	1	1	1
West South Central	5	5	5	5	5	5	6	6	6	7	7	7
Camden, Ark.	0	0	0	0	0	0	0	0	0	1	1	1
New Orleans, La.	1	1	1	1	1	1	1	1	1	1	1	1
Lake Charles, La.	0	0	0	0	0	0	0	0	1	0	0	1
Stillwater, Okla.	1	1	1	1	1	1	1	1	1	1	1	1
Tulsa, Okla.	1	1	1	1	1	1	1	1	1	1	1	1
Enid, Okla.	0	0	0	0	0	0	0	1	0	0	1	0
Ft. Worth, Tex.	1	1	1	1	1	1	2	1	1	2	1	1
Longview, Tex.	1	1	1	1	1	1	1	1	1	1	1	1
Western States	27	28	21	26	29	21	30	31	23	31	33	24
Mountain	5	6	4	5	6	7	7	7	6	7	8	7
Helena, Mont.	1	1	1	1	1	1	1	1	1	1	1	1
Pocatello, Idaho	1	1	0	1	1	0	1	1	0	1	1	0
Denver, Colo.	2	2	2	2	2	2	2	2	2	2	2	2
Las Vegas, Nev.	0	0	0	0	0	0	1	1	1	1	1	1
Douglas, Ariz.	0	0	0	0	0	0	0	0	0	0	1	0
Phoenix, Ariz.	0	1	0	0	1	0	0	1	0	0	1	0
Logan, Utah	1	1	1	1	1	1	1	1	1	1	1	1
Alamagordo, N.M.	0	0	0	0	0	0	1	0	0	1	0	0
Roswell, N.M.	0	0	0	0	0	0	0	0	1	0	0	1
Cheyenne, Wyo.	0	0	0	0	0	0	0	0	0	0	0	1
Pacific	22	22	17	21	23	17	23	24	17	24	25	17
Moses Lake, Wash.	1	0	0	0	1	0	1	1	0	1	1	0
Tacoma, Wash.	1	1	1	1	1	1	1	1	1	1	1	1
Spokane, Wash.	1	1	0	1	1	0	1	1	0	1	1	0
Seattle, Wash.	1	1	0	1	1	0	1	1	0	1	2	0
Eugene, Ore.	1	1	0	1	1	0	1	1	0	1	1	0
Anaheim-Santa Ana-Garden Grove, Calif.	0	0	0	0	0	0	0	0	0	1	0	0
San Bernardino-Riverside-Ontario, Calif.	2	2	2	2	2	2	2	2	2	2	2	2
San Francisco-Oakland, Calif.	3	3	1	3	3	1	4	4	0	4	4	0
Stockton, Calif.	1	1	1	1	1	1	1	1	1	1	1	1
Los Angeles-Long Beach, Calif.	5	5	5	5	5	5	5	5	5	5	5	5
Fresno, Calif.	2	2	2	2	2	2	2	2	2	2	2	2
Hollister, Calif.	0	0	1	0	0	1	0	0	1	0	0	1
San Jose, Calif.	1	2	1	1	2	1	1	2	1	1	2	1
San Diego, Calif.	0	0	1	0	0	1	0	0	1	0	0	1
Sacramento, Calif.	1	1	1	1	1	1	1	1	1	1	1	1
Fairbanks, Alaska	1	1	0	1	1	0	1	1	1	1	1	1
Honolulu, Hawaii	1	1	1	1	1	1	1	1	1	1	1	1
Territories	1	1	0	1	1	0	1	1	0	1	1	0
San Juan, Puerto Rico	1	1	0	1	1	0	1	1	0	1	1	0

[1] Regional distribution has been converted from FAA to Labor Department pattern. Labor areas are as defined by the U.S. Department of Labor, Manpower Administration.

[2] Key to ratings: A — Airframe mechanic; P — Powerplant mechanic; C — Combined Airframe and Powerplant mechanic.

SOURCE: Derived from U.S. Dept. of Transportation, Federal Aviation Administration, *Advisory Circulars,* AC 147-2B, AC 147-2C, AC 147-2D, and AC 147-2E.

Civilian pilots

In mid-1968 relatively few civilian pilots, 560 in all, were employed by the military services of the Department of Defense. Sixty percent of these were working for the Army and the remainder for the Air Force. The Navy employs no civilian pilots.

Available information on the Defense Department's employment of civilian pilots for the period 1967 to 1970 is summarized in table 31. In these years, the total number employed was expected to vary only slightly and to remain close to the 600 level. Peak-1970 employment was estimated at 620, only 40 above peak 1967. The size of the civilian pilot force used by the Army and the Air Force is relatively stable, resulting from the distinctive characteristics of the programs to which they are assigned. The Air Force employs civilian pilots to staff reserve stations. These pilots are a cadre necessary to maintain the reserve stations in a state of readiness. They are civil servants working a regular work week on maintenance and administrative tasks. When reservists are present in force and the station is functioning in its training capacity, these civilian pilots, who are themselves reserve officers, form the nucleus of the reserve staff.[31] The Army uses civilian pilots primarily as flight instructors to train military pilots, but they also function in other areas, e.g., for aerial mapping and for test flying planes which have been repaired.

Many civilian pilots with the Army and Air Force have retired from military service. Many of them, about 60 percent, had not acquired FAA commercial pilot certificates, and less than 10 percent had qualified for FAA airline transport ratings.

Civilian mechanics

Substantial numbers of civilian aircraft mechanics are employed by the Department of Defense. They are used by the military to provide continuity in repair and maintenance work, in addition to enlisted military aircraft mechanics.

[31] Pilots are employed in a similar capacity by the Air and Army National Guard.

The three military services reported that, in mid-1968, they had about 38,400 civilian aircraft mechanics on their payrolls, or more than a fourth of all the 144,200 civilian aircraft mechanics employed. This number represented an increase of 700 over 1967. Employment was expected to increase 1,100 more by 1969 but to drop sharply between 1969 and 1970. Peak 1970 civilian aircraft employment was estimated at 37,300, or 1,400 below peak 1967.

The Navy and Air Force together accounted for nearly 98 percent of the 1968 employment. The largest group of aircraft mechanics, 60 percent of the total, was employed by the Air Force. Its plan to cut back its civilian aircraft mechanic employment, if carried out, would reduce the number by 2,500, from 23,000 at peak 1967 to 20,500 at peak 1970. The Navy, the second largest military employer of civilian aircraft mechanics with 38 percent of the total, and the Army, with about 2 percent, reported plans for increases in civilian aircraft mechanic employment between peak 1967 and peak 1970 totaling 1,250.

U.S. DEPARTMENT OF DEFENSE PILOTS AND MECHANICS

Table 31. Civilian aviation, employment trends, by service, 1967-70

Date	All services	Army	Navy	Air Force
	Number of civilian pilots employed			
Summer of:				
1967	570	330	0	240
1968	560	335	0	225
1969 (est.)	600	355	0	245
1970 (est.)	620	355	0	260
Peak of:				
1967	580	330	0	250
1968 (est.)	620	355	0	265
1970 (est.)	620	360	0	260
	Number of civilian aircraft mechanics employed			
Summer of:				
1967	37,700	700	14,000	23,000
1968	38,400	850	14,650	22,900
1969 (est.)	39,500	970	15,880	22,650
1970 (est.)	37,300	1,100	15,700	20,500
Peak of:				
1967	38,700	840	14,710	23,150
1968 (est.)	40,000	900	15,600	23,500
1970 (est.)	37,300	1,100	15,700	20,500

SOURCE: National employment totals reported by Army, Navy, Air Force in USTES survey.

Appendix A. Civil Aviation, Definitions of Industry Divisions and Sectors

1. Air carriers

The civil air carrier division of the industry consists of two sectors, each of which is considered separately in this study.

Certificated route carriers include all scheduled and nonscheduled U.S. domestic and international airlines. These account for about 94 percent of all air carrier pilot and mechanic employment.

Other carriers refers to supplemental air carriers which are authorized to perform passenger and cargo charter services supplementing the scheduled route air carriers, and commercial operators which operate on a private for-hire basis.

2. General aviation

The definition of general aviation, as used in this study, differs from that of the Federal Aviation Administration. The term "general aviation," as defined by the FAA[1] includes all nonmilitary or civilian flying except that performed by the interstate and intrastate air carriers operating large aircraft. General aviation flying, thus defined, embraces a wide range of diverse uses of aircraft, from the transportation of personnel and cargo by business firms in privately owned aircraft, to special uses such as for crop dusting, power and pipeline patrol, and aerial advertising, as well as private flying for pleasure. These activities have been classified by the FAA into four major categories: Business flying, which includes executive transportation and business transportation; instructional flying; commercial flying, which includes air taxi, aerial application, and industrial/special flying; and personal flying.

Since this study is concerned only with *professional* pilots and with aviation mechanics employed as such, personal flying and business transportation[2] (as distinguished from executive transportation) have been eliminated from consideration and are not included in the figures for the general aviation division of the civil aviation industry. Included, moreover, are local, State, and nonmilitary Federal Government civilian flying activities which the FAA does not include in its general aviation category.

The categories of general aviation which are within the scope of this study may be described as follows:

Executive (corporate) transportation is any use of an aircraft by a corporation, company, or other organization for the purposes of transporting its employees and/or property, not for compensation or hire, and employing professional pilots for the operation of the aircraft.

Air taxi transportation includes both scheduled and nonscheduled air taxi service, as well as contract service, and charter service.

Aerial application is any use of an aircraft for work purposes which concern the production of food, fiber, and health control, in which the aircraft is used in lieu of farm implements or ground vehicles for the particular task accomplished. It includes the distribution of chemicals or seeds in agriculture, reforestation, and insect control. It excludes fire fighting operations. There are a

[1] FAA, Economics Division, *General Aviation - A Study and Forecast of the Fleet and its Use in 1975,* July 1966.

[2] Business transportation is defined by the FAA as any use of an aircraft, not for compensation or hire, by an individual for the purposes of transportation required by a business or profession in which he is engaged. A high proportion of its fleet is made up of small, single-engine aircraft which are used by individuals for transportation, much as an automobile might be, in conducting a business or providing a service. The business pilot is not a professional pilot, just as a man who drives a car in the course of his business is not a chauffeur.

multitude of specific uses for aircraft in agriculture and forestry operations, such as insect and plant disease control, weed and brush control, control of animal pests, application of fertilizers and trace elements, defoliation, seeding, restocking of fish and other wild life, cloud seeding to induce precipitation or fog dispersal, and the production of air turbulence (mainly by the downdraft from helio blades) for frost prevention, drying fruit and athletic fields, harvesting ripe fruit and nuts, chasing birds from crops, etc.

Industrial/special use includes specialized work allied with industrial activity, excluding transportation and aerial application. Examples are: pipeline and highway patrolling, aerial surveying, emergency and rescue operations, advertising, photography, helicopter hoist, fire fighting, etc.

Instructional flying in general aviation includes any use of an aircraft for the purpose of formal instruction with the flight instructor aboard, or with the maneuvers on the particular flight(s) specified by the flight instructor. It excludes military and air carrier flight instruction but does include all other forms of civil private pilot training.

Government, which the FAA does not include in general aviation but which is included in this report, covers State and local governments and Federal Government nonmilitary agencies such as the Coast Guard, the Federal Aviation Administration, the Departments of Agriculture, Justice, and Interior, the Tennessee Valley Authority, etc. Included are such activities as traffic surveillance and forest protection programs, but not flight instruction at public institutions which is included under instructional flying.

Repair stations are independent companies or firms engaged in the maintenance and repair of aircraft. Both certificated and noncertificated repair stations are included. Data for mechanics cover aircraft mechanics and aircraft repairmen.

3. U.S. Department of Defense

Included are the civilian flying and aircraft maintenance activities of the Army, Navy, and Air Force.

Appendix B.

Manpower Administration

U.S. Training and Employment Service

Questionnaires and Instructions

Including Descriptions of

Occupations

U.S. DEPARTMENT OF LABOR
Bureau of Employment Security
Form ES-552 (3-68)

QUESTIONNAIRE ON PILOTS AND AIRCRAFT MECHANICS --CIVIL AIR CARRIERS
AIR TRANSPORTATION SURVEY

Budget Bureau No. 44-S68002

1. DATE OF SURVEY (Month, day, year)	2. STATE CODE	3. STATE	4. LABOR AREA NO.	5. LABOR AREA NAME

6. TYPE OF ACTIVITY (Check one)

A. CERTIFICATED ROUTE CARRIER	B. OTHER (Specify)

7. FLEET SIZE					8. FIRM NO.	9. FIRM SIC CODE
A. TOTAL (Items 7B–7E)	B. NO. SINGLE ENGINE	C. NO. MULTI-ENGINE, PISTON	D. NO. TURBO	E. NO. HELICOPTER		

TO:

CIVIL AIR CARRIERS

(Fold)

10. SELECTED OCCUPATIONS
(If workers are not employed in either of these occupations, enter a zero.)

	ITEM	LINE NO.	PILOTS				AIRCRAFT MECHANICS				
			TOTAL PILOTS (Cols. B & D)	EXCLUDING FLIGHT INSTRUCTORS: TOTAL NUMBER	EXCLUDING FLIGHT INSTRUCTORS: NUMBER WHO ARE FLIGHT ENGINEERS	FLIGHT INSTRUCTORS	TOTAL MECHANICS (Cols. F-I)	AIRCRAFT AND ENGINE MECHANICS	ELECTRICIAN AIRPLANE	ELECTRONIC MECHANIC	OTHER MECHANICS
			A	B	C	D	E	F	G	H	I
EMPLOYMENT	CURRENT	01									
	AGE 50 YEARS AND OVER	02									
	ONE YEAR AGO	03									
	PEAK EMPL. IN 1967 (Enter month in paren.)	04	( )				( )				
	REPLACEMENT NEEDS IN 1968	05									
CURRENT VACANCIES	TOTAL	10									
	LESS THAN 1 MONTH	11									
	ONE MONTH OR MORE	12									
PROJECTED EMPLOYMENT	ONE YEAR HENCE	20									
	PEAK EMPL. IN 1968 (Enter month in paren.)	21	( )				( )				
	PEAK EMPL. IN 1970	22									
	FIXED-WING	23									
	HELICOPTER	24									
TRAINING	NUMBER TO BE TRAINED BY FIRM IN 1968	30									
HIGHEST RATING HELD	AIRLINE TRANSPORT	40									
	COMMERCIAL	41									
	INSTRUMENT	42									
CERTIFIED TO FLY	FIXED-WING ONLY	50									
	HELICOPTER ONLY	51									
	FIXED-WING AND HELIO	52									
HOURS FLOWN	TOTAL PILOT HOURS IN PAST 12 MONTHS	60									

COMMENTS (Use reverse if additional space is required.)

NAME OF PERSON RECORDING THIS INFORMATION	TITLE

U.S. DEPARTMENT OF LABOR
Bureau of Employment Security
Form ES-553 (3-68)

Budget Bureau No. 44-S68002

QUESTIONNAIRE ON PILOTS AND AIRCRAFT MECHANICS --GENERAL AVIATION AIR TRANSPORTATION SURVEY

1. DATE OF SURVEY (Month, day, year)	2. STATE CODE	3. STATE	4. LABOR AREA NO.	5. LABOR AREA NAME

6. TYPE OF ACTIVITY (Check one)

A. BUSINESS	B. AERIAL APPLICATION	C. INDUSTRY SPECIAL	D. AIR TAXI	E. FLIGHT GROUND SCHOOLS	F. FEDERAL, STATE, AND LOCAL GOVERNMENT	G. OTHER (Specify)

7. FLEET SIZE					8. FIRM NO.	9. FIRM SIC CODE
A. TOTAL (Items 7B–7E)	B. NO. SINGLE ENGINE	C. NO. MULTI-ENGINE, PISTON	D. NO. TURBO	E. NO. HELICOPTER		

TO: ┌ ┐

GENERAL AVIATION

└ ┘

(Fold)

10. SELECTED OCCUPATIONS
(If workers are not employed in either of these occupations, enter a zero.)

	ITEM	LINE NO.	TOTAL PILOTS A	TOTAL MECHANICS B
EMPLOYMENT	CURRENT	01		
	AGE 50 YEARS AND OVER	02		
	ONE YEAR AGO	03		
	PEAK EMPL. IN 1967 (Enter month in paren.)	04	( )	( )
	REPLACEMENT NEEDS IN 1968	05		
CURRENT VACANCIES	TOTAL	10		
	LESS THAN 1 MONTH	11		
	ONE MONTH OR MORE	12		
PROJECTED EMPLOYMENT	ONE YEAR HENCE	20		
	PEAK EMPL. IN 1968 (Enter month in paren.)	21	( )	( )
	PEAK EMPL. IN 1970	22		
	FIXED-WING	23		
	HELICOPTER	24		
TRAINING	NUMBER TO BE TRAINED BY FIRM IN 1968	30		
HIGHEST RATING HELD	AIRLINE TRANSPORT	40		
	COMMERCIAL	41		
	INSTRUMENT	42		
CERTIFIED TO FLY	FIXED-WING ONLY	50		
	HELICOPTER ONLY	51		
	FIXED-WING AND HELIO	52		
HOURS FLOWN	TOTAL PILOT HOURS IN PAST 12 MONTHS	60		

COMMENTS

NAME OF PERSON RECORDING THIS INFORMATION	TITLE

Questionnaire on Pilots and Aircraft Mechanics for Civil Air Carriers and Instructions for Completion

Except for items 1 and 7, all items in the heading of the questionnaire have been completed. Enter in item 1 the date the questionnaire is completed. Enter in item 7A (Fleet size) the total number of planes in your firm at the time of the survey. The entry for 7A should be the sum of items 7B through 7E. Include planes owned as well as those rented or leased from other firms. Please note: Firms owning planes for the purpose of renting or leasing to other firms should include only those planes in the firm which are not currently rented or leased. This distinction will avoid duplication in the overall count of planes.

For the purpose of this survey, please assume the following conditions when completing the questionnaire.

1. Qualified workers will be available to meet any anticipated employment needs.
2. The present long-term trend of economic growth of the United States will continue with no major setbacks for the next few years.
3. Scientific and technological advances will continue, affecting production methods, manpower requirements, and consumption patterns.
4. The present-day normal workweek at your firm will continue through the forecast periods.
5. Your current plans for expansion or modernization will materialize according to schedule.
6. Delivery of new planes will be on schedule.
7. Airport facilities will be adequate.
8. No further significant change in the international situation.
9. The Viet Nam conflict will neither abate nor accelerate.
10. No further call-ups of air reservists.

If your firm is engaged in more than one air-related activity such as an air taxi service, flight training, and operating an aircraft repair station, the data on the questionnaire should include all pilots and/or mechanics employed in all activities in all establishments of your firm.

Include data for pilots and mechanics stationed in foreign countries who are citizens of the United States.

Following are instructions for entries on individual items in the body of the questionnaire. See pages 41-42 for descriptions of the occupations. If you have a copy of the *Dictionary of Occupational Titles* (DOT) Volumes I and II, third edition, you may wish to refer to the codes given at the end of the descriptions on pages 41-42.

Columns A through I: Selected Occupations

In making a count of the number of workers to be entered in columns A through I, include only those workers who spend more than one-half of their time in the specified occupations. See the section beginning on page 41 for descriptions of occupations. On all lines, the entries in column A should represent the sum of the entries in columns B and D, and the entries in column E should represent the sum of entries in columns F through I.

1. Employment

a. *Current, Line 01.* Enter the current total employment in each of columns A through I. Current employment pertains to workers employed at some time during the week the survey is made.

(1) *Age 50 years and over, Line 02.* In column A, enter the number of pilots and enter in column E the number of mechanics who are 50 years of age and over.

b. *Year ago, Line 03.* Enter in each of columns A through I the employment during the same week a year ago.

c. *Peak employment in 1967, Line 04.* Enter in each of columns A through I the 1967 peak employment, and enter in columns A and E in the parenthesis below, the name of the month this peak occurred.

d. *Replacement needs in 1968, Line 05.* Enter in each of columns A through I, the estimated number of workers you expect to need for replacements in 1968. Estimates of replacement needs should be the number of expected job separations due to workers (1) promoted to another occupation, and (2) leaving the labor force for such reasons as death, retirement, disability or entering the Armed Forces. Do *not* include workers who will leave to seek or accept other jobs, or workers expected to separate from your firm because of reduction in force, inadequate performance on the job or misconduct.

2. Current Vacancies

a. *Total, Line 10.* Enter for each of columns A through I the number of current unfilled job openings which are immediately available for filling by workers outside the firm and which the firm is actively seeking to fill. Include all part-time, permanent, and temporary vacancies. Exclude (1) jobs held for employees who will be recalled (2) jobs to be filled by transfer or demotion (3) jobs held for workers on paid or unpaid leave (4) jobs filled by overtime work which are not intended to be filled by new workers (5) job openings for which new workers are already hired and scheduled to start work at a later date, and (6) jobs unoccupied because of a labor-management dispute.

(1) *Less than 1 month, Line 11.* Enter in each of columns A and B, and D through I the number of job openings existing for less than 1 month.

(2) *One month or more, Line 12.* Enter in each of columns A and B, and D through I the number of job openings existing for 1 month or more. If an exact count is not available, an estimate will suffice.

Note: Entries for lines 11 and 12 should add to the totals entered in line 10.

3. Projected Employment

a. *One year hence, Line 20.* Enter the estimated employment 1 year hence in each of columns A through I.

b. *Peak employment in 1968, Line 21.* enter in each of columns A through I the estimated 1968 peak employment, and enter in columns A and E in parenthesis below, the name of the month this peak is expected to occur.

c. *Peak employment in 1970, Line 22.* Enter in each of columns A through I the estimated 1970 peak employment.

(1) *Fixed-wing, Line 23.* Enter in columns A through D the estimated employment of fixed-wing pilots during the peak month in 1970.

(2) *Helicopter, Line 24.* Enter in columns A through D the estimated employment of helicopter pilots during the peak month in 1970.

Note: Entries for lines 23 and 24 should add to the total entered in line 22.

When making entries in lines 20, 21, and 22 please exercise care to insure that the employment data reflect total employment and not solely the additional workers needed. For example, if a firm has 100 pilots at the time of the survey and the number is estimated to increase by 20 in the following year, the total pilots 1 year hence should be reported as 120.

4. Training

a. *Number to be trained by firm in 1968, Line 30.* Enter in each of columns A through I the number of workers expected to complete formal company training programs for promotion to each of the specified occupations in 1968. Flight and ground schools should enter the number of trainees expected to graduate in 1968, and to be qualified for employment in the specified occupations described on pages 41-42.

5. Highest Rating Held

a. *Airline transport, Line 40.* Enter in each of columns A through D the number of pilots who possess an airline transport rating.

b. *Commercial, Line 41.* Enter in each of columns A through D the number of pilots whose highest rating is a commercial rating.

Note: The total of entries in lines 40 and 41 may be equal to but cannot exceed the number of pilots in line 01.

(1) *Instrument, Line 42.* Enter in each of columns A, B, and D the number of pilots with commercial ratings in Line 41 who also hold instrument ratings.

6. Certified to Fly

a. *Fixed-wing only, Line 50.* Enter in each of columns A, B, and D the number of pilots certificated to fly only fixed-wing aircraft.

b. *Helicopter only, Line 51.* Enter in each of columns A, B, and D the number of pilots certificated only to fly helicopters.

c. *Fixed-wing and helicopter, Line 52.* Enter in each of columns A, B, and D the number of pilots certificated to fly both fixed-wing and helicopter aircraft.

Note: The total of entries in lines 50, 51, and 52 should equal the entry in line 01.

7. Hours Flown

Total pilot hours flown in past 12 months, Line 60. Enter in each of columns A, B, and D the total number of hours flown by pilots in your firm in the 12 months preceding the survey week. If this is not available, an estimate will suffice.

Comments

Please supply any information which would be helpful in analyzing future needs for pilots and mechanics. Examples are plans for expansion of facilities, increase in size of plane fleet, or technological changes or trends which may, in your opinion, point to the need for training programs for additional pilots and mechanics or upgrading the skills of those already in those occupations. Also explain changes in the nature and extent of formal company training programs planned in future years, or difficulty in recruiting to fill existing job vacancies, particularly vacancies open 1 month or longer.

Descriptions of Occupations

Columns A, B, and D: Pilots

Includes occupations concerned with piloting airplanes for the transportation of passengers, freight, and mail, and other purposes such as charting the courses of planes by the use of instruments, charts, celestial observation, and dead reckoning. Must be federally licensed. Includes occupations concerned with the supervision of flight operations and maintenance when a pilot's or navigator's license is required. Included are chief pilots, instructor pilots, check pilots, airline pilots, and executive pilots. (See *Dictionary of Occupational Titles*–DOT codes 196.168, .268, .283, and 621.281.)

Column C: Flight Engineer–Pilot

Although an individual must be a certificated pilot, he must also meet the qualifications of a flight engineer as described below:

Makes preflight, inflight, and postflight inspections, adjustments, and minor repairs to insure safe and efficient operation of aircraft. Inspects aircraft prior to takeoff for defects such as fuel or oil leaks and malfunction in electrical, hydraulic, or pressurization systems according to preflight checklist. Verifies passenger and cargo distribution, and amount of fuel to insure that weight and balance of specifications are met. Monitors control panel to verify aircraft performance, and regulates engine speed according to instructions of pilot (DOT code 621.281).

Column D: Flight Instructor

Although an individual must be a certificated pilot, he must also meet the qualifications of a flight instructor as described below:

Trains new and experienced company airline pilots in policy and use of equipment. Instructs new pilots in company regulations and procedures. Conducts courses for experienced company pilots to familiarize them with new equipment. May conduct review courses for pilots. Also includes instructor pilots employed by certificated flight schools (DOT code 196.228).

Column F: Certificated Aircraft and Engine Mechanics

Services, repairs, and overhauls aircraft and aircraft engines to insure airworthiness; repairs, replaces, and assembles parts, such as wings, fuselage, tail assembly, landing gear, control cables, propeller assembly, and fuel and air tanks, using tools, such as power shears, sheet metal breaker, arc and acetylene welding equipment, rivet gun, and air and electric drills to rebuild or replace airframes or its components. Consults manufacturers' manuals and airlines' maintenance manuals for specifications, and to determine feasibility of repair or replacement according to malfunction (DOT code 621.281).

Column G: Certificated Airplane Electrician

Monitors and repairs airplane electrical equipment, using handtools. Examines conduits for breaks and weak areas before or after removal from airplane and replaces defective segments. Rewires airplane and arranges wiring and conduits so they do not become entangled or otherwise interfere with fuel lines or other equipment. Inspects and tests function boxes. Tests, repairs, and replaces airplane lighting systems including wiring, running, and landing light. Does not repair airplane ignition systems (DOT code 825.381).

Column H: Electronic Mechanics, as applied to Aviation

Repairs electronic equipment such as radar systems, telemetering systems, transmitters, antennas, and servomechanics, following blueprints and manufacturers' specifications, and using handtools and test instruments. Tests faulty equipment and applies knowledge of functional operation of electronic units and systems to diagnose cause of malfunction. Tests electronic components and circuits to locate defects, using instruments such as oscilloscopes, signal generators, ammeters, and voltmeters (DOT code 828.281).

Column I: Other Mechanics

Includes certificated radio, instrument, propeller, and specialized services mechanics not specified in the questionnaire. Also includes mechanics engaged in comparable work who have received some training in one or more of the aviation mechanic specialties but who are not certificated.

General Aviation

Questionnaire on Pilots and Aircraft Mechanics for Firms in General Aviation and Instructions for Completion

Except for items 1 and 7, all items in the heading of the questionnaire have been completed. Enter in item 1 the date the questionnaire is completed. Enter in item 7A (Fleet Size) the total number of

planes in your firm at the time of the survey. The entry for 7A should be the sum of items 7B through 7E. Include planes owned as well as those rented or leased from other firms. Please note: Firms owning planes for the purpose of renting or leasing to other establishments should include only those planes in the firm which are not currently rented or leased. This distinction will avoid duplication in the overall count of planes.

For the purpose of this survey, please assume the following conditions when completing the questionnaire.

1. Qualified workers will be available to meet any anticipated employment needs.
2. The present long-term trend of economic growth of the United States will continue with no major setbacks for the next few years.
3. Scientific and technological advances will continue, affecting production methods, manpower requirements, and consumption patterns.
4. The present-day normal workweek at your firm will continue through the forecast periods.
5. Your current plans for expansion or modernization will materialize according to schedule.
6. Delivery of new planes will be on schedule.
7. Airport facilities will be adequate.
8. No further significant change in the international situation.
9. The Viet Nam conflict will neither abate nor accelerate.
10. No further call-ups of air reservists.

If your firm is engaged in more than one air-related activity such as an air taxi service, flight training, and operating an aircraft repair station, the data on the questionnaire should include all pilots and/or mechanics employed in all activities in all establishments of your firm.

Include data for pilots and mechanics stationed in foreign countries who are citizens of the United States.

Following are instructions for entries of individual items in the body of the questionnaire. See pages 46-47 for descriptions of the occupations. If you have a copy of the *Dictionary of Occupational Titles* (DOT) Volumes I and II, third edition, you may wish to refer to the codes given at the end of the descriptions on pages 46-47.

Selected Occupations

In making a count of workers to be entered in columns A and B, include only those workers who spend more than one-half of their time in these occupations. See the section beginning on page 46 for descriptions of occupations.

1. Employment

a. *Current, Line 01.* Enter the current total employment in each of columns A and B. Current employment pertains to workers employed at some time during the week the survey is made.

(1) *Age 50 years and over, Line 02.* Enter the number of pilots and the number of mechanics who are 50 years of age and over.

b. *Year ago, Line 03.* Enter in each of columns A and B the employment during the same week a year ago.

c. *Peak employment in 1967, Line 04.* Enter in each of columns A and B the 1967 peak employment and enter in the parenthesis below, the name of the month this peak occurred.

d. *Replacement needs in 1968, Line 05.* Enter in each of columns A and B, the estimated number of workers you expect to need for replacements in 1968. Estimates of replacement needs should be the number of expected job separations due to workers (1) promoted to another occupation, and (2) leaving the labor force for such reasons as death, retirement, disability or entering the Armed Forces. Do not include workers who will leave to seek or accept other jobs, or workers expected to separate from your firm because of reduction in force, inadequate performance on the job or misconduct.

2. Current Vacancies

a. *Total, Line 10.* Enter in each of columns A and B the number of current unfilled job openings which are immediately available for filling by workers outside the firm and which the firm is actively seeking to fill. Include all part-time, permanent, and temporary vacancies. Exclude (1) jobs held for employees who will be recalled (2) jobs to be filled by transfer or demotion (3) jobs held for workers on paid or unpaid leave (4) jobs filled by overtime work which are not intended to be filled by new workers (5) job openings for which new workers are already hired and scheduled to start work at a later date, and (6) jobs unoccupied because of a labor-management dispute.

(1) *Less than 1 month, Line 11.* Enter in each of columns A and B the number of job openings existing for less than 1 month.

(2) *One month or more, Line 12.* Enter in each of columns A and B the number of job openings existing for 1 month or more. If an exact count is not available, an estimate will suffice.

Note: Entries for lines 11 and 12 should add to the totals entered in line 10, total number of vacancies.

3. Projected Employment

a. *One year hence, Line 20.* Enter the estimated employment 1 year hence in each of columns A and B.

b. *Peak employment in 1968, Line 21.* Enter the estimated 1968 peak employment and enter in the parenthesis below, the name of the month this peak is expected to occur in each of columns A and B.

c. *Peak employment in 1970, Line 22.* Enter the estimated 1970 peak employment in each of columns A and B.

(1) *Fixed-wing, Line 23.* Enter in column A the estimated employment of fixed-wing pilots during the peak month in 1970.

(2) *Helicopter, Line 24.* Enter in column A the estimated employment of helicopter pilots during the peak month in 1970.

Note: Entries for lines 23 and 24 should add to the total entered in line 22.

When making entries in lines 20, 21, and 22 please exercise care to insure that the employment data reflect total employment and not solely the additional workers needed. For example, if a firm has 100 pilots at the time of the survey and the number is estimated to increase by 20 in the following year, the total pilots 1 year hence should be reported as 120.

4. Training

a. *Number to be trained by firm in 1968, Line 30.* Enter in each of columns A and B the number of workers expected to complete formal company training programs for promotion to each of the specified occupations in 1968. Flight and ground schools should enter in each of columns A and B the number of trainees expected to graduate in 1968 and be qualified for employment in the specified occupations described on pages 41-42 of this attachment.

5. Highest Rating Held

a. *Airline transport, Line 40.* Enter the number of pilots who possess an airline transport rating.

b. *Commercial, Line 41.* Enter the number of pilots whose highest rating is a commercial rating.

Note: The total of entries in lines 40 and 41 may be equal to but cannot exceed, the number of pilots in line 01.

(1) *Instrument, Line 42.* Enter the number of pilots with commercial ratings in line 41 who also hold instrument ratings.

6. Certified to Fly

a. *Fixed-wing only, Line 50.* Enter the number of pilots certificated to fly only fixed-wing aircraft.

b. *Helicopter only, Line 51.* Enter the number of pilots certificated only to fly helicopters.

c. *Fixed-wing and helicopter, Line 52.* Enter the number of pilots certificated to fly both fixed-wing and helicopter aircraft.

Note: The total of entries in lines 50, 51, and 52 should be equal to the entry in line 01.

7. Hours Flown

Total pilot hours flown in past month, Line 60. Enter the total number of hours flown by pilots in your firm in the 12 months preceding the survey week. If this is not available, an estimate will suffice.

Comments

Please supply any information which would be helpful in analyzing future needs for pilots and mechanics. Examples are plans for expansion of facilities, increase in size of plane fleet, or technological changes or trends which may, in your opinion, point to the need for training programs for additional pilots and mechanics or upgrading the skills of those already in those occupations. Also explain changes in the nature and extent of formal company training programs planned in future years, or difficulty in recruiting to fill existing job vacancies, particularly vacancies open 1 month or longer.

Descriptions of Occupations

Pilots (Column A)

Includes occupations concerned with piloting airplanes for the transportation of passengers, freight, mail, agricultural operations, photography, and other purposes such as charting the courses of planes by the use of instruments, charts, celestial observation, and dead reckoning. Must be federally licensed. Includes occupations concerned with the supervision of flight operations and maintenance when a pilot's or navigator's license is required. Included are chief pilots, instructor pilots, check pilots, airline pilots, and executive pilots. (See *Dictionary of Occupational Titles*–DOT codes 196.168, .268, and .283.)

Mechanics (Column B)

1. Flight Engineer

Makes preflight, inflight, and postflight inspections, adjustments, and minor repairs to insure safe and efficient operation of aircraft. Inspects aircraft prior to takeoff for defects such as fuel or oil leaks and malfunction in electrical, hydraulic, or pressurization systems according to preflight checklist. Verifies passenger and cargo distribution, and amount of fuel to insure that weight and balance of specifications are met. Monitors control panel to verify aircraft performance, and regulates engine speed according to instructions of pilot (DOT code 621.281).

2. Certificated Aircraft and Engine Mechanics

Services, repairs, and overhauls aircraft and aircraft engines to insure airworthiness; repairs, replaces, and assembles parts, such as wings, fuselage, tail assembly, landing gear, control cables, propeller assembly, and fuel and air tanks, using tools, such as power shears, sheet metal breaker, arc and acetylene welding equipment, rivet gun, and air and electric drills to rebuild or replace airframes of its components. Consults manufacturers' manuals and airlines' maintenance manuals for specifications, and to determine feasibility of repair or replacement according to malfunction (DOT code 621.281).

3. Certificated Airplane Electrician

Monitors and repairs airplane electrical equipment, using handtools. Examines conduits for breaks and weak areas before or after removal from airplane and replaces defective segments. Rewires airplane and arranges wiring and conduits so they do not become entangled or otherwise interfere with fuel lines or other equipment. Inspects and tests function boxes. Tests, repairs, and replaces airplane lighting systems including wiring, running, and landing light. Does not repair airplane ignition systems (DOT code 825.381).

4. Electronic Mechanics, as applied to Aviation

Repairs electronic equipment such as radar systems, telemetering systems, transmitters, antennas, and servomechanics, following blueprints and manufacturers' specifications, and using handtools and test instruments. Tests faulty equipment and applies knowledge of functional operation of electronic units and systems to diagnose cause of malfunction. Tests electronic components and circuits to locate defects, using instruments such as oscilloscopes, signal generators, ammeters, and voltmeters (DOT code 828.281).

5. Other Mechanics

Include certificated radio, instrument, propeller, and specialized services mechanics not specified in the questionnaire. Also includes mechanics engaged in comparable work who have received some training in one or more of the aviation mechanic specialties but who are not certificated.

Appendix C. USTES Survey Scope and Methodology

The April, 1968 survey of pilots and mechanics in civil aviation conducted by the U.S. Training and Employment Service (USTES) and the affiliated State employment security agencies covered all civil air carriers, about 10 percent of the estimated number of firms in general aviation, and the three military services of the U.S. Department of Defense. Descriptions of industry divisions and sectors included appear in appendix A.

Format of Survey Questionnaire

The questionnaire used in the survey was developed with the assistance and concurrence of the Federal Aviation Administration and the Department of Defense, the two agencies sponsoring the study. Space limitations on the questionnaire, and the effort to keep it as simple as possible, prevented the gathering of more detailed information.

The questionnaire used to survey the civil air carriers differed slightly from that designed for general aviation firms. While "line item" totals were the same on both questionnaires, that for civil air carriers requested detailed information on various categories of pilots and mechanics. The questionnaire for general aviation firms requested information only on totals for pilots and mechanics. Copies of the two questionnaires and instructions for their completion are included in Appendix B.

Survey Conducted by State Agencies

The survey was by mail and was conducted by the local offices of the State employment security agencies affiliated with the U.S. Department of Labor's Manpower Administration. Each State agency was furnished with lists of selected names and addresses of firms to be surveyed in its State. At least one followup by mail was made on every nonrespondent. Fund limitations restricted the number of personal followups that could be made as part of the study.

Assumptions for Respondents

Employers were asked to assume the following in making their projections of employment:

1. Qualified workers will be available to meet any anticipated employment needs.
2. The present long-term trend of economic growth of the United States will continue with no major setbacks for the next few years.
3. Scientific and technological advances will continue, affecting production methods, manpower requirements, and consumption patterns.
4. The present-day normal work-week of the firm will continue through the forecast periods.
5. Current plans for expansion or modernization will materialize according to schedule.
6. Delivery of new planes will be on schedule.
7. Airport facilities will be adequate.

8. There will be no significant change in the international situation.

9. The Viet Nam conflict will neither abate nor accelerate.

10. There will be no further call-ups of air reservists.

Complete listings of establishments to use as a basis for sample selection were not readily available in many of the individual air transportation categories. However, after exploration with industry associations and other sources in the various sectors, USTES staff developed a reasonably complete listing of employers upon which the survey sample was based.

Listed below are the aviation categories covered in the survey and the sources of firm names used in drawing the sample for each category.

Category	Source
Civil Air Carriers	
Certificated route air carriers	Air Transport Association of America
Other (supplemental, commercial and intrastate carriers)	Federal Aviation Administration
General Aviation	
Executive transportation	National Business Aircraft Association
Aerial application	National Aerial Applicators Association, and State Aerial Applicator Associations
Air taxi, pilot and mechanic schools, and	FAA directories and the World Aviation Directory
Industrial/special	National Aerial Photographic Association, and firms indicating special activities on their questionnaires
Government—Federal nondefense, State, and local	National Association of Aviation Officials, and State employment security agencies. Coast Guard, FAA, TVA, Justice, Agriculture, and Interior. The remaining Federal agencies indicated that very few or no pilots or mechanics were employed.
Department of Defense	Army, Navy, Air Force

Cooperation Received

The U.S. Training and Employment Service and the affiliated State agencies received fine cooperation and assistance from many sources in obtaining responses from surveyed establishments and firms. The General Aviation District Offices (GADOS) of the FAA contacted and obtained responses from a number of aerial application firms, flight and ground schools, and repair stations which had failed to respond initially. In addition, these GADOS provided the State agencies with information on FAA-certificated aviation schools in selected labor areas for use in preparing

statements assessing the current labor supply-demand and training situation for pilots and mechanics. The Air Transport Association of America, an organization of the scheduled airlines, encouraged all of its members in advance to complete and return the questionnaires. Moreover, the ATA supplied estimates of missing data on airline questionnaires and followed up on questionnaires from selected nonresponding airlines.

Problems Encountered in the Survey

The identification and survey of firms in the civil air carrier division presented relatively few problems because of the relatively small number of firms. Most air carriers are members of the Air Transport Association of America, and most are required to make reports to the Civil Aeronautics Board on their employment and operations.

This was not true of the survey of general aviation firms, however. As a result of the problems encountered in covering this division of the industry, special procedures for the collection of data had to be developed.

The assembly of sufficiently large lists of establishment names in each of the general aviation sectors from which to draw a 10-percent sample was a major problem. The lists of establishments available from membership rosters of various associations of aviation-oriented firms represented only a portion of the estimated total. For example, the membership directory of the National Business Aircraft Association contained less than 1,000 names—a total considerably lower than the estimated total number of firms using planes for transportation of business executives. Moreover, many membership lists included firms certificated by the FAA for two or more aviation activities. The FAA directories are limited to "certificated" schools, air taxi firms, and aircraft repair stations. The identification of firms in the industrial/special category was particularly difficult as this activity was usually a sideline for many firms. Firms known as "fixed base operators," were also difficult to categorize for purposes of the survey since they engage in multiple aviation services.

Finally, there was the problem of assuring adequate response due to: (1) the absence of any overall organization of these firms to encourage response; (2) the inclination of many firms to distrust the government's motive in requesting the information; (3) the lack of incentive for many firms to complete the questionnaire because of their failure to appreciate the ultimate benefits of the study; and, finally, (4) the large turn-over among these firms, resulting in no response from firms no longer in business.

Establishment Response in Survey

The overall establishment response rate for the survey was 53 percent, with civil air carriers showing a higher rate as follows:

Number of questionnaires[1]	*Total*	*Civil Air Carriers*			*General aviation*
		Total	*Certificated route carriers*	*Other*	
Sent	2,364	88	42	46	2,276
Received	1,251	55	34	21	1,196
Percent response	53	63	81	46	52

[1] Excludes the three military services and 112 questionnaires received from various State and local government establishments in 40 States.

The coverage of pilot and mechanic employment by certificated route air carriers was substantially higher than the 81 percent establishment response rate would indicate. The

nonrespondents in the sector were mainly small carriers employing comparatively few pilots and mechanics.

Adjustments to Survey Data

The civil air carriers participating in the survey appeared to overestimate their short-term growth in pilots and mechanics. For example, the certificated route carriers indicated an increase of 8.2 percent in pilot employment between 1967 and 1968, or nearly double the actual increase of 4.5 percent subsequently reported by the Federal Aviation Administration. Accordingly, the survey data for 1968 were adjusted to show the actual rate of growth. Corresponding adjustments were made for other years on the assumption that the carriers also overestimated their prospective pilot employment growth. These adjustments affected projected gains between 1968 and 1969, and between peak employment in 1968 and peak employment in 1970. Appropriate adjustments were also made in the data for civil air carrier mechanics. However, no adjustments were made in the survey data for general aviation firms as no FAA "base employment" data were available for any year.

Inflation of Survey Data to National Totals

The 1967 and 1968 survey employment data for pilots and mechanics in civil air carrier firms were inflated to national totals on the basis of their relationship to the FAA figures for employment on certificate route air carriers for those years. Except for "hours flown by pilots," the other items on the questionnaire were inflated by the same factor as used to inflate the 1968 employment. "Hours flown" were inflated by the same factor used to inflate the 1967 employment, since this item was for "the past 12 months."

The survey employment data for general aviation firms were inflated to national totals by the ratio of the BLS employment estimates for 1967 to the survey employment data for 1967. (See U.S. Bureau of Labor Statistics, *Requirements for Pilots and Mechanics in Civil Aviation, 1967-77,* May 12, 1969).

Interpretation of Questionnaire Data

Peak Employment: Employers were asked for the month and level of peak employment for pilots and mechanics in 1967, 1968, and 1970. While the "peak employment" figure for a single employer would be valid, the sum of these figures probably would overstate the peak employment for the Nation. This is due to the fact that the individual employer peak months were spread over the year.

Training: Respondents were asked to report the number of persons expected to complete formal company training in 1968 for promotion to, or to qualify for, specified pilot and mechanic occupations in 1968. There were clear indications on many questionnaires that both employers and schools reported, instead, the number of employees or students in training. For this reason, these data are overstated.

Editing the Questionnaires: In addition to checking for internal consistency and arithmetical balance, each general aviation questionnaire was reviewed to determine that the firm was classified in the category most representative of its major activity, i.e., air taxi, school, aerial applicator, etc., as many firms indicated more than one activity.

Maintenance workers: The BLS and FAA data for civil air carrier mechanics include an estimated 3,000 maintenance workers, i.e., carpenters, electricians, etc., who work in air transportation establishments, but who are not considered aviation mechanics. The USTES survey data exclude these workers; they cover aircraft mechanics only.

Part II
Long-Range Manpower Requirements

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Summary

During the past two decades, airplane pilots and mechanics have been among the Nation's fastest growing occupations. In 1967, nearly 60,000 pilots and 103,500 mechanics were employed by the civil aviation industry. A continuation of this rapid employment expansion is expected during the 1967-77 period. The purpose of this study was to anticipate future needs and to establish, where data permitted, a sound procedure for estimating future requirements for these highly trained workers.

The projections presented in this study are based on the levels of aviation activity forecast by the Federal Aviation Administration (FAA).[1] Therefore, in evaluating the estimates of future manpower requirements, the assumptions underlying the FAA forecasts should be borne in mind. FAA defines the essential elements supporting its forecasts as:

> A continuing high rate of growth in the economy as measured by GNP and the assumption that the passenger fare structure will continue to decline. Gross national product is forecast at an average real growth rate of 4.25 percent, and average fares are forecast to decline, in real terms, between 2 and 3 percent per year.[2]

The FAA projections of aviation activity also were developed under the implicit assumption that the Viet Nam hostilities would not continue into the 1970's.

Expansion of employment in civil aviation is expected to be very rapid during the 1967-77 decade. Growth of the U.S. air carrier sector of civil aviation will be stimulated primarily by the rising transportation needs of the Nation's growing population, coupled with a continuing shift to air travel at the expense of other modes of commercial transportation. General aviation activity will continue to expand, spurred by population growth, rising personal and business incomes, and increased leisure time. Convenience and competitive advantage will attract more and more business firms to operate their own aircraft. The rising need for fast, convenient transportation service from airport to downtown business centers or other airports and between smaller urban areas will increase the need for air-taxi service. Growth in activities such as crop dusting, pipeline patrolling, and the use of aircraft in certain construction activities also will contribute to the growth of general aviation. In Federal, State and local governments, flying activities will continue to expand slowly, as aircraft are used increasingly in activity such as traffic surveillance, forest conservation protection programs, and flight instruction at public institutions.

The expansion of all civil aviation activities depends on the availability of qualified airplane pilots and mechanics. Requirements for pilots in civil aviation, resulting from both occupational employment growth and replacement needs, are expected to be approximately 60,000 through the decade ending in 1977. (See table 1.) More than 82 percent of total employment requirements, or about 50,000 workers, will result from growth as pilot employment requirements increase from an estimated 60,000 in 1967 to a projected 110,000 by 1977. (See table 2.) Approximately three-fifths, or about 37,000 of all pilot requirements will be needed during the 1973-77 period. The general aviation sector of the industry alone will require over 36,000 new pilots over the decade, with more than half of these needs occurring in the last half of the projection period. Total requirements for aircraft mechanics throughout civil aviation are expected to number 75,000, and most of these requirements will result from occupational growth as mechanic employment needs increase sharply from approximately 104,000 to 164,000 between 1967 and 1977. Unlike the situation for pilots, however, the need for mechanics is divided more equally between the first and second half of the projection period. Of the 75,000 new mechanics that will be needed, two-thirds, or 50,000, will be employed in general aviation.

[1] New air carrier forecasts to 1979 have been released recently by the FAA. Although direct comparisons for the target year 1977 cannot be made, indications are that several key variables (e.g., number of aircraft hours flown) may be somewhat higher in the more recent report. Consequently, the projections of pilot and mechanic requirements presented in this report may be understated, particularly in a specific flying activity, such as instructional flying, to the extent that the FAA forecasts for 1977 have been revised. Overall, however, such changes should not change substantially the future pilot and mechanic employment requirements shown in this report.

[2] *Aviation Forecasts Fiscal Years 1967-1977* (Federal Aviation Administration, January 1967), p. 3.

Note: The Federal Aviation Administration designation has changed recently from the Federal Aviation Agency. The title Federal Aviation Administration is used in this study to apply to both designations.

Table 1. Projected requirements for pilots and mechanics resulting from employment growth and from retirements and deaths, by sector of civil aviation, 1968-77, 1968-72, and 1973-77

Occupation and civil aviation sector	Projected requirements									Average annual requirements 1968-77
	1968-77			1968-72			1973-77			
	Total requirements	Growth	Replacements	Total requirements	Growth	Replacements	Total requirements	Growth	Replacements	
Pilots	60,200	49,600	10,600	23,400	19,600	3,900	36,800	30,100	6,800	6,000
Air carriers	22,800	18,000	4,800	6,500	5,000	1,500	16,300	13,000	3,300	2,300
General aviation	36,200	30,700	5,500	16,300	14,100	2,200	19,900	16,600	3,300	3,600
Government	1,200	900	300	600	500	200	600	500	200	100
Mechanics	75,000	60,400	14,600	37,200	30,700	6,500	37,900	29,700	8,200	7,500
Air carriers	24,700	18,000	6,700	12,100	9,000	3,100	12,600	9,000	3,600	2,500
General aviation	50,200	42,400	7,800	25,000	21,700	3,300	25,200	20,700	4,500	5,000
Government	100	--	100	100	--	100	100	--	100	(1/)

1/ Less than 50.
2/ Employment estimates in this bulletin are for 1967; projected requirements reflect the 1968 to 1977 period.

NOTE: Individual items may not add to totals due to rounding.

SOURCE: Bureau of Labor Statistics.

Table 2. Employment of pilots and mechanics, by sector of civil aviation, estimated 1967 and projected employment requirements, 1972 and 1977

Occupation and civil aviation sector	Estimated 1967 employment	Employment requirements		Net growth		
		1972	1977	Total 1968-77	1968-72	1973-77
Pilots	60,100	79,700	109,700	49,600	19,600	30,100
Air carrier	33,100	38,100	51,100	18,000	5,000	13,000
General aviation	25,000	39,200	55,700	30,700	14,100	16,600
Government 1/	2,000	2,400	2,900	900	500	500
Mechanics	103,500	134,200	163,900	60,400	30,700	29,700
Air carrier	52,000	61,000	70,000	18,000	9,000	9,000
General aviation	50,400	72,100	92,800	42,400	21,700	20,700
Government 1/	1,100	1,100	1,100	--	--	--

1/ Excludes all civilian pilots and mechanics employed by U.S. Department of Defense as well as military personnel.

NOTE: Individual items may not add to totals due to rounding.

SOURCE: Bureau of Labor Statistics.

Chapter I. U.S. Air Carrier Industry[3]

The U.S. air carrier industry is one of the fastest growing industries in the United States. As illustrated in chart 1, the number of domestic intercity passenger miles flown by scheduled air carriers has grown at a tremendous pace during the 1950's and 1960's. Commercial motor carrier passenger miles declined from 1951 through 1959, then moved upward through 1966 but did not exceed the 1951 level. Since 1951, intercity passenger miles traveled by railroads have declined.[4]

As table 3 indicates, only 10.3 billion revenue passenger miles (including domestic and international) were flown by air carriers in 1950; yet, by the end of the decade this number had nearly quadrupled, reaching 37.8 billion in 1959. The rapid rise in passenger traffic continued unabated into the present decade, and by 1967 revenue passenger miles topped 111.8 billion. Other indicators of airline activity showed similar increases. Between 1950 and 1967, revenue ton-miles grew from 1.4 billion in 1950 to 15.7 billion; revenue passenger originations jumped from 19.5 million to 135.4 million.[5]

Although employment has increased at a rapid pace, the growth in the volume of air carrier traffic has been much greater. This faster growth in traffic has been possible because of rapid productivity gains in the industry. Improvements in aircraft and a myriad of other innovations, ranging from improved baggage handling techniques to the introduction of computerized reservation procedures, have produced a rapid rise in output per man-hour. According to a recent BLS study, "output per employee indexes for the air transportation industry have increased at a rate of almost 8 percent a year since 1947, the highest rate for any major industry. As a result of this rate of gain, productivity levels in 1966 were five times greater than in 1947. By contrast, output per worker in the total private economy during the same period increased at an annual average rate of only 2.8 percent."[6] The growth in traffic, however, increased faster than the gains in productivity and resulted in the rapid growth of employment levels experienced by the industry during the past two decades.

Industry outlook

During the 1967-77 decade, the Nation's air carriers are expected to undergo further expansion. In 1977, scheduled route air carriers are expected to fly a total of 266 billion revenue passenger miles, compared with an estimated 87.5 billion in 1967, an increase of 204 percent. (See table 6.) This growth represents an annual increase of nearly 12 percent, almost equal to the annual rate of growth experienced during the 1950-67 period, but substantially lower than the average growth of 20 percent reported for 1964-67.[7] Increases in air freight volume are anticipated to be even greater. Freight and express revenue ton-miles accounted for only 11 percent of total revenue ton-miles in 1947, yet by 1966, it had increased to about 25 percent.[8] Even faster growth is expected in the coming decade with the advent of aircraft specially designed to carry cargo. Such aircraft will make possible faster service at reduced rates, which will attract additional customers. Because of larger, more

Table 3. Scheduled and nonscheduled route air carrier activity, selected measures, 1950, 1955, 1958-67

[In thousands of miles flown]

Year	Revenue passenger miles	Revenue cargo ton-miles	Revenue ton-miles	Revenue aircraft miles
1950	10,343,000	380,385	1,397,670	488,227
1955	24,732,502	682,885	3,087,808	800,499
1958	32,967,549	951,578	4,120,228	1,022,044
1959	37,782,162	1,104,424	4,734,093	1,081,678
1960	40,049,643	1,173,816	5,024,283	1,040,058
1961	41,791,655	1,372,831	5,394,631	1,017,090
1962	46,269,857	1,780,437	6,238,261	1,074,044
1963	53,216,469	1,756,272	6,860,302	1,143,890
1964	61,798,668	2,058,097	8,015,942	1,239,127
1965	73,215,954	2,807,221	9,894,983	1,418,373
1966	88,142,740	3,862,774	12,440,855	1,602,785
1967	111,778,520	4,760,382	15,683,236	2,009,032

SOURCE: 1950: BLS Estimates Based on *Handbook of Airline Statistics,* 1965 Edition, (Civil Aeronautics Board). 1955, 1958-64: *Handbook of Airline Statistics,* 1965 Edition, (Civil Aeronautics Board), p. 129. 1965-66: FAA *Statistical Handbook of Aviation,* 1967 Edition (Federal Aviation Administration), pp. 160-161. 1967: Unpublished Data from the Federal Aviation Administration.

[3] The U.S. air carrier industry, as covered in this report, includes (1) scheduled and nonscheduled domestic and international route airlines, (2) supplemental air carriers authorized to perform passenger and cargo charter service, and (3) commercial-operator air carriers that do business on a private for-hire basis.

[4] Since employment and traffic data are incomplete for supplemental and commercial-operator air carriers, the discussion of past trends is limited to the (scheduled and nonscheduled) route air carriers. However, in the discussion of projected employment requirements, the needs of all U.S. certified air carriers, including the supplemental and commercial operators, are taken into account.

[5] *FAA Statistical Handbook of Aviation,* 1958 through 1967 Editions, (Federal Aviation Administration).

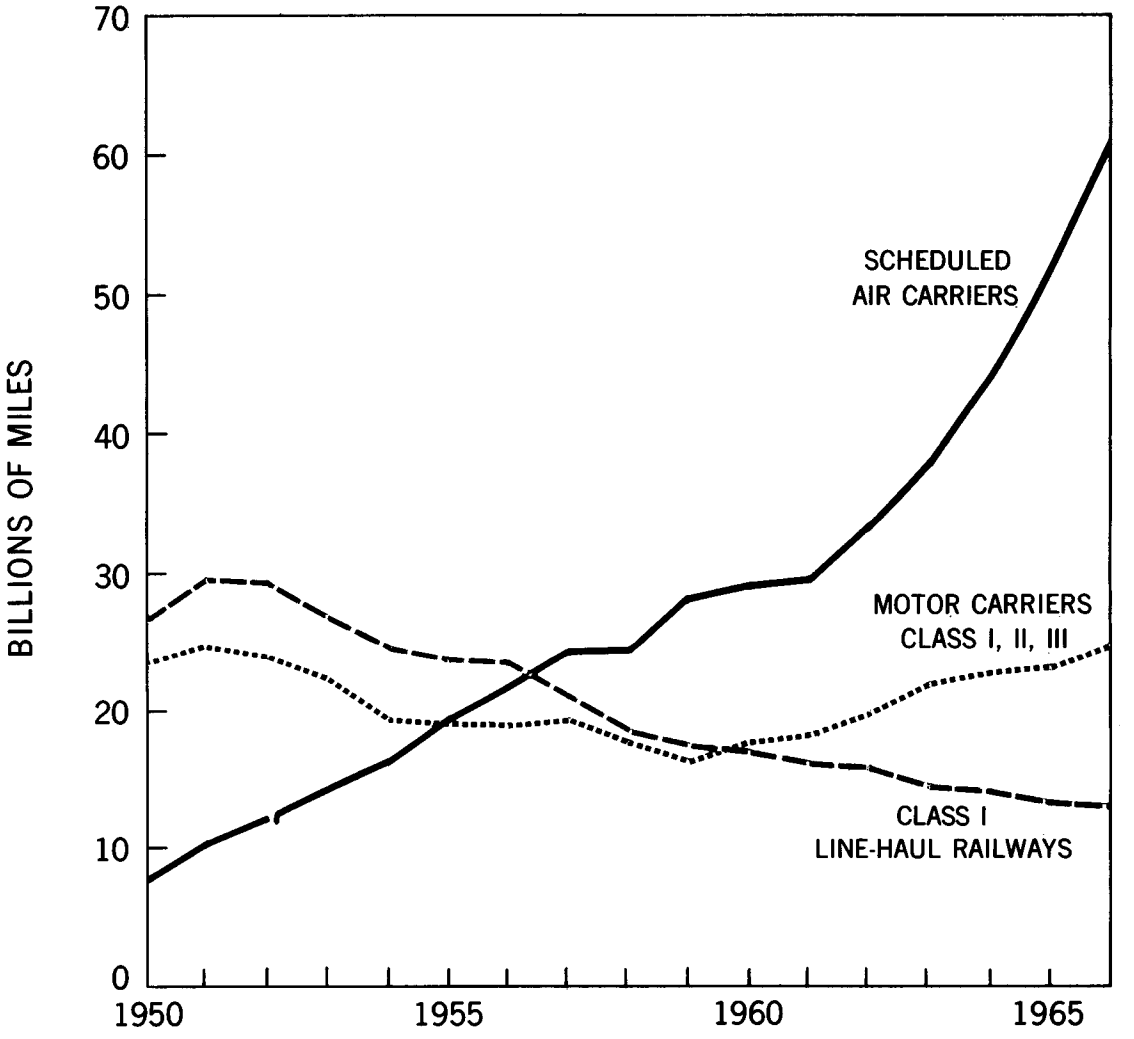
[6] Joseph E. Dragonette and Chester Myslicki, "Air Transport: Trends in Output Per Employee," *Monthly Labor Review* (U.S. Department of Labor, Bureau of Labor Statistics, February 1968), pp. 13-16.

[7] *Aviation Forecasts, Fiscal Years 1967-1977* (Federal Aviation Administration, January 1967), p. 20.

[8] Dragonette and Myslicki, op. cit., p. 16.

CHART 1

DOMESTIC INTERCITY PASSENGER-MILES, SELECTED CARRIERS, 1950-66



SOURCES: FAA STATISTICAL HANDBOOK OF AVIATION, (FEDERAL AVIATION ADMINISTRATION), 1962 AND 1967 EDITIONS.

Table 4. Aircraft in certificated route air carrier operations, by type of aircraft, 1950, 1955, 1958-67

Year	Fleet size	Aircraft type			
		Piston	Turboprop	Turbojet	Helicopter
1950 . .	1,179	1,168	--	--	11
1955 . .	1,480	1,453	8	--	19
1958 . .	1,895	1,777	90	6	22
1959 . .	1,850	1,530	213	84	23
1960 . .	1,867	1,413	227	202	25
1961 . .	1,877	1,282	257	319	19
1962 . .	1,831	1,164	251	396	20
1963 . .	1,832	1,136	250	426	20
1964 . .	1,863	1,026	259	558	20
1965 . .	1,896	867	296	712	21
1966 . .	2,027	676	352	978	21
1967 . .	2,188	460	414	1,292	22

SOURCE: 1950: *FAA Statistical Handbook of Aviation,* 1960 edition, op. cit. 1955: *FAA Statistical Handbook of Aviation,* 1963 edition, op. cit., table 7.3, p. 83. 1958-1966: *FAA Statistical Handbook of Aviation,* 1967 edition, op. cit., table 7.8, p. 83. 1967: *Facts and Figures, 1968* (Air Transport Association of America, Washington, D.C.), p. 38

powerful aircraft that are now in the development and testing stages, all indications point toward a substantial increase in air-freight activity during the next decade.

The size and composition of the aircraft fleet are expected to change substantially during the next decade. According to FAA estimates, the number of aircraft operated by U.S. air carriers will grow from an estimated 2,337 in 1967 to 3,500 in 1977. (See table 7.) The growing volume in both passengers and freight will increase aircraft requirements. During the past decade, fleet size has remained relatively stable, as the increases in passenger and freight volume largely were absorbed through the transition to larger capacity and faster aircraft. Between 1958 and 1964, the number of aircraft in operation remained approximately the same, yet available seat miles doubled from 55 billion to 110 billion and revenue cargo ton-miles more than doubled from about 1 billion to slightly over 2 billion. (See table 3.) Future increases in aircraft capacity and speed will be more than offset by the growth expected in passenger and freight volume and will result in an increase in the fleet size and change in its composition. (See table 7.)

The number of aircraft operated by route air carriers also has grown but at a far slower pace; this figure increased from 1,179 in 1950 to 2,188 in 1967. (See table 4.) The rapid growth in traffic unaccompanied by a corresponding increase in fleet size was possible because of the transition from the piston powered aircraft of the early 1950's to turboprop and turbojet aircraft which are larger and faster. Turbine powered aircraft were utilized for the first time in the air carrier service in 1955. The first pure jets, or turbojets, were put into service in 1958. By 1967, turbine powered aircraft made up over three-fourths of the route air carrier fleet; turbojets alone accounted for nearly three-fifths of all aircraft.

[9] For the purpose of this study, pilots are defined as all cockpit personnel including pilots, copilots, flight engineers, and navigators.

Employment trends

Pilots. In response to the rapid increase in the demand for air travel, employment in the U.S. air carrier industry also has undergone a dramatic increase. As table 5 shows, only 86,000 workers were employed by certificated route air carriers in 1950. Throughout the 1950's employment increased steadily as the volume of passenger traffic moved upward. By 1960, employment had reached 167,300 workers, an increase of 95 percent during the decade. Employment continued to expand during the early 1960's and by 1967 reached a high of 276,000 workers. Between 1950 and 1967, employment in the route airlines increased 221 percent, far outstripping the growth rate reported in nearly every major industry.

During the same period, employment in manufacturing increased only 27 percent; finance, insurance, and real estate, 68 percent; and transportation and public utilities, 6 percent. (See chart 2.)

In 1967, about 31,000 pilots[9] were employed by U.S. certificated route air carriers, and another 2,000 were estimated to be employed by suplemental and commercial operator air carriers. (See table 8.) The number of pilots employed by certificated route air

Table 5. Total employment and pilot and mechanic employment in certificated route air carriers, 1950, 1955, 1958-67

Year	Total air carrier employment	Pilots[1/]	Mechanics[2/]
1950	85,900	9,500	20,500
1955	126,900	14,600	30,400
1958	152,100	17,600	30,800
1959	165,500	18,800	32,800
1960	167,300	17,500	34,500
1961	169,941	18,098	34,065
1962	172,827	17,971	34,925
1963	178,887	18,310	34,453
1964	191,818	19,551	39,360
1965	210,795	21,972	41,667
1966	243,701	27,807	45,327
1967	276,023	30,956	50,016

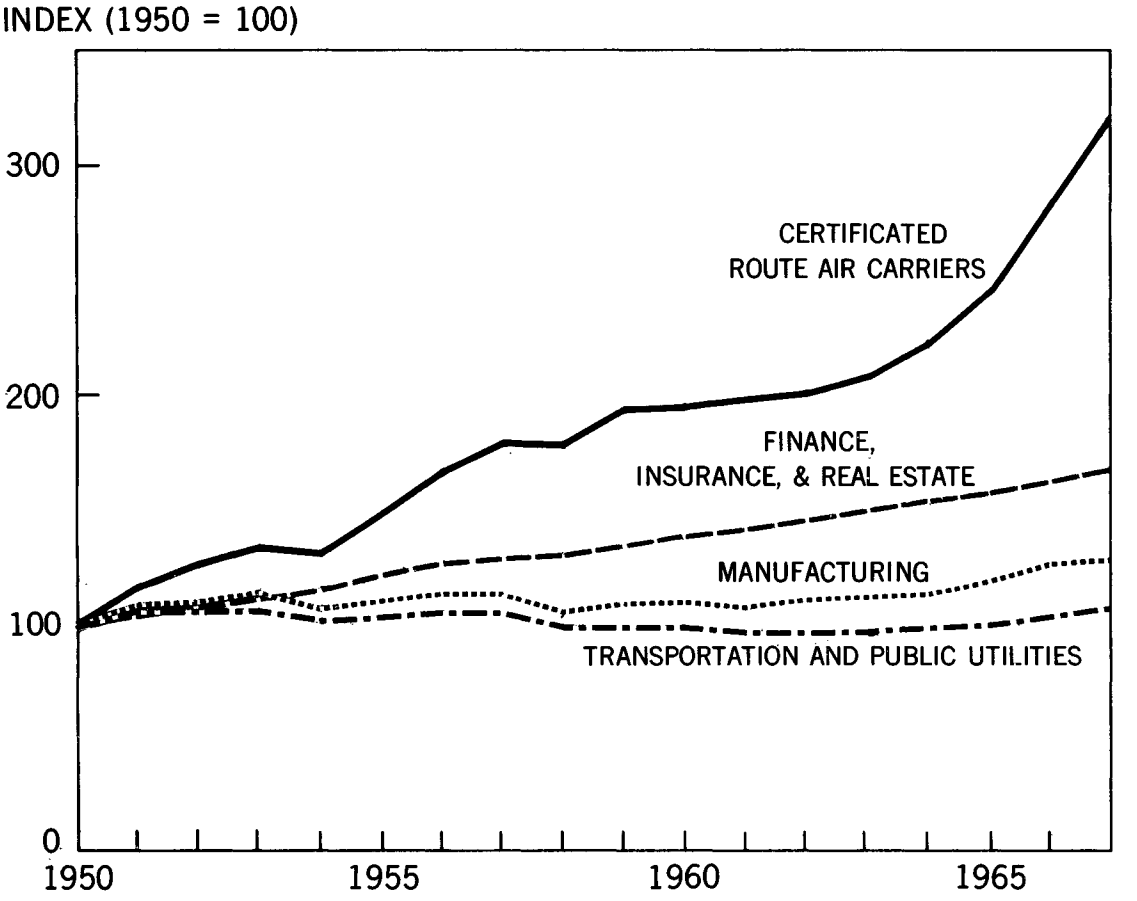
1/ Include pilots, copilots, flight engineers, and navigators.

2/ Includes small number of other maintenance workers, such as carpenters and electricians, that are included in Federal Aviation Administration statistics covering mechanics.

SOURCE: 1950, 1955, 1958-60: *Employment Requirements and Changing Occupational Structure in Civil Aviation,* (BLS Bulletin 1367, June 1964), table 8, p. 18. 1961-66: *FAA Statistical Handbook of Aviation,* op. cit., 1962-67 Editions. 1967: *Facts and Figures, 1968,* op. cit., p. 40.

CHART 2

EMPLOYMENT IN U.S. CERTIFICATED ROUTE AIR CARRIERS, AND SELECTED INDUSTRY GROUPS, 1950-67



SOURCE: AIR CARRIER EMPLOYMENT – FAA STATISTICAL HANDBOOK OF AVIATION, op. cit., 1958 THROUGH 1967 EDITIONS.

OTHER INDUSTRIES – EMPLOYMENT AND EARNINGS STATISTICS FOR THE UNITED STATES 1909-68, (BUREAU OF LABOR STATISTICS, AUGUST 1968).

Table 6. Revenue passenger miles flown by scheduled route air carriers, by type of traffic, estimated 1967 and projected 1972 and 1977

Type of traffic	Estimated 1967	Projected		Percent increase 1967-77
		1972	1977	
Revenue passenger miles (billions) . .	87.5	149.0	266.0	204
Domestic	66.1	112.0	200.0	203
International	21.4	37.0	66.0	208

SOURCE: *Aviation Forecast Fiscal Years 1967-1977,* (Federal Aviation Administration, January 1967,) table 1, p. 20.

carriers has grown substantially during the 1950's and 1960's. As shown in table 5, fewer than 10,000 pilots were employed by these air carriers in 1950. During the 1950's, employment grew rapidly and reached nearly 19,000 by 1959. Little change in pilot employment occurred during the early 1960's. However, since 1964, the number of pilots employed by certificated route air carriers has grown by over 58 percent, increasing from 19,600 in 1964 to nearly 31,000 in 1967. Pilots employed by supplemental and commercial operator air carriers increased from fewer than an estimated 1,000 in 1950 to about 2,200 in 1967.

In general, pilot employment has grown in response to an acceleration in the demand for air transportation services. However, although measures of output, such as revenue passenger miles flown or revenue ton-miles flown, have increased at a fairly constant rate since 1950, pilot employment has grown in a more irregular manner. These varying trends result primarily from factors influencing pilot productivity. Overall, pilot productivity increased dramatically during the 1950's and 1960's. Revenue passenger miles flown grew tenfold during this period, whereas pilot employment only tripled. These gains in productivity resulted primarily from the introduction of larger and faster aircraft.

Table 7. Total aircraft in the service of U.S. air carriers, estimated 1967 and projected 1972 and 1977

Aircraft type	Estimated 1967	Projected		Percent change 1967-77
		1972	1977	
Total aircraft	2,337	2,875	3,500	+ 50
Fixed wing aircraft	2,315	2,847	3,470	+ 50
Jet	1,044	2,194	2,923	+180
Turboprop	396	402	488	+ 23
Piston	875	251	59	- 93
Helicopter	22	28	30	+ 36

NOTE: Total aircraft in service differs from aircraft in certification route air carrier operations (table 4 of this report) in that it includes aircraft operated by supplemental and commercial operator air carriers.

SOURCE: *FAA Aviation Forecasts Fiscal Years 1967-1977,* (Federal Aviation Administration, January 1967) table 3, p. 22.

Between 1958 and 1963, the shift toward jet-powered aircraft was largely responsible for a 61 percent increase in revenue passenger miles flown, but pilot employment did not increase. Over the long run, however, growth in traffic volume has more than offset productivity gains and the net effect has been a rise in the requirement for pilots. During the past 3 years (1965-67), increases in traffic volume have far outstripped productivity gains, and pilot employment has grown at an unprecedented pace. (See table 5.) The increase in pilot employment was 2,400 in 1965, 5,800 in 1966, and 3,100 in 1967, or an average increase of 3,800 a year for the period. Although a number of factors, such as increased training and retraining and pilot stockpiling, played a role in this rapid rise, the primary determinant was the unprecedented growth in air carrier traffic.

Mechanics. In 1967, the Nation's air carriers employed 52,000 mechanics, certified route air carriers employed about 50,000, and supplemental and commercial operator air carriers employed an estimated 2,000. (See table 8.) During the 1950's and 1960's, the number of mechanics employed by certificated route air carriers increased rapidly, though at a somewhat slower pace than the employment of pilots. (See table 5.) Mechanic employment by these carriers rose from 20,500 in 1950 to 50,000 by 1967, an increase of 144 percent. Employment of these workers increased nearly every year during this period; the most rapid growth occurred during the 1960's, especially since 1963.

To a large extent, the mechanic work force has expanded to meet the growing maintenance needs of a larger, more sophisticated aircraft and an expanded aircraft fleet. In 1950, only 1,179 piston aircraft were operated by route air carriers (table 4). Many of these aircraft were relatively small, such as the DC-3. By 1967, the number of aircraft owned and operated by the Nation's certificated route air carriers had grown to 2,188—larger turbojet aircraft accounted for nearly three-fifths of these.

Several new types of aircraft will be introduced during the decade. The first "jumbo" jets (Boeing 747) were scheduled to enter service in late 1969 and will account for an important part of the total fleet by 1977. The smaller 2-engine jets already in operation also will grow in number as more are put into service on intermediate and short distance routes.[10] According to

[10] *Aviation Forecasts, Fiscal Years 1967-1977* (Federal Aviation Administration, January 1967), table 3, p. 22.

Table 8. Employment of pilots and mechanics by U.S. air carriers, estimated 1967 and projected employment requirements, 1972 and 1977

Occupation	Estimated 1967 employment	Projected requirements		Percent increase, 1967-77
		1972	1977	
Pilots	33,100	38,100	51,100	54
Mechanics	52,000	61,000	70,000	35

NOTE: Percents based on unrounded numbers.

SOURCE: Bureau of Labor Statistics.

FAA, the first supersonic transport, the "Concorde," will begin operations in 1972, with the American SST joining the air carrier fleet in 1975. The introduction of these aircraft will be a continuation of the historical trend toward larger and faster aircraft. By 1977, the FAA estimates that 86 SST's will be in operation; undoubtedly most will be used in transoceanic flights. As the size and speed of aircraft increased, the need for more sophisticated instrumentation and increasingly complex guidance, communication, and control systems also increased. These and other technological advances in aircraft design added substantially to maintenance requirements, especially for electronics and instrument repairmen.

Some technological innovations partially offset the increases in maintenance requirements during the 1950's and 1960's. Turbine engines required less maintenance than the piston engines they replaced. Increases in the reliability of airframes, communication systems, and many other aircraft parts made possible by new materials, such as plastics and new alloys as well as improvements in component design, also have reduced maintenance needs. The development of modern test equipment and advances in tool design also reduced maintenance requirements. Overall, such advances increased the productivity of the maintenance work force and tended to moderate the growth in maintenance manpower requirements.

Projected pilot and mechanic requirements

Total pilot and mechanic requirements of the Nation's air carriers for 1972 and 1977 were made within the framework of the air carrier activity and fleet forecasts developed by the FAA in its 1967 report, *Aviation Forecasts Fiscal Years 1967-1977.* In preparing these projections, a variety of methods were tested. For a complete discussion of the methods selected for use in developing the projections of employment requirements and the procedures followed in determining replacement needs, see chapter IV, Projection Methods.

Pilot requirements. A total of about 23,000 additional pilots will be needed by the Nation's air carriers between 1967 and 1977. Nearly four-fifths of the new requirements will result from occupational growth. (See table 9.) Between 1967 and 1977, pilot requirements resulting from growth of the occupation are expected to rise 18,000, from 33,000 to 51,000, an increase of 54 percent (See table 8.) By comparison, during the 1958-67 decade, pilot employment increased 13,000, about one-fourth less than the projected growth over the decade ahead. However, the 1967-77 rate of increase implied by this projection is only 54 percent, compared with the 76-percent increase of the 1958-67 decade. A large share (over 11,000) of this past employment growth occurred in 3 years, 1965-67. Except for this period, the rate of increase was far less than that projected for the 1967-77 decade.

In addition to occupational growth requirements, 4,800 new pilots will be needed over the next decade as replacements. Based on age data from FAA airmen-medical records and unpublished data obtained from the Air Transport Association, 1 out of every 7 pilots currently employed by the air carriers can be expected to retire or die from 1968 through 1977. These relatively high replacement needs reflect the large number of air carrier pilots who received their flight training during World War II and now are approaching retirement age.

The employment needs for U.S. air carrier pilots are not divided equally between the two halves of the projection period. (See table 9.) Employment growth requirements for the 1968-72 period are projected to be considerably below that expected for the second half of the decade. These differing growth rates stem from several causes. Short-run projections are affected more strongly by cyclical influences. Pilot employment increased at an unusually rapid pace during 1966 and 1967, far above the long-run trends. Thus, the computed employment level for 1967, developed through regression analysis, was considerably lower than the actual employment level reported by the FAA. Although full assessment of the recent spurt in employment is difficult, much of the increase may reflect short-run influences, i.e., increases in training and retraining activity, transport demands of the Viet Nam situation, and possible pilot stockpiling due to concern over possible future shortages. During the 9-month period ending March 31, 1968, Civil Aeronautics Board records show

Table 9. Projected requirements for pilots and mechanics resulting from employment growth and from retirements and deaths, by U.S. air carriers, 1968-77, 1968-72, and 1973-77

Occupation and type of requirement	Requirements					
	1968-77		1968-72		1973-77	
	Number	Percent of total	Number	Percent of total	Number	Percent of total
Total pilots	22,800	100	6,500	29	16,300	71
Growth	18,000	100	5,000	28	13,000	72
Retirement and death	4,800	100	1,500	31	3,300	69
Total mechanics	24,700	100	12,100	49	12,600	51
Growth	18,000	100	9,000	50	9,000	50
Retirement and death	6,700	100	3,100	46	3,600	54

NOTE: Individual parts may not add to total due to rounding.

SOURCE: Bureau of Labor Statistics.

that employment increased only 1,400, a possible indication that pilot employment growth patterns already may be returning to long-run trends. Also, pilot productivity is expected to increase more rapidly during the first 5-year period, modifying pilot requirements. During this period, jet aircraft will continue to replace the slower piston and turboprop aircraft and consequently increase pilot productivity. By 1972, most of the conversion to jet aircraft will have been completed, and pilot productivity increases should slow during the 1973-77 period. This slowdown is expected to result in a more rapid rise in the requirements for pilots during this period.

When compared with expected traffic growth, projections of pilot employment rise at a much slower pace, approximately 54 percent over the next decade. The much greater growth in traffic, unaccompanied by a correspondingly large increase in the number of pilots, reflects the impact of continuing technological change on pilot productivity. Primary among these changes will be further shifts in fleet composition. (See table 7.) Not only will the smaller capacity piston aircraft be phased out during the next decade, but new second and third generation jets will be put into service. The increase in average aircraft speed resulting from the expansion of the subsonic jet fleet (Boeing 747 and DC-10) and the introduction of supersonic aircraft will reduce further the trip time and increase output per pilot. Pilot productivity gains, however, will be moderated by a number of offsetting influences. Actual pilot flight hours, or "stick time," may decline as a result of scheduling difficulties and increased flight preparation time. Traffic congestion may lengthen landing and takeoff times and modify the effect of the increase in average flight speed. Increases in training and retraining resulting from the advent of new types of aircraft also will increase pilot needs. Furthermore, pilot requirements may be influenced by future shifts in institutional factors such as longer vacations or, even more important, by negotiated reductions in the pilots' maximum monthly duty hours.

Mechanic requirements. About 25,000 new airplane mechanics will be needed by U.S. air carriers during the 1967-77 decade. (See table 9.) About three-fourths of this increase will result from employment growth. The number of mechanics employed by the Nation's air carriers is expected to increase from 52,000 in 1967 to 70,000 in 1977, an increase of 35 percent (table 8). Most of the growth will occur in the certificated route air carriers, where employment is expected to increase by 17,000 to 67,000 in 1977, about equal to the employment growth experienced during the past decade. The remaining additional workers—about 1,000—will be required by the supplemental and commercial operator air carriers where mechanic employment will grow to about 3,000 by 1977.

Employment growth is projected to be equally divided between the two halves of the projection period, increasing 9,000 in each period. Replacement needs,

Table 10. Revenue aircraft hours, by type of aircraft, U.S. air carriers, estimated 1967 and forecast 1972 and 1977

[In millions]

Aircraft type	Hours			Percent change, 1967-77
	Estimated 1967	Forecast		
		1972	1977	
Total aircraft	5.27	7.20	9.27	+ 76
Fixed-wing aircraft	5.24	7.17	9.23	+ 76
Jet	3.06	6.14	8.18	+167
Turboprop	0.87	0.83	1.01	+ 16
Piston	1.31	0.20	0.04	- 97
Helicopters	0.03	0.03	0.04	+ 33

SOURCE: *FAA Aviation Forecasts Fiscal Years 1967-77,* (Federal Aviation Administration, January 1967) table 4, p. 22.

however, will be higher in the second half of the decade. From 1968 through 1972, 3,100 workers will be needed to replace mechanics who die or retire, whereas replacement requirements will be 3,600 for the later period, 16 percent higher.

Growth in the employment of mechanics will result primarily from two factors. First, the number of aircraft operated by air carriers is expected to increase substantially during the next decade. In addition flight hours are expected to rise about 76 percent above the 1967 level. (See table 10.) The maintenance of this larger, more extensively utilized aircraft fleet will require additional mechanics. Second, aircraft are becoming larger and more complex. The increased sophistication of aircraft control, guidance, and communications systems will add to maintenance requirements.

Some technological developments, on the other hand, will tend to moderate employment growth. The continued shift toward jet-powered aircraft will reduce engine maintenance requirements. Other innovations ranging from the use of complex monitoring and testing systems to the development of improved hand tools will increase mechanic productivity and moderate the rate of employment growth over the coming decade.

Chapter II. General Aviation[11]

General aviation is a large and rapidly expanding part of the Nation's air transportation system. In 1967, general aviation accounted for nearly 97 percent of all the aircraft operated in the civil aviation industry. Of the 106,337 aircraft inventoried by FAA, 104,000 were in general aviation. (See table 11.)

General aviation has grown substantially in recent years. As speed, safety, and comfort have increased, aircraft have gained in acceptance as a mode of transportation. Population growth, rising personal and business incomes, and increased leisure time have spurred the expansion in all types of general aviation flying. Business flying has increased as more and more companies have discovered the convenience and competitive advantages of operating their own aircraft. Air taxi service has increased in response to the need for feeder service to major air terminals and for air transportation to remote locations not serviced by air carriers. In recent years, modern agriculture and industry increasingly have required additional aircraft for activities such as pesticide spraying, pipeline patrolling, and certain construction operations. To meet these and similar needs, general aviation has become one of the most rapidly expanding sectors.

Changes in the size of the general aviation aircraft fleet and the increase in the number of hours flown in general aviation provide an indication of industry growth. According to FAA, the fleet grew by more than 38,700 aircraft between 1958 and 1967, an increase of about 60 percent. (See table 11.) Of the various types of aircraft, growth has been most rapid for the larger multiengine aircraft. In 1958, multiengine aircraft accounted for 8 percent of the general aviation fleet, but their share had grown to 12 percent by 1967.

The total hours flown in general aviation have increased even faster than the number of aircraft. Although only 12.6 million hours were flown by general aviation aircraft in 1958, flight hours had increased to an alltime high of 22.2 million by 1967, an increase of 76 percent over the decade. (See table 12.)

In terms of number of aircraft, personal use flying makes up the largest part of general aviation; this activity accounted for 54 percent of the 104,000 general aviation aircraft in 1967. (See table 13.) Among nonpersonal uses, business flying accounted for 22 percent of the general aviation fleet, followed by commercial flying, 14 percent; instructional flying, 8 percent; and other flying, 2 percent. Although representing less than one-half of the aircraft fleet, nonpersonal flying accounted for slightly over three-fourths of all the hours flown in general aviation. Personal use flying accounted for only 23 percent of hours flown in 1967, whereas business flying accounted for 30 percent. Other important sectors in terms of hours flown were commercial and instructional flying, which accounted for 18 and 28 percent, respectively, of the total. The larger proportion of hours flown relative to the number of aircraft reported for nonpersonal uses reflects the much higher rates of aircraft utilization in the nonpersonal flying sectors.

The most rapid increase in hours flown between 1958 and 1967 occurred in instructional flying. Hours flown in instructional flying increased 191 percent. Other sectors recording rapid growth in hours flown during this period were personal use flying (119 percent) and commercial flying (66 percent).

Outlook

According to FAA, the general aviation fleet will continue to expand rapidly during the coming decade, stimulated by the same factors that spurred activity during the past decade. By 1977, the number of such aircraft is forecast to increase to 180,000, or 73 percent above the 1967 level. (See table 14.)

Piston aircraft are expected to account for most of the increase in the number of general aviation aircraft. Single-engine piston aircraft are forecast to grow by 55,600, or 63 percent between 1967 and 1977. During the same time period, multi-engine piston aircraft will approximately double in number and increase from 12,500 to 23,000. Turbine powered aircraft, both turbojet and turboprop, are expected to show the sharpest rate of growth by jumping from fewer than 1,000 in 1967 to 8,000 by 1977. Most of the turbine powered aircraft will be used in business and air taxi operations, where their relatively lower maintenance costs and higher speeds make them especially attractive.

The number of hours flown by general aviation aircraft also is forecast by FAA to rise sharply between 1967 and 1977. (See table 12.) Total aircraft hours will

[11] General aviation covers the following categories as identified by the Federal Aviation Administration: (1) business flying, (2) commercial flying (air taxi, aerial applications and industrial-special use), (3) instructional flying, (4) personal-use flying, and (5) other flying. Also included in this category are the certified and noncertified repair stations that service general aviation aircraft.

Table 11. Active general aviation aircraft, by type of aircraft, 1958-67, and forecast 1972 and 1977

Year, as of January 1	Number of active aircraft	Aircraft type				
		Piston		Turbine	Rotorcraft	Other
		Single-engine	Multiengine			
1958	65,289	59,649	5,036	(1)	344	260
1959	67,839	61,692	5,416	(1)	439	292
1960	68,727	61,844	5,957	77	525	324
1961	76,549	68,301	7,129	114	634	371
1962	80,632	71,010	8,211	186	798	427
1963	84,121	73,456	8,978	213	967	507
1964	85,088	73,626	9,458	245	1,171	588
1965	88,742	76,136	10,346	306	1,306	648
1966	95,442	81,134	11,422	574	1,503	809
1967	104,000	88,000	12,500	950	1,700	850
1972	144,000	118,300	17,800	4,100	2,650	1,150
1977	180,000	143,600	23,000	8,000	4,000	1,400

1/ Not available.

SOURCE: *FAA Statistical Handbook of Aviation*, Federal Aviation Administration, 1958-67 edition. *Aviation Forecasts Fiscal Years 1967-77*, (Federal Aviation Administration, January 1967).

grow by nearly three-fifths; the increase will be from 22.2 million in 1967 to 35.0 million by 1977. By 1977, the nonpersonal uses of aircraft still will make up almost three-fourths of all the hours flown in general aviation. Business flying will continue to account for the largest share; its increase is expected to be nearly 60 percent, from 6.6 to 10.4 million hours between 1967 and 1977. A growing number of business firms, especially those that have operations in more than one geographic location, are expected to buy or lease aircraft to provide more direct travel for company executives. Business-owned aircraft also are being used more widely to transport sales staffs and customers, and to provide a responsive technical service staff for product installation and maintenance.

Flight hours also are expected to grow substantially in both commercial (3.9 to 7.2 million) and instructional (6.3 to 7.4 million) flying between 1967 and 1977. Most of the increase in commercial flying will result from the growing demand for air taxi services. From 1957 to 1967, the number of certificated air taxi operators has risen steadily. Future growth will result primarily from the expansion of air taxi service to communities too small to warrant regular air carrier service, and from the demand for air taxi service to connect major air terminals with downtown areas and suburban communities. Several major air carriers already are including air taxi fares in ticketing procedures, a practice that will be expanded further in the 1967-77 decade.

Flight hours in personal use flying are forecast to grow by nearly 90 percent during 1967-77. (See table 12.) A population with more leisure time and higher incomes, together with the public's growing awareness of the availability and convenience of flying, will stimulate this rapid expansion.

Pilot employment trends

Historical data on the number of pilots have been limited, for the most part, to a count of active pilot certificates. According to FAA, the number of persons holding commercial certificates—the rating held by most pilots employed in general aviation—more than doubled between 1957 and 1967 and increased from 71,000 to 150,000.[12] A large share of this growth occurred during the 1963-67 period, when the number of pilots holding commercial certificates rose sharply from 96,000 to 150,000. This data, however, represent the total pilot

[12] *FAA Statistical Handbook of Aviation*, 1966 Edition, (Federal Aviation Administration), p. 77. Unpublished data for 1967 were obtained from FAA.

Table 12. Estimated hours flown in general aviation, by type of flying, 1950-67 and FY 1972 and 1977

[Thousands of hours]

Year	Total hours	Type of flying									
		Business		Commercial		Instructional		Personal use		Other	
		Hours	Percent	Hours	Percent	Hours	Percent	Hours	Percent	Hours	Percent
1950	9,650	2,750	28	1,500	16	3,000	31	2,300	24	100	1
1951	8,451	2,950	35	1,584	19	1,902	23	1,880	22	135	1
1952	8,186	3,124	38	1,727	21	1,503	18	1,629	20	203	3
1953	8,527	3,626	42	1,649	19	1,248	15	1,846	22	158	2
1954	8,963	3,875	43	1,829	20	1,292	15	1,920	22	47	(1/)
1955	9,500	4,300	45	1,950	21	1,275	13	1,975	21	--	--
1956	10,200	4,600	45	2,000	20	1,500	15	2,100	20	--	--
1957	10,938	4,864	45	2,013	18	1,864	17	2,109	19	88	1
1958	12,579	5,699	45	2,365	19	2,150	17	2,365	19	--	--
1959	12,903	5,699	44	2,365	18	2,043	16	2,796	22	--	--
1960	13,121	5,699	44	2,365	18	1,828	14	3,172	24	57	(1/)
1961	13,602	5,699	42	2,634	19	1,796	13	3,398	25	75	1
1962	14,500	5,431	38	3,051	21	2,385	16	3,489	24	144	1
1963	15,106	5,740	38	3,172	21	2,417	16	3,626	24	151	1
1964	15,738	5,823	37	3,305	21	2,675	17	3,777	24	158	1
1965	16,733	5,857	35	3,348	20	3,346	20	4,016	24	166	1
1966	21,023	7,057	33	3,555	17	5,674	27	4,540	22	197	1
1967	22,153	6,578	30	3,918	18	6,262	28	5,173	23	222	1
1972	27,200	8,400	31	5,700	21	5,600	21	7,300	27	200	1
1977	35,000	10,400	30	7,200	21	7,400	21	9,700	28	300	1

1/ Less than 0.05 percent.

SOURCE 1950-66: *FAA Statistical Handbook of Aviation* (Federal Aviation Administration), 1963 and 1967 Editions, table 5.2 and 5.4. 1967: Unpublished data from the FAA. 1972 and 1977: *Aviation Forecasts Fiscal Years 1967-77*, op. cit., table 8, p. 27.

population, not persons actually employed as pilots in general aviation.[13]

Based on a special tabulation prepared from FAA aeromedical records,[14] 25,000 pilots were employed by general aviation in 1967. Almost one-half of these pilots (11,900) were reportedly in executive transportation (table 15). Air taxi operations accounted for the second largest concentration of pilots (6,200), followed by instructional flying (3,300). The remaining pilots were divided among the other general aviation activities; 1,500 were reported in aerial application, 1,500 in industrial/special, and 500 in other uses.

Mechanic employment trends

Historical data on general aviation mechanic employment have been limited in the past to FAA data reporting the number of persons holding mechanic certificates. The number of certificated mechanics has grown substantially in the past decade; the increase was from 103,000 in 1957 to over 147,000 in 1967.[15] These

[13] The discussion of historical trends in the number of pilots is limited in this section to active certificated pilots. The total pilot population reflected in the FAA data includes many persons who fly solely for recreation, and others who are employed primarily in other occupations, but who fly occasionally for business reasons or as a secondary job. Although recognizing that many thousands of additional pilots may be employed on a casual part-time basis, for the purpose of this study, the Bureau's statisticians decided that meaningful future pilot training requirements would best be determined if current and projected employment estimates were limited to those persons who were employed primarily as professional pilots. Lack of historical data on professionally-employed pilots in general aviation prevented development of estimates for years prior to 1967.

[14] For a complete discussion of the source and methods followed in preparing pilot employment estimates, see p. 19.

[15] *FAA Statistical Handbook of Aviation*, 1966 Edition, op. cit., p. 77. Unpublished data for 1967 were obtained from FAA.

data, however, include many persons not employed as mechanics in general aviation and exclude others.[16]

Based on certificated repair station inspection records and FAA regional office estimates,[17] mechanic employment in general aviation was estimated at about 50,000 in 1967. (See table 16.) Three-fifths (32,600) of these mechanics were employed at certificated repair stations. The remainder, about 18,000, were estimated to be employed by the usually smaller, noncertificated repair stations. At certificated repair stations, noncertificated mechanics were estimated to number about 24,000; certificated mechanics, 4,800; and certificated repairmen, 3,600.

Projected pilot and mechanic requirements

As in the air carrier industry, the manpower requirements presented in this section reflect both those resulting from expansion in the general aviation sector and those resulting from the need to replace persons who die or retire. The growth projections were made within the framework of general aviation flight activity and fleet forecasts developed by FAA in its 1967 report, *Aviation Forecasts Fiscal Years 1967-77.*

For a complete discussion of the methods used in developing the employment projections and estimating replacement requirements, see Part II of this bulletin.

Pilot requirements. About 36,000 new pilots will be required in general aviation from 1968 through 1977 because of occupational growth and the need to replace pilots who will retire or die. (See table 17.) Requirements resulting from employment growth will account for nearly 85 percent of all new pilot needs. Pilot employment is projected to more than double between 1967 and 1977; the increase is expected to be from an estimated 25,000 to about 56,000. (See table 18.)

More than 80 percent of the new pilot requirements will be concentrated in two flying activities—executive transportation and air taxi operations. In the executive transportation sector alone, pilot requirements will exceed 19,000 over the 1967-77 decade. (See table 17.)

[16] The discussion of historical trends in the number of mechanics is limited in this section to certificated mechanics. Mechanics employed by air carriers are included in FAA data as are persons who hold an active mechanic rating but are employed in another occupation. Excluded from the FAA data are a large number of mechanics without active certificates. Lack of historical data on mechanics employed in general aviation prevented development of estimates for the years prior to 1967.

[17] For a complete discussion of the sources and procedures followed in estimating mechanic employment, see p. 34.

Table 13. Estimated distribution of general aviation aircraft, by type of flying, 1967

Type of flying	Percent distribution
Total	100
Personal use	54
Business	22
Commercial	14
Instructional	8
Other flying	2

SOURCE: Bureau of Labor Statistics.

Employment growth will account for most of these requirements as the number of pilots engaged in executive flying is projected to increase from nearly 12,000 to about 28,000. An additional 2,700 pilots will be needed in executive flying as replacements for those who retire or die during the decade. In air taxi flying, slightly over 11,000 new pilots will be required, the sharpest rate of increase for any flying activity. By 1977, the number of pilots engaged in this activity will grow by one and a half times its 1967 level—from 6,200 to 15,800. An additional 1,500 pilots will be required by air-taxi flying as replacements.

Of the remaining pilot requirements in general aviation, nearly two-thirds (3,700) will be in instructional flying. Employment needs will nearly double in this sector, growing from 3,300 in 1967 to 6,300 in 1977. Another 700 pilots will be needed as replacements for those pilots who retire or die during this period. Smaller numbers of new pilots will be required in the other types of general aviation flying—800 in industrial/special; 900 in aerial application; and 400 in other types of flying.

Pilot growth requirements will be somewhat higher during the second half of the 1967-77 decade. Employment requirements are projected to increase by 16,600 during the second half of the decade, compared with 14,100 during the first half; and replacement needs will

Table 14. Active general aviation aircraft, by type of aircraft, estimated 1967 and forecast 1972 and 1977

Type of aircraft	Aircraft			
	Estimated 1967	Forecast		Percent increase, 1967-77
		1972	1977	
Total	104,000	144,000	180,000	73
Piston	100,500	136,100	166,600	66
Single-engine	88,000	118,300	143,600	63
Multiengine	12,500	17,800	23,000	84
Turbine	950	4,100	8,000	742
Rotorcraft	1,700	2,650	4,000	135
Other	850	1,150	1,400	65

SOURCE: *Aviation Forecasts Fiscal Years 1967-77*, op. cit., table 6, p. 25.

Table 15. Estimated employment of pilots in general aviation, by type of flying, 1967

Type of flying	Estimated 1967 employment	Percent distribution
Total	25,000	100.0
Executive transportation	11,900	47.5
Air taxi	6,200	24.9
Aerial application	1,500	6.2
Industrial/special	1,500	6.1
Instructional	3,300	13.3
Other	500	2.0

NOTE: Individual items may not add to total due to rounding. Percents based on unrounded numbers.

SOURCE: Bureau of Labor Statistics. Estimates based on data obtained from FAA Aeromedical Records.

average about 700 a year in the 1973-77 period, compared with nearly 400 a year in the 1968-72 period.

The growth in pilot employment throughout the various sectors of general aviation will be generated by the rapid rise in the demand for general aviation services discussed earlier. Although numerous technological advances are expected in aircraft design and in operating systems, these changes are not expected to have a major impact on the manpower requirements for pilots in general aviation.

Mechanic requirements. An estimated 50,300 new mechanics will be needed in general aviation from 1967 through 1977, an average of nearly 5,000 each year. Employment needs are expected to nearly double over the 1967-77 decade; the expected increase will be from 50,400 to 92,800. (See table 18.) Six out of every seven new job openings will result from employment expansion. The remaining requirements (7,800) will result from the need to replace workers who will die or retire.

Employment of mechanics will grow to about 72,000 by 1972, an increase of nearly 22,000, compared with a projected increase of 20,700 during the second 5-year period. Replacement needs also will be greater during the second 5-year period—4,500 compared with 3,300.

A number of factors will spur the growth of mechanic employment. As indicated earlier, the general aviation fleet is expected to expand from 104,000 in 1967 to 144,000 by 1972 and 180,000 by 1977, an increase of 73 percent for the decade. Perhaps even more important in determining mechanic requirements is the sharp increase in flight hours forecast by the FAA. Not only is the general aviation fleet and its utilization increasing, but aircraft also are becoming more complex as new

Table 16. Estimated mechanics employed in general aviation, by type of repair station, 1967

Type of repair station	Estimated 1967 employment
Total mechanics	50,400
Certificated repair station	32,600
Certificated mechanics	4,800
Certificated repairmen	3,600
Noncertificated repair station	17,800

NOTE: Individual parts may not add to totals due to rounding.

SOURCE: Bureau of Labor Statistics. Estimates based on unpublished FAA records.

Table 17. Projected requirements for general aviation pilots and mechanics resulting from employment growth and from retirements and deaths, 1968-77, 1968-72, and 1973-77

Occupation	Requirements								
	1968-77			1968-72			1973-77		
	Total	Growth	Deaths and retirements	Total	Growth	Deaths and retirements	Total	Growth	Deaths and retirements
Pilots	36,200	30,700	5,500	16,400	14,100	2,200	19,900	16,600	3,300
Executive flying	19,300	16,500	2,700	8,200	7,200	1,100	11,000	9,400	1,600
Air taxi	11,100	9,600	1,500	5,200	4,600	600	6,000	5,000	900
Aerial application	900	700	300	500	400	100	400	300	100
Industrial/special	800	600	200	400	300	100	400	300	100
Instructional	3,700	3,000	700	1,900	1,600	300	1,800	1,400	400
Other	400	300	100	200	200	(1/)	200	200	(1/)
Mechanics	50,300	42,400	7,800	25,100	21,800	3,300	25,200	20,700	4,500

1/Less than 50.

NOTE: Individual parts may not add to totals due to rounding.

SOURCE: Bureau of Labor Statistics.

Table 18. Employment of pilots and mechanics in general aviation, estimated 1967 and projected employment requirements, 1972 and 1977

Occupation	Estimated 1967 employment	Projected requirements		Percentage increase 1967-77
		1972	1977	
Pilots	25,000	39,200	55,700	123
Executive transportation	11,900	19,100	28,400	139
Air taxi	6,200	10,800	15,800	155
Aerial application	1,500	1,900	2,200	47
Industrial/special	1,500	1,800	2,100	40
Instructional	3,300	4,900	6,300	91
Other	500	700	800	60
Mechanics	50,400	72,100	92,800	84

NOTE: Individual items may not add to totals due to rounding.

SOURCE: Bureau of Labor Statistics.

equipment and instrumentation are being developed continually, creating additional maintenance demands. However, other influences will offset the increased maintenance created by the growing complexity of general aviation aircraft. New and better maintenance equipment and procedures will increase mechanic productivity. The shift towards jet powered aircraft, which have fewer engine maintenance requirements, also will tend to moderate the growth in requirements for certain mechanic specialties. These technological developments will offset one another in the aggregate. In the last analysis, the rapid expansion expected in the size of the fleet and in hours flown will generate a substantial increase in maintenance requirements, and consequantly, mechanic employment will rise sharply during the 1967-77 decade.

Presented in this section is a discussion of the growth of and outlook for Federal, State, and local government flying activities, excluding all activities of the U.S. Department of Defense, civilian and military.[18]

Pilot employment trends

Nearly 2,000 pilots were estimated to be employed in nonmilitary activities by Federal, State, and local government agencies in 1967. (See table 19.) The Federal Government accounted for almost one-half (1,200) of all pilots employed by all levels of government. Most were employed by the Federal Aviation Administration and are involved in activities such as aircraft, airway, and flight procedure testing, and in pilot proficiency testing. Other Federal agencies employing significant numbers of pilots were the Departments of Agriculture, Justice, and Interior. These agencies utilize pilots for border patrolling, forest and game conservation activities, and experimental work.

State and local governments were estimated to employ 800 pilots in 1967. Many were engaged in State and local police patrolling activities; others were employed in State forestry and natural resource agencies engaged in conservation programs. A growing number are being utilized for student instruction in public universities and colleges.

In the Federal Government, pilot employment in nondefense activities has declined slightly since 1957. Although the number of FAA pilots engaged in testing airway systems has declined, the decrease was offset, in part, by an increase in the number of pilots engaged in pilot and flight checkout. Employment in the other Federal agencies grew slightly over the decade but has remained relatively stable during the past few years. No historical data on pilot employment in State and local governments are available.

[18] Excluded from the scope of this study are about 500 civilian pilots employed by the U.S. Department of Defense.

[19] Excluded from the scope of this study are 33,000 civilians employed as airplane mechanics by the U.S. Department of Defense.

[20] Estimates of the number of mechanics employed by the Federal Government from 1958-67 were based on data from the U.S. Civil Service Commission and the Federal Aviation Administration.

[21] Reductions in programs, such as the monitoring of air carrier flights, are possible during the decade. If such program reductions are made, the number of pilots employed by the Federal Government actually may decline.

Mechanic and employment trends

In 1967, an estimated 1,100 mechanics were employed by government agencies in nondefense activities.[19] (See table 19.) Nearly all were employed by the Federal Government, principally by the Federal Aviation Administration. Fewer than 100 mechanics were estimated to be employed by State and local government agencies. Because of the small aircraft fleet operated by State and local governments, most maintenance work is contracted out to privately-operated repair stations.

Mechanics working for Federal agencies are engaged largely in the maintenance of agency operated aircraft. In 1958, about 1,200 were employed by Federal nondefense agencies. Employment increased during the early 1960's to about 1,700 in 1962. By 1967, however, the number of mechanics dropped to 1,100, slightly below the 1958 level.[20]

Projected pilot and mechanic requirements

The following section discusses future pilot and mechanic manpower requirements in government. The manpower requirements presented reflect both those resulting from expansion and those resulting from the need to replace persons who die or retire.

For a complete discussion of the methods used in developing employment projections and estimating replacement requirements, see pages 33 and 39 of this report.

Pilot requirements. The number of pilots employed by government is expected to grow by nearly 1,000 between 1967 and 1977 to a total of 2,900. (See table 19.) In addition to growth requirements, 300 pilots will be needed to replace those who will die or retire. (See table 20.) The growth in employment requirements will be somewhat greater in the Federal Government (500) than in State and local government agencies (400). In Federal agencies, the increase in requirements will result from the further expansion of flight procedure testing and pilot checkout activities conducted by the FAA. The growth in flight activity, both commercial and private, will require a larger staff of these specialized personnel. The increases may be offset, in part, however, by further reductions in frequency of certain inspection programs.[21] In State and local government agencies, further expansion of patrolling activities, especially highway and other police patrolling, and the growth of flight instruction in public supported schools will account for most of the increase in pilot requirements.

Table 19. Employment of pilots and mechanics in government, by type of government, estimated 1967 and projected employment requirements, 1972 and 1977

Occupation	Estimated 1967 employment	Projected requirements		Percentage increase 1967-77
		1972	1977	
Total pilots	1,980	2,440	2,900	46
Federal	1,180	1,440	1,700	44
Federal Aviation Administration	1,020	1,260	1,500	47
Other Federal	160	180	200	25
State and local	800	1,000	1,200	50
Total mechanics	1,100	1,100	1,100	--
Federal	1,000	1,000	1,000	--
State and local	100	100	100	--

SOURCE: Bureau of Labor Statistics. Federal employment estimates for 1967 based on data from the U.S. Civil Service Commission and the Federal Aviation Administration. State and local employment estimates for 1967 based on special tabulation of FAA aeromedical records.

Mechanic requirements. Little change is expected in the number of mechanics employed by government during the 1967-77 decade. The size of the fleet operated by FAA is expected to decline slightly, but it will consist of larger, more complex aircraft. As in the past, employment is expected to remain relatively stable, and new mechanic requirements will stem primarily from the need to replace workers who retire or die. Estimates are that only 100 new mechanics will be required for this purpose. (See table 20.) No change is expected in employment of mechanics in State and local governments, since maintenance work probably will continue to be performed by private repair stations.

Table 20. Projected requirements for pilots and mechanics in government[1/] resulting from employment growth and from retirements and deaths, 1968-77, 1968-72, and 1973-77

Occupation and type of government	Requirements								
	1968-77			1968-72			1973-77		
	Total	Growth	Deaths and retirement	Total	Growth	Deaths and retirement	Total	Growth	Deaths and retirement
Total pilots	1,250	920	330	610	460	150	640	460	180
Federal	720	520	200	350	260	90	370	260	110
State and local	530	400	130	260	200	60	270	200	70
Total mechanics	120	--	120	60	--	60	60	--	60
Federal	100	--	100	50	--	50	50	--	50
State and local	20	--	20	10	--	10	10	--	10

1/Excludes personnel employed by the U.S. Department of Defense.

SOURCE: Bureau of Labor Statistics.

Chapter IV. Projection Methods

A number of techniques for estimating future pilot and mechanic requirements in civil aviation were tested and evaluated before those used in this study were selected. The techniques used account for the future environment of the industry as reflected by forecasts made by the Federal Aviation Administration of industry variables such as fleet size and composition, revenue passenger miles, and revenue aircraft hours flown. These variables express the expected demand for the services of civil aviation, and the technological, economic, and other factors that will influence the level of demand and manpower requirements. The BLS projections of manpower requirements, therefore, are dependent upon the realization of the FAA forecasts. The techniques finally selected are presented in a manner that facilitates revision of the manpower projections if the FAA projections are modified. Such a presentation is highly desirable, since the rapidly changing environment of civil aviation makes all projections subject to constant review.

Pilot and mechanic employment requirements

Several techniques were selected to estimate pilot requirements resulting from expected growth in civil aviation activity. For U.S. air carriers, two separate techniques were used, the results of each verifying the other. The first (method A)[22] was based on the need for pilots, as reflected in FAA's estimated fleet size and composition and the total number of hours these aircraft would be flown[23], as well as BLS estimates of the average number of crews expected per aircraft and the number of pilots expected per crew. The second (method B) involved the development of a multiple regression equation. The variables used in the equation were selected after testing and evaluating the relationship of historical data on pilot requirements. The equation reflects the impact of total hours flown, the changing technology of civil aviation (complexity, fleet composition, utilization of aircraft), and other factors.

For general aviation, only one technique for estimating pilot requirements was selected. The need for pilots was estimated by type of flying (executive flying, aerial-application, etc.) on the basis of the relationship between current pilot employment and the number and utilization of different types of aircraft. The pilot/aircraft relationships then were extended to the target years and applied to estimates of fleet size in each flying activity.[24] Projections of the relatively small number of pilots employed in government were made on the basis of an evaluation of available historical data and consultation with the various government agencies employing these workers.

Two techniques were selected to project the growth of employment requirements for mechanics in civil aviation—one for the growth of requirements in air carriers and the other for requirements in general aviation. For U.S. air carriers, a multiple regression equation was selected from among many tested, which considered the total number of hours flown, and speed, a variable which reflects the changing composition and utilization of the fleet. For general aviation, a ratio technique was used that allowed the projection of the number of mechanics on the basis of their relationship to the current (1967) and expected total number of hours flown by general aviation aircraft.[25] Because of the small numbers of mechanics employed by government, employment estimates and projections for these workers were made on the basis of an evaluation of available historical data and consultation with the various government agencies where they are employed.

U.S. air carrier pilot projection—method A

The first technique used to project employment requirements for pilots by air carriers was based on the expected size, composition, and utilization of the fleet in the projection years. Tables 21 and 22 present a step-by-step application of the technique. The historical data on pilot employment in U.S. air carriers and the projected employment requirements in 1972 and 1977 using method A are illustrated in chart 3. The data used to project pilot employment requirements by method A originate from different sources. The FAA provides projections of the fleet size, composition, and hours flown by type of aircraft in the target years. Other factors used in the technique were developed by BLS and are explained in detail below.

[22] This method is a modification of the technique used in *Forecasts of Airline Pilot Requirements* (Task 67-17, Subtask 3, Logistics Management Institute, Washington, D.C., May 1967).

[23] *Aviation Forecasts Fiscal Years 1967-77.* op. cit.

[24] Base year estimates of pilot employment in each segment of general aviation were taken from aeromedical records maintained at the Civil Aeromedical Institute, Federal Aviation Administration, Oklahoma City, Oklahoma.

[25] The base-year level of mechanic employment in general aviation was estimated from Annual Inspection Report Records of Certificated Repair Stations, and unpublished estimates of mechanic employment in noncertificated repair stations maintained by FAA regional offices.

Table 21. U.S. air carrier pilot employment requirements projection to 1972 (method A)

Aircraft type	Number in inventory	Total revenue hours flown (millions)	Revenue hours flown by aircraft Col. 2 ÷ Col. 1	Average crews per aircraft Col. 3 ÷ 508	Pilots per crew	Pilot employment Col. 1 x 4 x 5
	(1)	(2)	(3)	(4)	(5)	(6)
2-Engine jet	1,252	3.08	2,460	4.84	2.5	15,149
3-Engine jet						
4-Engine jet	942	3.06	3,248	6.39	3.0	18,058
Supersonic jet						
1 and 2 engine turboprop	353	.74	2,096	4.13	2.0	2,916
4-Engine turboprop	49	.09	1,837	3.62	3.0	532
1 and 2 engine piston	155	.08	516	1.02	2.0	316
4-Engine piston	96	.12	1,250	2.46	3.0	708
Helicopter	28	.03	1,071	2.11	2.0	118
Total	2,875					37,797

SOURCE: Number in Inventory and Total Revenue Hours Flown—*Aviation Forecasts Fiscal Years 1967-77,* op. cit., tables 3 and 4, pp. 22 and 23.
Pilots per crew—"Specifications-U.S. Commercial Transports," *Aviation Week and Space Technology,* Vol. 88, No. 12, March 18, 1968, p. 204.

Table 22. U.S. air carrier pilot employment requirements projection to 1977 (method A)

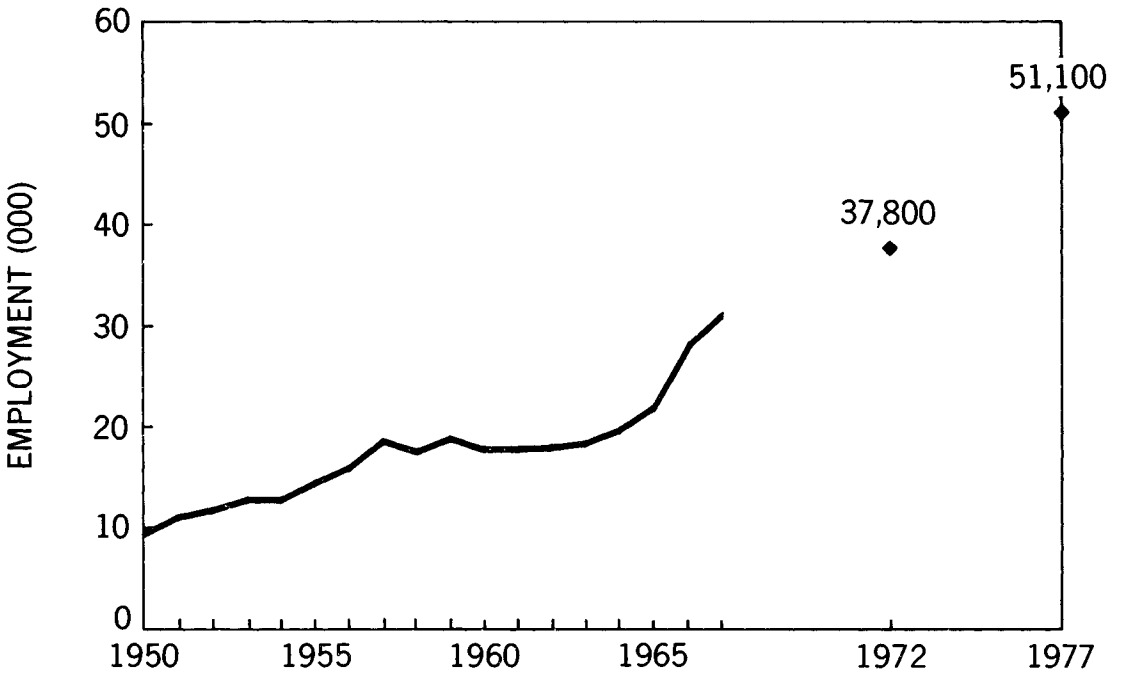
Aircraft type	Number in inventory	Total revenue hours flown (millions)	Revenue hours flown by aircraft Col. 2 ÷ Col. 1	Average crews per aircraft Col. 3 ÷ 483	Pilots per crew	Pilot employment Col. 1 x 4 x 5
	(1)	(2)	(3)	(4)	(5)	(6)
2-Engine jet	1,746	4.41	2,526	5.23	2.5	22,829
3-Engine jet						
4-Engine jet	1,091	3.50	3,208	6.64	3.0	21,733
Supersonic jet	86	.27	3,140	6.50	3.0	1,677
1 and 2 engine turboprop	453	.97	2,141	4.43	2.0	4,014
4-Engine turboprop	35	.04	1,143	2.37	3.0	249
1 and 2 engine piston	26	.05	1,923	3.98	2.0	207
4-Engine piston	33	.04	1,212	2.51	3.0	248
Helicopter	30	.04	1,333	2.76	2.0	166
Total	3,500					51,123

SOURCE: Number in Inventory and Total Revenue Hours Flown—*Aviation Forecasts Fiscal Years 1967-77,* op. cit., tables 3 and 4, pp. 22 and 23.
Pilots per crew—"Specifications-U.S. Commercial Transports," *Aviation Week and Space Technology,* Vol. 88, No. 12, March 18, 1968, p. 204.

CHART 3

EMPLOYMENT OF PILOTS BY U.S. ROUTE AIR CARRIERS, 1950-66, AND PROJECTED EMPLOYMENT REQUIREMENTS, 1972 AND 1977

(METHOD A)



SOURCE: 1950-60 – EMPLOYMENT REQUIREMENTS AND CHANGING OCCUPATIONAL STRUCTURE IN CIVIL AVIATION, op. cit.

1961 – FACTS AND FIGURES 1967, (AIR TRANSPORT ASSOCIATION OF AMERICA, WASHINGTON, D.C.).

1962-67 – FACTS AND FIGURES 1968, (AIR TRANSPORT ASSOCIATION OF AMERICA, WASHINGTON, D.C.).

1972 & 1977 – BUREAU OF LABOR STATISTICS.

Average crews per aircraft. The average number of crews per aircraft in the projected years (column 4) was derived by dividing the expected average revenue hours flown per individual aircraft (column 3) by a factor representing average annual hours flown per crew. Average annual hours flown per crew (508 for 1972 and 483 for 1977) were developed by extrapolating the experience of one large air carrier between 1957 and 1966. The validity of attributing the experience of one air carrier to all air carriers was tested in two ways: First, by discussing the reasonableness of the procedure with industry officials; and second, through testing the projection technique by recreating total air carrier pilot employment in a past year using the historical annual hours experience of pilots employed by one major air carrier, and comparing the results with published pilot employment for that year.

Chart 4 shows the average monthly pilot pay hours and actual flight hours for a major air carrier between 1957 and 1966 and BLS projections to 1972 and 1977. With the induction of jet aircraft during the 1960's, the difference between pilot pay hours and flight hours increased, but at a decreasing rate. In recent years, the rate of decline in flight hours has slowed. By 1966, the average stood at 48 compared with 68 in 1957, an annual average decline of 3.3 percent. Between 1960 and 1966, however, average flight hours dropped from about 57 to 48, or an average of 2.6 percent a year. The slow change in monthly flight hours anticipated after 1966 reflects the industry's expectation that actual flying hours per pilot will not continue to decline as rapidly as between 1960 and 1966 when the conversion to jet aircraft is complete. (Annual average flying hours used in the estimating procedure are monthly hours multiplied by 12 months.)

Industry officials agreed that the level and changes in the level of average monthly flying hours for one major carrier were reasonably representative of the industry as a whole. Moreover, the test of method A using the experience of this air carrier proved valid. Using these data, total 1961 pilot employment in the air carriers calculated by method A was only 3 percent below the published level.

Pilots per crew. The numbers of pilots per crew used in column 5 in tables 21 and 22 are consistent with current Federal regulations and, for the projected years, the opinions of industry officials for aircraft that will become operational between 1967 and 1977. Once these variables were determined, pilot projections then were computed for each target year by multiplying the number of aircraft by the average crews per aircraft and the number of pilots per crew. Following the procedure shown in tables 21 and 22, air carrier (including supplemental airlines and commercial operator air carriers) pilot employment was estimated at approximately 37,800 in 1972 and 51,100 in 1977.

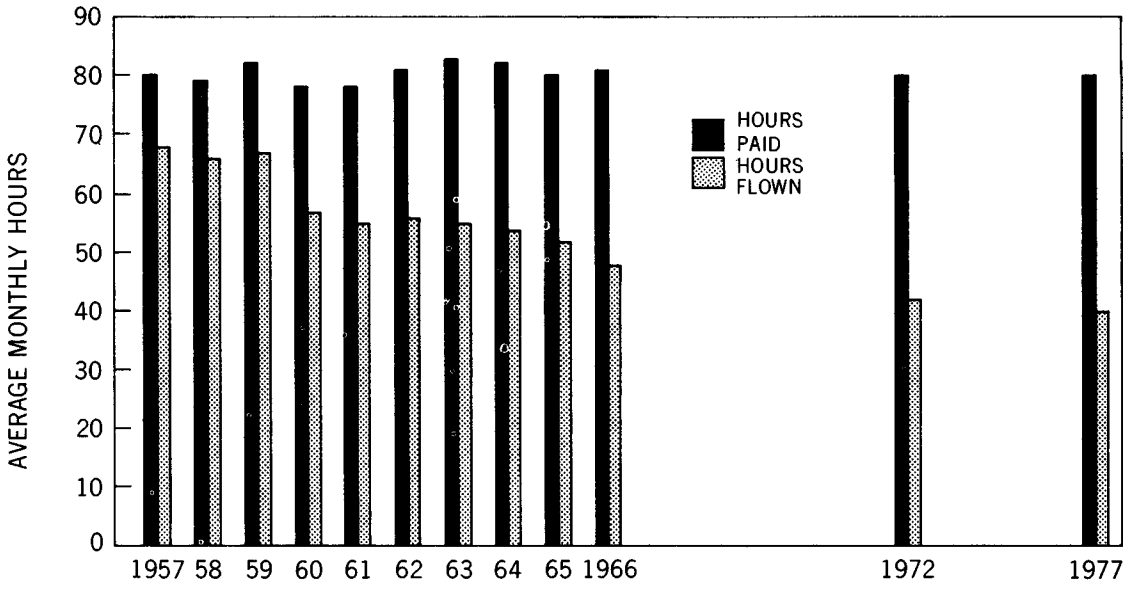
U.S. air carrier pilot projection—method B

To project pilot employment requirements by U.S. route air carriers, a number of variables were selected and regressed separately and in combination against a series on historical employment. The purpose of these tests was to determine the basic causes of change in the employment series. Not only were variables finally selected on the basis of the most logical underpinning possible, but each variable was tested for statistical significance.

To understand better the presentation that follows, a number of limitations to the technique should be noted. First, the types of series available, although perhaps more numerous and of better quality than available for the analysis of almost any other occupation, are nonetheless limited. Therefore, the specification of theories in equation form made use of proxy variables that best reflect influences relevant to the aircraft industry. In some cases, variables that contribute significantly to the explanation of changes in the level of employment of pilots must be either discarded or redefined as proxies before they can be accepted on the basis of empirical evidence. The use of proxy variables is admittedly crude and risky and places the burden of proof squarely on the analysts undertaking the research. Second, a great deal of multicolinearity (high inter-correlation) exist among some of the explanatory variables tested. The rapid growth of civil aviation over the last 20 years is associated with the rapid growth of other variables related to the industry. Therefore, although the correlation between two variables may be high, (logical) qualitative analysis would indicate that the actual cause and effect relationship between them is rather low, both having been influenced by a third variable. Third, the development of an equation (theory) explaining changes in past employment could not be divorced from consideration of expected future changes in the explanatory variables. The use of an equation for projection purposes assumes that the environment of the system or model generally will continue in the future as it has in the past so that the impact of the variable will continue to be similar. For air transportation, however, current indications are that this may not be true. A new dimension in civil aviation may become important by the 1970's that

CHART 4

PILOT MONTHLY PAY HOURS AND FLIGHT HOURS, EXPERIENCE OF A MAJOR U.S. AIR CARRIER, 1957-66, AND BLS PROJECTIONS, 1972 AND 1977



SOURCE: BUREAU OF LABOR STATISTICS.

Table 23. Data inputs for projecting requirements for U.S. route air carrier pilots (method B) and mechanics

Year	Revenue aircraft hours (In thousands)	Speed (miles flown ÷ hours flown)
1953	3,327.6	200
1954	3,365.3	209
1955	3,759.1	213
1956	4,209.7	216
1957	4,683.1	219
1958	4,571.4	224
1959	4,749.4	228
1960	4,281.6	243
1961	3,845.9	264
1962	3,736.3	287
1963	3,785.3	302
1964	3,947.0	314
1965	4,256.6	333
1966	4,781.2	335
1967	5,249.3	351
1972	7,171.9	382
1977	9,234.0	388

SOURCE: 1953-54: *Handbook of Airline Statistics,* 1963 Edition, op. cit., p. 127. 1955-64: *Handbook of Airline Statistics,* 1965 Edition, op. cit., p. 129. 1965-66: *Air Carrier Traffic Statistics,* (Civil Aeronautics Board), December 1966, p. 1. 1967-77: Bureau of Labor Statistics.

will have an impact on pilot employment not adequately accounted for in an equation that explains historical changes in employment. The number of new aircraft should grow more rapidly than in the past. The passenger and freight capacity of aircraft is expected to expand, while average airborne speed, influenced strongly by the past introduction of jets, will tend to increase at a slower rate in the future. In terms of model development, these changes may reflect a major modification in the environment. Such a limitation, of course, is inherent in all projection models but may be particularly applicable to air carrier operations.

The equation finally selected to project pilot employment by route air carriers was of the linear form $y = a + b_1 x_1 + b_2 x + b_3 x_3$, where y represents employment of pilots, x_1 revenue hours flown, x_2 speed, and x_3 time.

$$y = -22{,}509 + .005006\,X_1 + .09187\,X_2 - .460801$$
$$(.0008) \qquad (.0292) \qquad (.3600)$$

The basic data used in the multiple regression equation are shown in table 23, and the actual and computed levels of pilot employment and the projected employment requirements are presented in chart 5. Table 24 provides additional information on the statistical relationship between the variables selected.

The three variables in the equation "explain" 95 percent of the variation in employment of pilots over the 1953-66 period. Although the number of observations is too small for the Durbin-Watson statistic to apply, this statistic computed as a matter of routine was 1.79, which would indicate that unexplained residuals on a year-to-year basis for a larger sample could be distributed randomly about the line of regression. In other words, the Durbin-Watson statistic of 1.79 is not inconsistent with a randomly distributed series for a larger sample. Finally, the independent variable taken together—revenue aircraft hours and average airborne speed—are statistically significant at the 95 percent level. The time variable is much less significant.

Revenue aircraft hours. The impact of annual revenue aircraft hours on the requirement for pilots is quite clear. As hours flown increase, the demand for pilots will also increase (all else remaining constant). The interaction of total revenue passenger miles and average airborne speed are reflected in revenue aircraft hours. As the number of miles increase, speed remaining constant, hours rise (all else remaining constant), increasing the requirements for pilots. Similarly, if speed increases and miles flown remain constant, the demand for pilots declines (all else remaining constant; for example, the fleet mix of aircraft). Therefore, both quantitatively, in terms of the equation, and qualitatively, in terms of what could be expected empirically, an increase in revenue aircraft hours normally will have a positive influence on pilot requirements.

Average airborne speed. The second independent variable, average airborne speed, is used in the equation not as speed per se, which is accounted for in the revenue aircraft hours variable, but as a proxy for factors such as the changing composition of the fleets, the utilization rates of the various types of aircraft, and the general complexity of air carrier operations. In other words, the variable is an indicator of the type of technology and its influence on pilot requirements as it affects the nature of air carrier operations: for example, the rapid increase in average airborne speed in the late 1950's and in the 1960's (table 23) reflects the

Table 24. Selected results of regression analysis for projecting employment requirements for pilots in U.S. route air carriers (method B)

Independent variable	Projected pilot employment (1977)	Variables statistically significant (t-value) p = .05	Standard error of estimate	R^2	Durbin-Watson (based on 14 years of data)
A[1]	45,293	1/A	2,911	0.46	0.21
B[2]	26,419	2/B	2,315	.66	.84
C[3]	31,888	3/C	1,964	.75	.88
A[1], B[2]	47,047	1/A, 2/B	1,014	.94	1.46
A[1], C[3]	45,825	1/A, 3/C	1,326	.90	.89
A[1], B[2], C[3]	47,834	1/A, 2/B	986	.95	1.79

1/A = Revenue aircraft hours.
2/B = Average airborne speed.
3/C = Time.

SOURCE: Bureau of Labor Statistics.

CHART 5

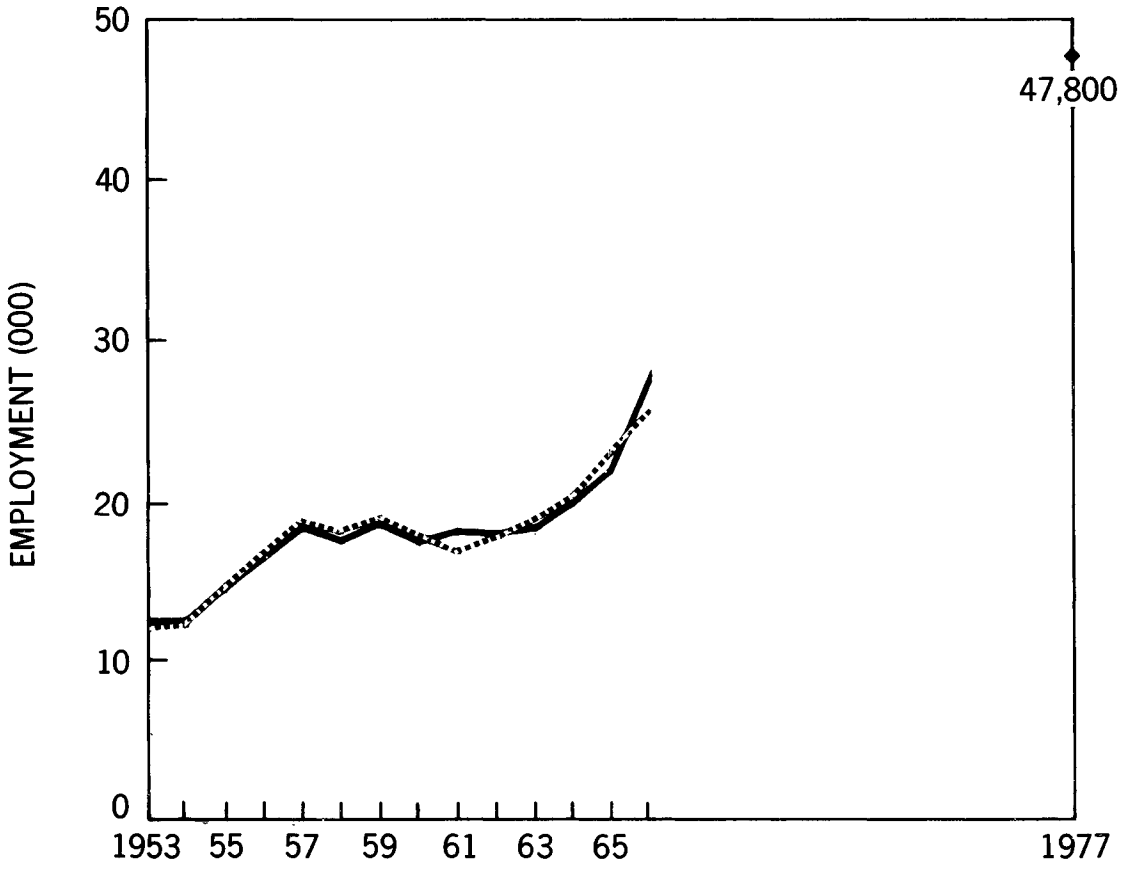
EMPLOYMENT OF PILOTS IN U.S. ROUTE AIR CARRIERS, ACTUAL 1953-66, AND ESTIMATED 1953-66, 1972, AND 1977

(METHOD B)

ACTUAL
CALCULATED

X_1 = REVENUE AIRCRAFT HOURS
X_2 = AVERAGE AIRBORNE SPEED
X_3 = TIME

$$y = -22{,}509 + .005006\ X_1 + .091857\ X_2 - .460801\ X_3$$
$$(.0008) \qquad (.0292) \qquad (.3600)$$



SOURCE: BUREAU OF LABOR STATISTICS.

continuing introduction of jet aircraft into the fleet and, theoretically, should have resulted in a reduction of pilot requirements (all else remaining constant). However, not only did jet aircraft generally require more pilots and crews per aircraft during this period (more complex technology and higher utilization), but the preparation time for pilots in relation to actual flying time also increased. (See chart 4.) This increase had a positive impact on requirements for pilots. In short, the average airborne speed in the late 1950's and 1960's serves as a proxy for the impact of the changing technology and environment of air carrier operations during this period. BLS estimates, derived from FAA forecasts, show that the average airborne speed of aircraft will increase at a much slower pace through 1977. According to FAA,[26] the substitution of jet for propeller-driven craft will be completed in the early 1970's. Thus, the impact of jet aircraft on pilot requirements will not be as important a factor through most of the 1970's as during the late 1950's and 1960's. Therefore, the effect of the expected slowdown in the growth of the speed variable on pilot requirements aptly simulates what should be expected over the projection period as the technology and environment of air carrier operations changes.

Admittedly, average airborne speed is a crude factor to measure the net impact of all the complex and diverse factors that affect requirements for pilots. However, data were limited, and attempts to develop variables more directly representing the influence of factors such as the mix of aircraft were not successful. Test equations became extremely complex and unwieldy, and the quality of the data inputs became questionable, notwithstanding the practical problem of adequately projecting these variables before an estimate of pilot employment in the target year could be developed.

Time. Time as an independent variable in the method B equation measures the net impact of the changing relationship among revenue aircraft hours, the proxy variable, and pilot employment during the 1953-66 period. It may, for example, be measuring a general increase in the efficiency of air carrier operations over the period caused by factors such as improved scheduling of flights, improved aid to pilot flight preparation, and economies of scale. Time in the equation (with other influences being held constant) has a negative influence on requirements for pilots. If revenue aircraft hours and speed were unchanged from one year to the next, about 460 fewer pilots would be needed to maintain the level of air carrier operations. The magnitude of the impact of the time variable appears reasonable.

[26] *Aviation Forecasts Fiscal Years 1967-77,* op. cit., table 3, p. 22.

Table 25. Selected results of regression analysis for projecting employment requirements for mechanics in U.S. route air carriers

Independent variable	Projected mechanic employment (1977)	Variables statistically significant (t-value) p = .05	Standard error of estimate	R^2	Durbin-Watson (based on 14 years of data)
A[1]	61,948	---	4,657	0.26	0.22
B[2]	46,801	[2]/B	2,326	.81	1.09
C[3]	54,088	[3]/C	2,126	.85	1.03
A[1], B[2]	64,779	[1]/A, [2]/B	1,497	.93	1.72
A[1], C[3]	62,811	[3]/C	1,993	.88	1.02
A[1], B[2], C[3]	65,844	[1]/A, [2]/B	1,474	.94	2.02

[1]/A = Revenue aircraft hours.
[2]/B = Average airborne speed.
[3]/C = Time.

SOURCE: Bureau of Labor Statistics.

The 1977 U.S. route air carrier pilot employment projection developed through method B is 47,800. (See chart 5.) Supplemental airline and commercial operators pilot employment in 1977, not covered by this technique, is estimated at about 3,000; this increase brings the total U.S. air carrier pilot projection to nearly 51,000. This estimate is nearly identical to the estimate derived through method A. (See table 22.)

U.S. air carrier mechanic projection method

A number of variables were selected and regressed separately and in combination against mechanic employment in U.S. route air carriers for the period 1953-66. All variables were analyzed before the explanatory equation was selected and used to project mechanic employment requirements.

The combination of variables best explaining mechanic employment in U.S. route air carriers over the 1953-66 period was revenue aircraft hours, average airborne speed, and time. The explanatory variables and the form of the equation were the same as those selected for projecting pilot employment (page 24) and are as follows:

$$y = -16{,}158 + .004739\,X_1 + .138728\,X_2 - .623520\,X_3$$
$$\qquad\qquad (.0013) \qquad (.0437) \qquad (.5383)$$

The basic data used in the equation are shown in table 23, and the actual and computed levels of mechanic employment and the projected requirements are presented in chart 6. Table 25 provides additional information on the statistical relationships among the variables selected. In summary, the three independent variables together explain about 94 percent of the

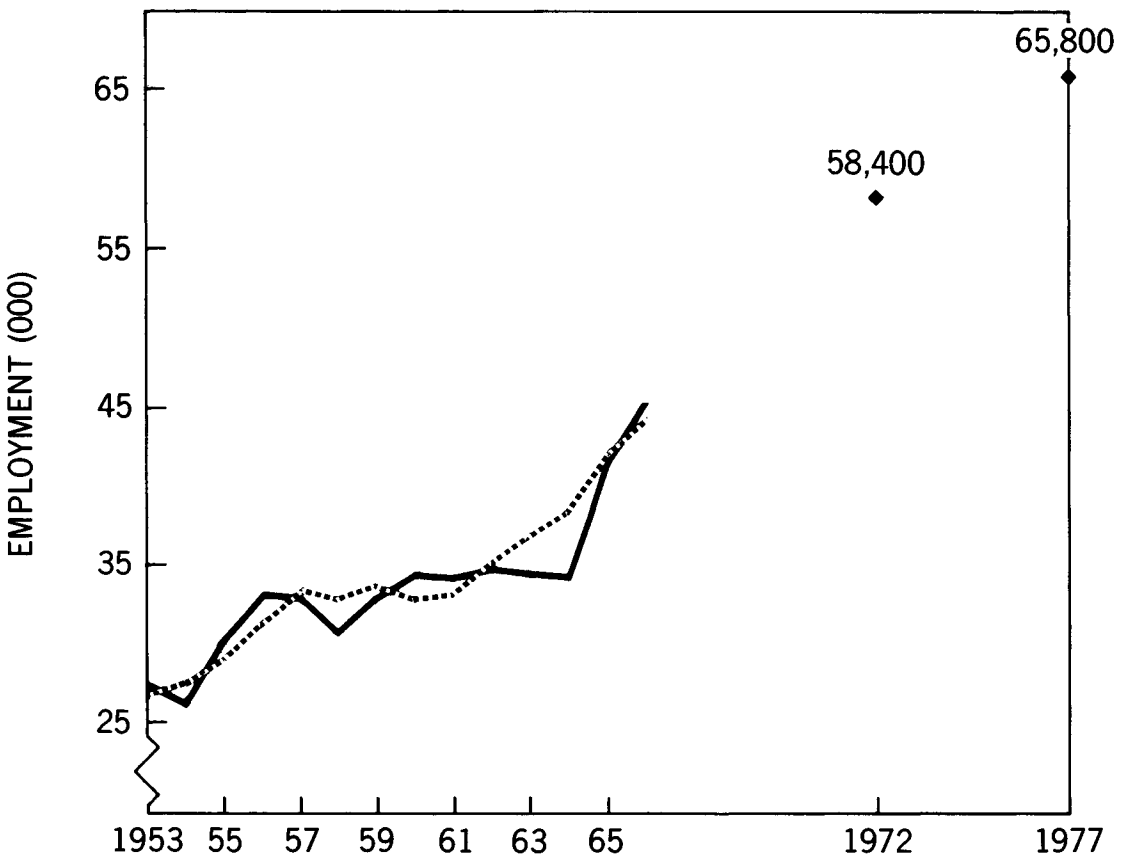
CHART 6

EMPLOYMENT OF MECHANICS IN U.S. ROUTE AIR CARRIERS, ACTUAL 1953-66, AND ESTIMATED 1953-66, 1972, AND 1977

ACTUAL
CALCULATED

X_1 = REVENUE AIRCRAFT HOURS
X_2 = AVERAGE AIRBORNE SPEED
X_3 = TIME

$$y = -16{,}158 + .004739\ X_1 + .138728\ X_2 - .623520\ X_3$$
$$(.0013) \qquad (.0437) \qquad (.5383)$$



SOURCE: BUREAU OF LABOR STATISTICS.

variation in mechanic employment between 1953 and 1966. The unexplained residuals are not inconsistent with being distributed randomly. Both hours and speed are statistically significant in the equation; time is much less so. Based on the information available, a final projection for mechanics of 67,000 for 1977 and 58,500 for 1972 seems reasonable. These projected requirements levels are somewhat above the computed levels but well within the possible range of error in the computed projection. (See table 25.) This upward adjustment was made to reflect the anticipated ratio of mechanics to aircraft. (See discussion, page –)

In addition to mechanics employed by certificated route air carriers, a relatively small number of mechanics are employed by supplemental and commercial operators. The number of mechanics employed by these carriers is estimated at about 2,500 in 1972 and 3,000 in 1977; the total U.S. air carrier mechanic employment projections are 61,000 for 1972 and 70,000 for 1977.

Revenue aircraft hours. Annual revenue aircraft hours is a very important determinant of the requirements for mechanics. Given fleet size and mix, the demand for mechanics rises as revenue aircraft hours increase.

Average airborne speed. Speed, in the equation explaining mechanic employment, functions in much the same manner as in the equation explaining pilot employment. It is a proxy for the changing mix and utilization of aircraft and the level of technology embodied in the aircraft. In addition, the general efficiency of the process of providing fleet maintenance is also reflected by the speed value in the equation. The problems involved in performing multiple regression analysis for the air carrier industry and the limitations of proxy variables were discussed earlier. (See pp. 22 and 24.)

Time. Time as an independent variable in the equation explains the net impact of the changing relationship between revenue aircraft hours, the proxy variable speed, and mechanic employment during the 1953-66 period. Moreover, time may be measuring a long-term improvement in the reliability of aircraft equipment and in the efficiency of aircraft maintenance and repair services. According to the results of the equation, if revenue aircraft hours and speed were unchanged from 1 year to the next, about 624 fewer mechanics would be needed to maintain the fleet in the second year. Similar to the impact of time in the equation for projecting pilot requirements, the magnitude of the impact appears reasonable in this equation.

Table 26. Ratio of mechanics to aircraft, U.S. route air carriers, 1953-67

Year	Mechanics	Aircraft	Ratio of mechanics to aircraft
1953	27,400	1,421	19.3
1954	26,100	1,446	18.0
1955	30,400	1,480	20.5
1956	32,700	1,723	19.0
1957	32,900	1,835	17.9
1958	30,800	1,895	16.3
1959	32,800	1,850	17.7
1960	34,500	1,867	18.5
1961	34,065	1,877	18.1
1962	34,925	1,831	19.1
1963	34,453	1,832	18.8
1964	39,360	1,863	21.1
1965	41,667	1,896	22.0
1966	45,327	2,027	22.4
1967	50,016	2,188	22.9

SOURCE: 1953-60: *Employment Requirements and Changing Occupational Structure in Civil Aviation,* op. cit., pp. 18 and 21. 1961-66: *FAA Statistical Handbook of Aviation,* op. cit., 1962-67 Editions. 1967: *Facts and Figures, 1968,* op. cit., pp. 38 and 40.

To verify the reasonableness of the above mechanic projections, mechanic to aircraft ratios were computed for the period 1953-66 and compared with the corresponding ratio implied by the 1977 projections. (See table 26.) Based on the FAA forecasts of 3,500 aircraft in the fleet in 1977,[27] the projection of 70,000 mechanics in 1977 results in a ratio of 20 mechanics to each aircraft—a ratio somewhat higher than in most of the 1953-66 period but somewhat below the level in the mid-1960's. The ratios appeared reasonable for several reasons. First, the number of aircraft used to develop the ratios for the projection periods represent all U.S. air carriers, whereas those for the 1953-67 period are only for U.S. route air carriers. The smaller supplemental and commercial operators contract out a large share of their maintenance activities to general aviation repair stations. If these carriers were included in the 1953-67 data, the resulting ratios would be somewhat lower. Second, the recent high mechanic-to-aircraft ratios may be viewed as unusual—perhaps a response to recent rapid rises in air travel and aircraft utilization rates. Also, the training of mechanics probably was increased during this period as the shiftover from piston to jet aircraft and the introduction of second generation jets required reorientation and refresher courses for some mechanics. Thus, with large numbers of mechanics being retrained, the employment level of mechanics rose atypically. On the other hand, the high ratios of mechanics to aircraft in the mid-1960's may signify that the mix of aircraft of the future will require an increasing number of mechanics per aircraft. The increased complexity of instrumentation, for example, may more than offset the

[27] *Aviation Forecasts Fiscal Years 1967-77,* op. cit., table 3, p. 22.

Table 27. Preliminary and final estimates of the instructional flying aircraft fleet, by type of aircraft, 1967, 1972, and 1977

Type of aircraft	1964 fleet size	1975 original FAA forecast of fleet size	Preliminary estimates of fleet size			Final estimate of fleet size		
			Interpolated 1967	Interpolated 1972	Extrapolated 1977	1967	1972	1977
Total	6,855	14,550	9,059	12,731	15,952	8,680	12,775	16,399
Single-engine	6,545	14,000	8,666	12,200	15,357	8,315	12,267	15,734
Multiengine	120	200	142	178	215	134	175	210
Turbine	9	30	20	39	34	9	32	58
Rotorcraft	73	170	109	168	188	96	150	227
Other	108	150	122	146	158	126	151	170

SOURCE: 1964 Fleet Size—*General Aviation—A Study and Forecast of the Fleet and Its Use in 1975,* op. cit., pp. 48-52. Preliminary and final estimates for 1967, 1972, and 1977 developed by the Bureau of Labor Statistics.

easier to maintain jet engines, the greater efficiencies in aircraft maintenance, and the greater reliability of electronic equipment. The argument in favor of higher mechanic to aircraft ratios in the future was discarded, however, after discussing the matter with industry officials and evaluating the experience of other industries as to the effect of rapid changes in technology on mechanic levels. Thus, the projected employment requirements for mechanics by the air carriers of 61,000 and 70,000 for 1972 and 1977, respectively, were considered reasonable.

General aviation pilot and mechanic employment requirements

The lack of historical data on general aviation pilot and mechanic employment made more difficult the development of methods for projecting employment in this sector. The specificity needed in pilot projections (type of flying) further narrowed the potential approaches. The methods selected and described in the following paragraphs were designed to utilize the data that were already available or that could be developed from existing records. These methods, and those of the air carriers, were designed to reflect forecasts of key industry variables published by the FAA; for example, forecasts of the size and composition of the aircraft fleet and flight hours. They were structured so that future shifts in FAA forecasts may be incorporated into the procedures and their implications on manpower requirements measured. The employment projections presented in this study reflect, and are dependent upon, the realization of general aviation forecasts prepared by FAA.[28]

[28] *Aviation Forecasts Fiscal Years 1967-77,* op. cit.

General aviation pilot projection method

In general, the procedure selected to project general aviation pilot employment requirements by type of flying was (1) to construct current pilot-to-aircraft ratios; (2) project these relationships to the target years; and (3) apply the projected relationship to aircraft fleet forecasts. This procedure assumes that there exists a relationship between changes in the number of aircraft operated by the various sectors of general aviation and the requirements for pilots. The three basic inputs used in this system are:

1. Current pilot employment by type of flying.
2. Fleet size for each flying activity, by type of aircraft, 1967, 1972, and 1977.
3. Pilot-to-aircraft ratios for each type of flying activity, by type of aircraft, 1967, 1972, and 1977.

Current pilot employment. In the past, studies conducted to determine future pilot needs in general aviation have been hampered by the complete lack of reliable data on the current employment of professional pilots. The availability of current employment is essential, of course, as a base upon which to build projections. To establish current pilot employment, the FAA was requested to prepare a special tabulation of pilot employment from active aeromedical records. This tabulation provided an unduplicated count of all pilots residing in the United States who had undergone the required medical examination during the 15-month

period ending August 1967. This tabulation identified both the occupation and industry of employment of the pilots and made possible the elimination of all nonprofessional pilots from consideration in the pilot count. For example, those reporting their primary occupation as other than pilot were deleted. Similarly, pilots employed outside of general aviation, such as airlines and government, were removed.

The following tabulation shows pilot employment levels in 1967 for each type of flying activity, derived from FAA aeromedical records:

Type of flying	*1967 Pilot employment*
Total, general aviation	25,028
Aerial application	1,543
Instructional flying	3,336
Other flying	[1]500
Total, not specified	19,649
Executive	[2]11,893
Air Taxi	[2]6,224
Industrial/special	[2]1,532

[1] Based on the small size and low utilization of the aircraft in this flying activity, pilot employment was estimated to be about 500 in 1967. It should be noted that while this is basically a judgment estimate, it seems reasonable and, even if it is in substantial error, it would have little impact on total pilot requirements during the next decade.

[2] Only a single employment control total for executive, air taxi, and industrial/special flying activities could be obtained from the FAA medical records data. To determine the 1967 employment levels for each of these flying activities, the control total was used to establish pilot/aircraft ratios. The ratios then were applied to estimates of the aircraft fleet by type of aircraft in each activity and the resulting pilot employment summed to a total for each activity.

General aviation aircraft fleet, by type of aircraft and flying activity, 1967, 1972, and 1977. Estimates of the general aviation fleet size by type of aircraft and type of flying were derived through the use of two FAA reports. The first provided 1975 fleet forecasts by type of aircraft for each activity.[29] The second provided revised forecasts at an aggregated level but did not identify the information on aircraft by type of flying (table 11). To move from the forecasts presented in these reports to the final fleet estimates required by the projection technique, three separate steps were required. First, using the 1964-75 data presented in the first FAA report, preliminary 1967, 1972, and 1977 fleet estimates were developed by type of flying and type of aircraft by extrapolating the 1964-75 estimated aircraft fleet to 1977 and interpolating to derive 1967 and 1972 estimates. These preliminary estimates then were totaled by type of aircraft and compared with the more recent FAA forecasts. Revised estimates of fleet size for each type of flying then were computed by forcing, on a simple prorata basis, the preliminary estimates to the more current FAA forecasts. (Table 27 illustrates this procedure and shows the resulting 1967, 1972, and 1977 fleet estimates for instructional flying.) Since this study concerns only professional pilots, the final step was to eliminate from the fleet estimates all aircraft used in personal flying, as well as business aircraft flown by nonprofessionals. Aircraft used for personal purposes were removed simply by subtracting from the total general aviation fleet all aircraft used in personal flying. On the other hand, the business fleet was first divided into two components—executive and other business—on the basis of the proportion reported in each activity in 1964. The aircraft in the "other business" component then were subtracted from the general aviation fleet estimates. Table 28 shows the final estimates and projections of fleet size for each flying activity by type of aircraft derived through this procedure.

General aviation pilot/aircraft ratios. Having developed estimates of pilot employment and aircraft fleet for each flying activity, an overall pilot-to-aircraft ratio then could be computed (pilot employment/number of aircraft) for each type of flying in general aviation. However, in order that final pilot employment projections reflect the forecasted shifts in aircraft fleet mix during the next decade, it was necessary to establish pilot-to-aircraft ratios for each type of aircraft in each flying activity.

Such ratios were computed separately for aerial application, instructional flying, and other flying. Only one set of ratios representing executive transportation, air taxi, and industrial/special flying combined could be developed, since pilot employment data from FAA aeromedical records were limited to a single control total covering all three of these activities. Although a distinct set of ratios for each flying activity would be preferable, the single set may be adequate since the aircraft utilization patterns reported[30] for these flying activities are quite similar.

Table 29 illustrates the procedures followed in developing pilot/aircraft ratios for executive, air taxi, and industrial/special flying combined. First, the 1964 aircraft fleet and total flight hours by type of aircraft

[29] *General Aviation—A Study and Forecast of the Fleet and Its Use in 1975* (Federal Aviation Administration, July 1966).

[30] *General Aviation, A Study and Forecast of the Fleet and Its Uses, 1975,* (Federal Aviation Administration, July 1966), tables 24-53.

Table 28. Estimated general aviation aircraft fleet,[1] by type of flying and type of aircraft, 1967, 1972, and 1977

Type of flying	Type of aircraft					
	Total aircraft	Single-engine	Multiengine	Turbine	Rotorcraft	Other
Executive transportation:						
1967	12,610	5,974	5,601	705	330	--
1972	17,500	7,203	6,724	2,993	580	--
1977	22,817	8,103	7,978	5,814	922	--
Air-taxi:						
1967	7,029	4,091	2,300	172	456	10
1972	11,198	5,567	4,151	811	642	27
1977	15,270	6,810	5,880	1,618	919	43
Aerial application:						
1967	5,169	4,905	87	--	177	--
1972	6,240	5,859	95	--	286	--
1977	7,081	6,542	100	--	439	--
Industrial/special:						
1967	1,867	1,348	236	--	279	4
1972	2,206	1,553	276	--	371	6
1977	2,513	1,685	306	--	514	8
Instructional:						
1967	8,680	8,315	134	9	96	126
1972	12,775	12,267	175	32	150	151
1977	16,399	15,734	210	58	227	170
Other:						
1967	2,235	1,697	360	7	100	71
1972	2,814	2,157	325	22	172	138
1977	3,302	2,522	273	38	271	198

[1] Excludes aircraft in personal and business flying except executive transportation.

SOURCE: Bureau of Labor Statistics.

reported by the FAA were used to obtain average annual hours flown by type of aircraft (Col. 3). The annual flight hours then were applied to the estimated 1967 aircraft fleet resulting in estimates of total hours flown by each type of aircraft for 1967. Total 1967 hours then were adjusted for the estimated crew compliment (Col. 7), and the resulting distribution (Col. 8) was used to distribute the total pilot population (19,649) (Col. 9) among the various type aircraft. Individual pilot/aircraft ratios for each type of aircraft then were computed by simply relating the number of pilots to the number of aircraft (Col. 10).

This procedure was followed for each of the other flying activities, i.e.,–aerial application, instructional flying, and other flying activities. Estimates of pilots per crew for multi-engine aircraft varied among the flying activities, depending on the proportion of aircraft over 800 h.p. to the total number of multi-engine aircraft in the various flying activities. The estimated number of pilots per crew for turbine powered aircraft was based on normal crew compliments reported by FAA.[31]

The final estimates of 1967 pilot-to-aircraft ratios developed for general aviation, by type of aircraft and type of flying, are shown in table 30.

Projections of pilot-to-aircraft ratios in general aviation to 1972 and 1977 were based on expected changes in aircraft utilization patterns (hours flown), assuming that regulated crew sizes in each type of flying activity will not change over the projection period. Table 31 shows that FAA forecasts little change in the average flight hours for most types of aircraft flown by professional pilots in general aviation, the sole exception

[31] Ibid.

Table 29. Procedure for estimating executive, air taxi, and industrial/special flying pilot/aircraft ratios, by type of aircraft, 1967

Type of aircraft	Aircraft fleet[1/]	1964 total hours flown[2/] (In thousands)	1964 average hours flown per aircraft (Col. 2 ÷ Col. 1)	1967 estimated aircraft fleet[3/]	1967 estimated hours flown (In thousands) (Col. 3 x Col. 4)	Pilots per crew	Weight flight hours (In thousands) (Col. 5 x Col. 6)	Percent distribution of weight flight hours	1967 estimated number of pilots	1967 estimated pilot/aircraft ratios (Col. 9 ÷ Col. 4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Total . . .	28,205	8,189	--	21,506	6,428	--	7,246	100.0	19,649	--
Single-engine . . .	18,333	5,091	277.7	11,413	3,169	1.00	3,169	43.7	8,587	.7524
Multiengine . . .	8,652	2,643	305.5	8,137	2,486	1.25	3,108	42.9	8,429	1.0359
Turbine	285	127	445.6	877	391	1.50	587	8.1	1,592	1.8153
Rotorcraft	932	326	349.8	1,065	373	1.00	373	5.2	1,022	.9596
Other	3	2	666.7	14	9	1.00	9	.1	20	1.4286

SOURCE: 1964 Aircraft Fleet – *General Aviation–A Study and Forecast of the Fleet and Its Use in 1975,* op. cit., appendix tables C, I, and M, pp. 109, 115, and 119. 1964 total hours flown–Ibid., appendix tables D, J, and N, pp. 110, 116, and 120. 1967 estimated aircraft fleet–Bureau of Labor Statistics. See table 28. Pilots per Crew–*General Aviation–A Study and Forecast of the Fleet and Its Use in 1975,* op. cit., tables 42 and 43. 1967 estimated number of pilots–pilots population from text tabulation, p. 93.

Table 30. Estimated ratio of pilots to aircraft in general aviation, by type of aircraft and type of flying, 1967

Type of flying	Type of aircraft				
	Single-engine	Multiengine	Turbine	Rotorcraft	Other
Executive transportation	0.75	1.04	1.82	0.96	1.43
Air-taxi	.75	1.04	1.82	.96	1.43
Aerial application	.29	.13	--	.69	--
Industrial/special	.75	1.04	1.82	.96	1.43
Instructional	.39	.43	.78	.39	.13
Other	.15	.37	1.71	.80	.31

NOTE: Ratios have been rounded for presentation.

SOURCE: Bureau of Labor Statistics.

being a 25 percent rise in the flight hours of turbine-powered aircraft. To reflect FAA's forecast of a rise in turbine aircraft utilization in BLS projections of pilot/aircraft ratios, the 1967 turbine ratios for each type of flying activity were increased by 12.5 percent and 25 percent for 1972 and 1977, respectively. The 1972 and 1977 ratios for all other types of aircraft were held at their 1967 levels.

The last step in projecting employment requirements for pilots in general aviation was to apply the individual pilot/aircraft ratios developed for 1972 and 1977, by type of aircraft, to the corresponding estimate of fleet size in each flying activity. (See table 32 for an illustration of this procedure as applied to instructional flying.) The resulting number of pilots, by type of aircraft, then were totaled for each flying activity. (See table 18 for final projections of pilot employment requirements in general aviation.)

It should be noted again that the development of satisfactory pilot projection methods was hampered severely by the lack of relevant statistical data. Should data such as an annual series on pilot employment in general aviation become available, the method presented here should be reappraised.

General aviation mechanic projection method

The method used to project mechanic employment requirements in general aviation involved the development of 1967 ratio of mechanics to total general aviation flight hours, and the application of this ratio to FAA forecasts[32] of flight hours in 1972 and 1977. This procedure assumes that increases in mechanic productivity resulting from improved tools, testing equipment, and the centralization of repair activities will be offset by the continued trend toward larger, more complex aircraft with higher maintenance requirements. Of the available data, flight hours were selected as the best measure of future growth in mechanic employment, since a large share of aircraft maintenance results from regulations requiring aircraft inspection and overhaul based on the number of hours flown.

To determine a 1967 mechanic employment level, two sources were utilized. First, an estimate was made of mechanic employment in certificated repair stations by tabulating the number of technical personnel (mechanics and repairmen) shown on each repair station's annual inspection report (FAA form 3572).[33] Employees of certificated repair stations outside general aviation, i.e., government and air carriers, were identified and deducted from the total. Next, estimates of mechanics and repairmen employed in noncertificated repair stations were obtained from unpublished records maintained at each FAA regional office. By combining the data from these sources, mechanic employment in 1967 was estimated to be 50,400 (table 16). Using this employment estimate, the ratio of mechanic to flight hours was computed and applied to the FAA 1972 and 1977 forecast of flight hours in general aviation (table 12). Following this procedure, requirements for mechanics were projected to increase to 72,100 in 1972 and 92,800 in 1977.

Table 31. Average annual utilization of general aviation aircraft, by type of aircraft, 1964, and forecast to 1975

Type of aircraft	Average annual utilization (hours flown)		
	1964	1975	Percent change, 1964-75
Single engine piston (four-places and over)	176	172	- 2.3
Multiengine piston	278	260	- 6.5
Turbine	448	560	+25.0
Rotorcraft	342	337	- 1.5
Other	88	83	- 5.7

SOURCE: *General Aviation*—A Study and Forecast of the Fleet and Its Use in 1975, op. cit., table 2; Pt. III, p. 19.

Government pilot and mechanic employment requirements

The projections of pilot employment requirements in government are judgmental, based on an analysis of available historical data and discussions with knowledgeable government officials. The relatively small numbers of pilots and mechanics employed in this sector, coupled with limited data available, precluded the development of a projection model. Current levels of pilot and mechanic employment in nonmilitary government agencies was compiled from several sources. The U.S. Civil Service Commission provided historical information on most pilots employed by Federal agencies. Additional data were obtained directly from the principal Federal agencies employing pilots and mechanics. State and local government estimates were developed from the special tabulation of aeromedical records provided by the FAA.

To project employment, historical data relating to Federal Government employment of pilots and mechanics were analyzed. Discussions concerning probable future developments were held with officials of

[32] *Aviation Forecasts Fiscal Years 1967-77,* op. cit., table 8, p. 27.

[33] In addition to the total number of technical personnel, this report also enumerates separately the number of mechanics and repairmen who were certificated.

Table 32. Procedure for projecting employment requirements for pilots in instructional flying, by type of aircraft, 1972 and 1977

Type of aircraft	1972			1977		
	Aircraft fleet	Pilot/aircraft ratios	Pilot employment requirements (Col. 1 x Col. 2)	Aircraft fleet	Pilot/aircraft ratios	Pilot employment requirements (Col. 4 x Col. 5)
	(1)	(2)	(3)	(4)	(5)	(6)
Total	12,775	--	4,927	16,399	--	6,344
Single-engine (four-places and over)	12,267	.3870	4,747	15,734	.3870	6,089
Multiengine	175	.4254	74	210	.4254	89
Turbine	32	.7778[1/]	28	58	.7778[1/]	56
Rotorcraft	150	.3854	58	227	.3854	87
Other	151	.1349	20	170	.1349	23

[1/] 1967 pilot/aircraft ratios for turbine aircraft were adjusted upwards by 12.5 percent to derive the 1972 estimate and by 25 percent for the 1977 estimate; all other ratios were maintained at the 1967 level.

SOURCE: Aircraft Fleet—data from table 27. Pilot/aircraft ratios—data from table 29 (unrounded).

most of the principal Federal agencies employing these workers. Based on this information, requirements for pilots are expected to increase from an estimated 2,000 in 1967 to 2,400 by 1972 and 2,900 by 1977 (table 19). Mechanic employment, however, is expected to remain at about 1,100 throughout the projection period.

Pilot and mechanic replacement requirements

For the purpose of this study, replacement requirements relate to the number of pilots and mechanics who will be needed to replace those who leave employment due to normal, early, and disability retirement, and death.[34] Lack of data prevented the development of a single, systematic procedure for estimating pilot and mechanic replacement needs for each sector of civil aviation. In air carriers, all pilots reaching age 60 during the decade ahead were assumed to have retired. Estimates of early retirements, disability retirements, and deaths were based on recent industry experience. In general aviation and government, all pilots reaching age 65 were assumed to have retired. Losses due to death, early retirement, etc., were developed using the BLS age specific separation rates. These rates also were used to estimate mechanic losses in all three sectors of civil aviation.

U.S. air carrier pilot replacement needs. The technique used to estimate U.S. air carrier pilot losses due to retirement and death were based on the following major assumptions: (1) The mandatory retirement age for U.S. air carrier pilots will remain at age 60, and early retirement provisions will remain open to most airline pilots at age 55; (2) The number of pilots leaving employment for other than normal retirement, i.e., for early retirement, disability retirement, and death, will follow patterns similar to recent experience; and (3) the new pilots hired by air carriers will be limited to persons under 45 years of age.

During the next decade, a large proportion of replacement needs will stem from the retirement of currently employed pilots. (According to this study, retirements alone will account for 70 percent of all replacement needs.) Currently, FAA regulations require that air carrier pilots retire at 60 years of age. Most company, union, and Government officials indicate that a change in the mandatory retirement age is unlikely over the next decade.

[34] To fully appraise the overall requirements for pilots and mechanics in civil aviation over the next decade, transfers out of these occupations should be considered. However, lack of appropriate data made the development of such estimates impossible. A transfer out of an occupation occurs when a worker moves to another occupation, e.g., from airline pilot to real estate salesman or from aircraft mechanic to automobile mechanic. Hypothetically, if 5 percent of the mechanics employed in civil aviation transferred out each year over the next decade, about 65,000 job openings would be created. However, caution should be used in interpreting such estimates. An analysis of the supply of workers in the occupation, not attempted in this study, would include data on transfers to aircraft mechanic from other occupations. The magnitude of transfers-in theoretically could exceed, equal, or fall short of the number of transfers-out. Thus, the number of transfers-in can reduce the importance of transfers-out in any evaluation of occupational requirements. Equally important, the experience level of workers transferring into an occupation should be evaluated in developing estimates of training requirements.

Since all pilots currently over 50 years of age will retire or otherwise leave the labor force during the 1967-77 decade, the first step was to obtain an age distribution of currently employed U.S. air carrier pilots. For this purpose, a special unpublished tabulation was prepared from FAA aeromedical records reporting the age distribution of all air carrier pilots. Pilot retirement losses then were derived by totaling the number of pilots reaching the mandatory retirement age during each of the projection periods–1968-72 and 1973-77. For example, all air carrier pilots currently 55-59 years of age will leave the work force by 1972. This procedure accounted for losses, due to all causes, that will be experienced by pilots currently 50 years of age or over.[35]

In addition, it was necessary to estimate the number of pilots currently under 50 years of age who will take advantage of early retirement options. Air carrier pilots, currently 45 to 50 years of age, will be eligible for early retirement some time during the 1973-77 period. Estimates of early retirements for these pilots were developed from a special survey conducted by the Air Transport Association.[36] This survey reported the number of early retirements experienced during 1966. By relating early retirements to the eligible pilot population (those 55-60 years of age) in 1966, an early retirement rate of 1.84 percent was derived. Estimates of early retirements for the 1973-77 period then were computed by applying this rate to the number of pilots eligible for early retirement each year beginning in 1973 (the year those currently 50 years of age are eligible for early retirement).

The remaining replacement requirements covered by this study, i.e., those stemming from disability retirement and death of persons under 50 years of age, were developed based on 1966 experience reported in the previously cited special ATA survey. An annual rate was developed from this survey that measured the number of pilots leaving the work force in 1966 either because of disability, retirement, or death. Estimates for the next decade then were computed by applying this rate (.35 percent) to the total pilot employment projection needs for each year from 1968 to 1977. (See table 9 for estimates of U.S. air carrier pilot replacement needs.)

General aviation and government pilot replacement needs. The estimates of retirement and death requirements for general aviation and government pilots were based on a number of assumptions. First, to facilitate estimating pilot retirements, it was assumed that general aviation and government pilots will retire by age 65. Since fewer than 150 pilots over 65 years of age were employed in general aviation in 1967, this stipulation had little impact on future pilot needs. Second, the age distribution of pilots in general aviation and government was assumed to remain constant through the decade ahead. Finally, it was assumed that "age specific separation rates," developed by BLS and based on the worklife experience of all males, are applicable to general aviation and government pilots in comparable age groups under 60 years of age.[37]

The development of estimates of general aviation and government pilot losses due to retirements and deaths involved two major procedures. First, the distribution of pilots by current age was based on the special tabulation prepared from FAA aeromedical records. All pilots reaching age 65 during either of the two projection periods (1968-72 and 1973-77) were counted as losses to employment. Next, estimates were made of the number of pilots who will not reach age 65 by 1977, but who will leave the work force due to retirement or death, by applying BLS 5-year age specific separation rates to comparable pilot age distribution intervals. To carry out this procedure, it was necessary to estimate the mid-points of employment requirements in each projection period (1968-72 and 1973-77) through interpolation.[38] The mid-point employment estimates then were distributed among the age groups using the current age distribution obtained from the FAA aeromedical records. Finally, the BLS 5-year age specific separation rates were applied to employment in each age interval. (See tables 33 and 34.) Total replacement needs then were determined by summing estimated losses for all age groups in each period, 1968-72 and 1973-77. Within general aviation, estimates of deaths and retirements were established for each flying activity by distributing losses for each projection period among the separate

[35] Early retirements are not identified separately for those pilots currently over 50 years of age. Consequently, the resulting estimates of losses may be somewhat understated for the first 5-year period and overstated for the second 5-year period. Furthermore, the estimates include a small number of pilot losses for reasons other than retirement or death, such as promotion or transfer to another industry of employment.

[36] Air Transport Association of America, unpublished survey, June 1966, dated January 1967.

[37] For a full discussion of the development and use of BLS separation rates, including their limitations, see *Tomorrow's Manpower Needs, National Manpower Projections and a Guide to Their Use as a Tool in Developing State and Area Manpower Projections* (BLS Bulletin 1606, Volume I, "Developing Area Manpower Projections") p. 47.

[38] The mid-point of each projection period was used to account for the retirement or death of entrants into the occupation during the next decade.

Table 33. Procedure for estimating general aviation pilot retirement and death losses, 1968-72 and 1973-77

Age group	Percent distribution of pilots	Estimated distribution of employment		5-Year age specific separation rates for males	Deaths and retirements		
		Mid-point 1968-72 (Col. 2 x total of Col. 3)	Mid-point 1973-77 (Col. 2 x total of Col. 4)		Total 1968-77 (Col. 7 + Col. 8)	1968-72 (Col. 3 x Col. 5)	1973-77 (Col. 4 x Col. 5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total	100.0	32,094	47,446		5,502	2,220	3,282
16-19	.18	58	85	.00762	1	0	1
20-24	3.60	1,155	1,708	.00882	25	10	15
25-29	9.27	2,975	4,398	.00903	67	27	40
30-34	14.47	4,644	6,865	.01485	171	69	102
35-44	39.54	12,690	18,760	.02917	917	370	547
45-54	27.00	8,665	12,810	.09162	1,968	794	1,174
55-59	3.71	1,191	1,760	.19614	579	234	345
60 and over . .	2.23	716	1,058	(1/)	1,774	716	1,058

1/All pilots reaching age 65 during either of the two projection periods were counted as losses to employment.

NOTE: Individual parts may not add to totals due to rounding.

SOURCE: Percent distribution of pilots—based on FAA aeromedical records. Five-year age specific separation rates for males—BLS estimates based on the work life experience of all male workers.

Table 34. Procedure for estimating government pilot retirement and death losses, 1968-77, 1968-72, and 1973-77

Age group	Percent distribution of pilots	Estimated distribution of employment		5-Year age specific separation rates for males	Deaths and retirements		
		Mid-point 1968-72 (Col. 2 x total of Col. 3)	Mid-point 1973-77 (Col. 2 x total of Col. 4)		Total 1968-77 (Col. 7 + Col. 8)	1968-72 (Col. 3 x Col. 5)	1973-77 (Col. 4 x Col. 5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total	100.0	2,210	2,671		337	153	185
16-19	.18	4	5	.00762	0	0	0
20-24	3.60	80	96	.00882	1	1	1
25-29	9.27	205	248	.00903	4	2	2
30-34	14.47	320	386	.01485	11	5	6
35-44	39.54	874	1,056	.02917	56	25	31
45-54	27.00	597	721	.09162	121	55	66
55-59	3.71	82	99	.19614	35	16	19
60 and over . .	2.23	49	60	(1/)	109	49	60

1/All pilots reaching age 65 during either of the two projection periods were counted as losses to employment.

NOTE: Individual parts may not add to totals due to rounding.

SOURCE: Percent distribution of pilots—based on FAA aeromedical records. Five-year age specific separation rates for males—BLS estimates based on the work life experience of all male workers.

Table 35. Estimated general aviation pilot retirements and deaths, by type of flying, 1968-77, 1968-72, and 1973-77

Type of flying	Estimated percent distribution of employment		Retirement and deaths		
	Mid-point 1968-72	Mid-point 1973-77	Total	1968-72	1973-77
Total	100.0	100.0	5,502	2,200	3,282
Executive transportation	48.2	50.1	2,713	1,070	1,643
Air-taxi	26.5	28.1	1,510	589	921
Aerial application	5.4	4.3	260	119	141
Industrial/special	5.2	4.1	251	116	135
Instructional	12.9	11.9	676	286	390
Other	1.8	1.6	92	40	52

SOURCE: Bureau of Labor Statistics.

Table 36. Procedure for estimating U.S. air carrier mechanic retirement and death losses, 1968-77, 1968-72, and 1973-77

Age group	Percent distribution of airplane mechanics	Estimated distribution of employment		5-Year age specific separation rates for males	Deaths and retirements		
		Mid-point 1968-72 (Col. 2 x total of Col. 3)	Mid-point 1973-77 (Col. 2 x total of Col. 4)		1968-77 (Col. 7 + Col. 8)	1968-72 (Col. 3 x Col. 5)	1973-77 (Col. 4 x Col. 5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total	100.0	56,500	65,500		6,663	3,086	3,577
14-19	.75	424	491	.00762	7	3	4
20-24	7.13	4,028	4,670	.00882	77	36	41
25-29	16.55	9,351	10,840	.00903	182	84	98
30-34	15.68	8,859	10,270	.01485	285	132	153
35-44	35.29	19,939	23,115	.02917	1,256	582	674
45-54	17.21	9,724	11,273	.09162	1,924	891	1,033
55-59	4.43	2,503	2,902	.19614	1,060	491	569
60-64	2.14	1,209	1,402	.51542	1,346	623	723
65 and over	.84	475	550	.51273	526	244	282

NOTE: Individual parts may not add to totals due to rounding.

SOURCE: Percent distribution of mechanics—U.S. Census of Population: 1960. Subject reports. *Occupational Characteristics*, final report PC (2)-7A. (U.S. Bureau of the Census), table 6, p. 75. 5-Year age specific separation rates for males—BLS estimates based on the work life experience of all male workers.

Table 37. Procedure for estimating general aviation mechanic retirement and death losses, 1968-77, 1968-72, and 1973-77

Age group	Percent distribution of airplane mechanics	Estimated distribution of employment		5-Year age specific separation rates for males	Retirements and deaths		
		Mid-point 1968-72 (Col. 2 x total of Col. 3)	Mid-point 1973-77 (Col. 2 x total of Col. 4)		1968-77 (Col. 7 + Col. 8)	1968-72 (Col. 3 x Col. 5)	1973-77 (Col. 4 x Col. 5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total	100.0	61,270	82,490		7,850	3,347	4,503
14-19	.75	460	619	.00762	9	4	5
20-24	7.13	4,369	5,882	.00882	91	39	52
25-29	16.55	10,140	13,652	.00903	215	92	123
30-34	15.68	9,607	12,934	.01485	335	143	192
35-44	35.29	21,622	29,111	.02917	1,480	631	849
45-54	17.21	10,545	14,197	.09162	2,267	966	1,301
55-59	4.43	2,714	3,654	.19614	1,249	532	717
60-64	2.14	1,311	1,765	.51542	1,585	676	909
65 and over . .	.84	515	693	.51273	619	264	355

NOTE: Individual parts may not add to totals due to rounding.

SOURCE: Percent distribution of airplane mechanics—U.S. Census of Population: 1960, op. cit., table 6, p. 75. 5-Year age specific separation rates for males—Bureau of Labor Statistics estimates based on the work life experience of all male workers.

Table 38. Procedure for estimating government mechanic retirements and death losses, 1968-77, 1968-72, and 1973-77

Age group	Percent distribution of airplane mechanics	Estimated distribution of employment		5-Year age specific separation rates for males	Retirements and deaths		
		Mid-point 1968-72 (Col. 2 x total of Col. 3)	Mid-point 1973-77 (Col. 2 x total of Col. 4)		1968-77 (Col. 7 + Col. 8)	1968-72 (Col. 3 x Col. 5)	1973-77 (Col. 4 x Col. 5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total	100.0	1,100	1,100		122	61	61
14-19	.75	8	8	.00762	0	0	0
20-24	7.13	78	78	.00882	2	1	1
25-29	16.55	182	182	.00903	4	2	2
30-34	15.68	172	172	.01485	6	3	3
35-44	35.29	388	388	.02917	22	11	11
45-54	17.21	189	189	.09162	34	17	17
55-59	4.43	49	49	.19614	20	10	10
60-64	2.14	24	24	.51542	24	12	12
65 and over . .	.84	9	9	.51273	10	5	5

NOTE: Individual parts may not add to totals due to rounding.

SOURCE: Percent distribution of airplane mechanics—U.S. Census of Population: 1960, op. cit., table 6, p. 75. 5-year age specific separation rates for males—Bureau of Labor Statistics estimates based on the work life experience of all male workers.

general aviation flying activities on the basis of projected pilot employment requirements at the mid-point in each projection period. (See table 35.)

U.S. air carrier, general aviation, and government mechanic replacement needs. A single method was followed to estimate retirement and death losses for mechanics in each sector of civil aviation—air carriers, general aviation, and government. The procedure was as follows: First, estimated employment requirements at the mid-point of each projection period (1968-1972 and 1973-1977) were made through interpolation.[39] Next, employment at each mid-point then was distributed by age group using the age distribution reported in the 1960 decennial Census of Population.[40] Finally, the BLS 5-year age specific separation ratios were applied to employment in each age interval. Total replacement needs were derived by summing estimated losses for all age groups in each projection period. Tables 36-38 show the steps followed and the resulting death and retirement estimates for each sector of civil aviation.

[39] See footnote 38, p. 35.

[40] U.S. Census of Population: 1960. Subject Reports. *Occupational Characteristics*, Final Report PC (2)-7A. (U.S. Bureau of the Census), table 6, p. 71. This procedure assumes that the age distribution of mechanics remains constant during the 1960-77 period. A comparison of the 1950 and 1960 Census data indicates that the age structure shifted upward during the 1950's. However, this trend may not continue during the 1960's and 1970's because of the large number of young workers entering the labor force during these decades.

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