



CURRENT AND HISTORICAL TRENDS IN GENERAL AVIATION IN THE UNITED STATES

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This report is based on the S.M. Thesis of Kamala I. Shetty submitted to the Department of Aeronautics and Astronautics in partial fulfillment of the requirements for the degree of Master of Science in Aeronautics and Astronautics at the Massachusetts Institute of Technology.

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by

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Abstract

General aviation (GA) is an important component of aviation in the United States. In 2011, general aviation and air taxi operations represented 63% of all towered operations in the United States, while commercial aviation was responsible for 34% of those operations. It is clear that GA is a considerable component of the national airspace and airport system, even when only accounting for towered operations. Because of this significant presence, insight into GA is relevant to issues in air traffic management, air transportation infrastructure, and aviation safety, among others. Beyond the operational aspect, GA is of significance to society as a whole and to other stakeholders, including pilots groups, aircraft manufacturers, and the work force. In 2009, general aviation generated 496,000 jobs and its total economic contribution to the U.S. economy was valued at \$76.5 billion.

However, a comparison of general aviation's impact on jobs and on the economy between 2008 and 2009, shows a 20% decrease in jobs and a 21% decrease in total economic impact in the course of a year. There is also a significant decreasing trend in the active pilot population, along with steady decreases in GA flight hours and towered operations.

The objective of this thesis is to explore the details of these changing trends and to determine what drives and what hinders general aviation activity in the country. A combination of data analysis and the development of a survey administered to general aviation pilots shed light on what has driven activity in the past on a national scale, what factors affect an individual pilot's level of activity, and what challenges the general aviation community faces in the future.

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Chapter 1

Introduction

1.1 Research Motivation

The goal of this study is to gain a better understanding of the factors that drive general aviation activity in the United States. Historical levels of activity are analyzed along with changes in related time series that include fuel costs, aircraft shipments and average ages, numbers of active pilots, socioeconomic indicators, etc. Another aspect of the study involves a survey of general aviation pilots in order to gain additional insights into these factors by gathering details from the experience of individual pilots and the reasons they choose to fly or to stop flying. The results of the survey along with the analysis of historical trends will help identify any challenges facing the growth of general aviation and its role in the greater aviation community, including what may promote or hinder activity in the future.

1.1.1 What is General Aviation

Commercial aviation activities in the US are easily defined as all operations that are regulated by Part 121 of the Federal Aviation Regulations put forth by the FAA, which encompasses all scheduled air carrier service [1].

The term general aviation, on the other hand, is a catch-all phrase for all aviation activities that do not fall under commercial aviation, major cargo or military operations, and covers a broad spectrum of aviation activity uses. The FAA, in its annual *General Aviation and Part 135 Survey*, categorizes GA activity by use. Figure 1-1 shows the different categories of GA activity and their corresponding portion of all hours flown in 2009.

From an operational standpoint, these GA activities can be categorized as either local or itinerant operations, whereas commercial aviation is almost exclusively itinerant. Operations are defined as either an arrival or departure of local or itinerant nature. Local operations are defined as operations performed by aircraft that are operating within the local traffic pattern of the airport or within sight of the airport, are going to designated local practice areas within 20 miles of the airport, or are performing simulated instrument approaches or low passes at the airport [3]. For instance many operations that fall within the personal or instructional use category

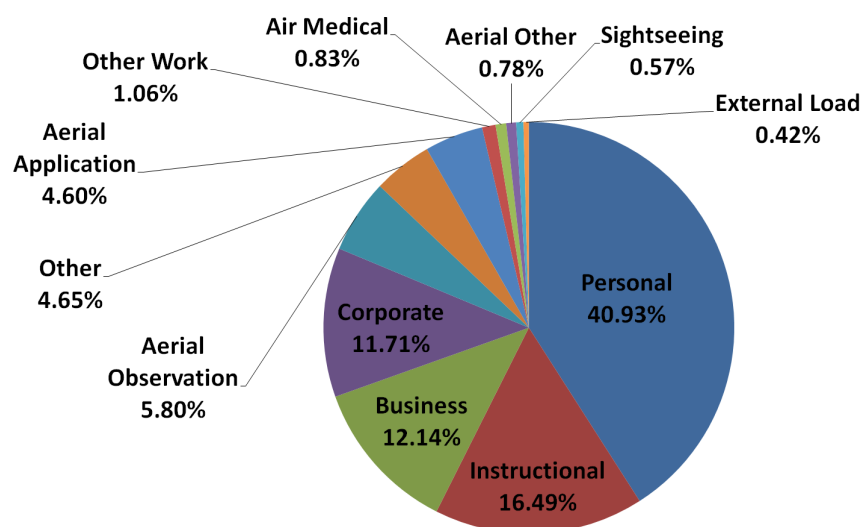


Figure 1-1: 2009 *General Aviation and Part 135 Survey Results: Total Hours Flown by Use* [2]

are categorized as local. Itinerant operations are defined as the complement of local operations, i.e. aircraft coming from or going to a different airport. Most business or corporate transportation uses would call under itinerant operations.

1.1.2 Current Trends in General Aviation

Figure 1-2 compares historical trends for commercial operations and general aviation operations at towered airports across the country. The plot shows that the two categories have not followed the same general trends and are driven by different factors.

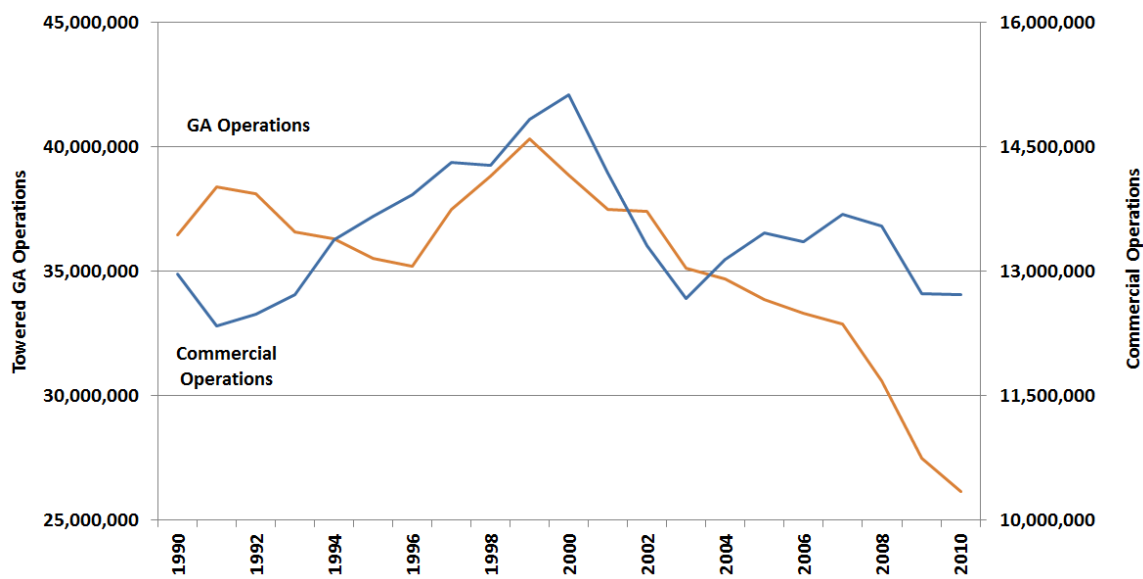


Figure 1-2: Historical Trend of Commercial and General Aviation [4]

Historical trends have shown that the growth in annual commercial air travel, measured in revenue passenger kilometers (RPK), is approximately twice the annual growth rates of gross domestic product (GDP) [5]. This strong relationship to GDP indicates a significant dependence on the national and world economy and commercial operations, through some relationship with RPKs, should change in a tractable way. Unlike commercial aviation, GA in recent history has not closely followed aggregate economic indicators, such as the GDP. This is illustrated in Figure 1-3. Even in the decades before 2000, when activity on an average trended upwards along with growth in GDP, there were significant anomalies that indicate that there are other major factors at play.

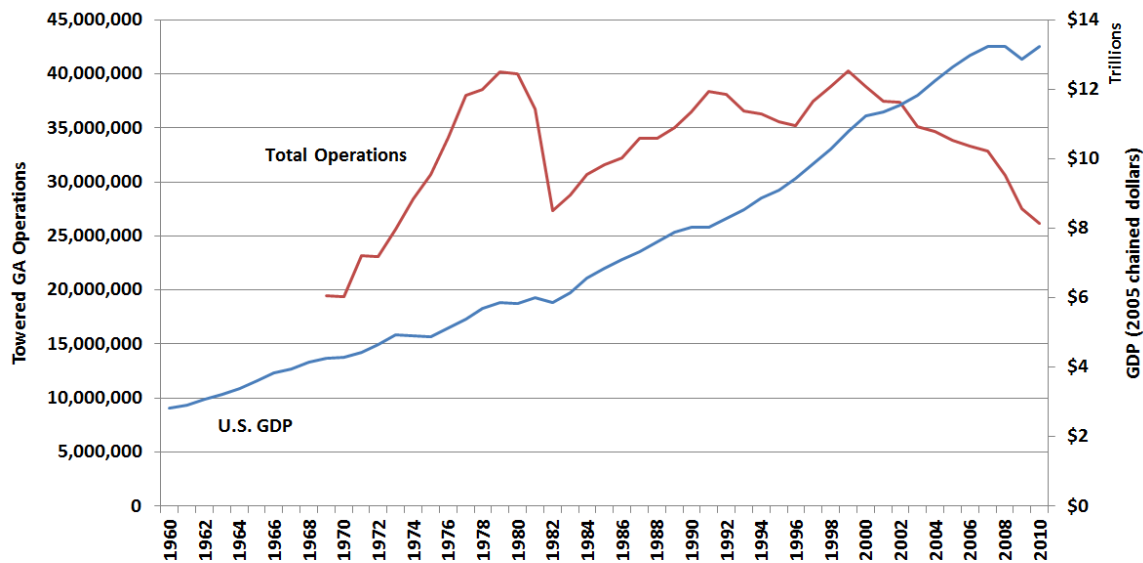


Figure 1-3: GA activity and GDP [4]

Since GA is such a broad category of aviation, many differing drivers are working at one time to affect aggregate levels of operations. Some of these factors include economics, the volatility of fuel prices, increased use of internet in business (hence, decreasing business travel), tax incentives for aircraft ownership, the costs of owning and operating personal aircraft, the total private pilot and GA aircraft populations, and many more.

Two things are now clearly evident. First, it is clear that while commercial aviation and general aviation may share some drivers, such as economic growth, they do have their own distinct characteristics and factors affecting their levels of activity. This leads to the question of whether or not forecasting one group over the other has shown to be more accurate. Second, it is clear that general aviation activity at an aggregate level has suffered a significant and seemingly persistent decline over the past 12 years.

1.1.3 General Aviation Stakeholders

Many groups are interested in and play a role, in one way or another, in general aviation and its future in the United States.

Airports

The FAA's National Plan of Integrated Airport Systems (NPIAS) identifies all domestic, public use airports that are considered a significant part of the civil air transportation system. As of February 2010, There were a total of 19,734 airports (including heliports and seaplane bases), of which only 3,380 are included in the NPIAS [6]. Airports that are included are categorized as follows [6]:

- Primary Commercial Service Airports - airports receiving scheduled passenger service and having 10,000 or more enplaned passengers per year
- Nonprimary Commercial Service Airports - airports receiving scheduled passenger service and having 2,500 or more enplaned passengers per year
- Reliever Airports - airports that relieve congestion at Commercial Service Airports by providing improved general aviation service
- General Aviation Airports - all other airports

Figure 1-4 maps out all airports by its category. It is clear that there is a significant amount of airports that solely accommodate GA activity as compared to the number of primary and secondary airports which, in general, are also able to accommodate GA activity. Table 1.1 shows the actual number of airports by category and their corresponding percentage of the NPIAS. Commercial aviation is concentrated in about 15% of the nation's significant airports, while GA activity is clearly more dispersed.

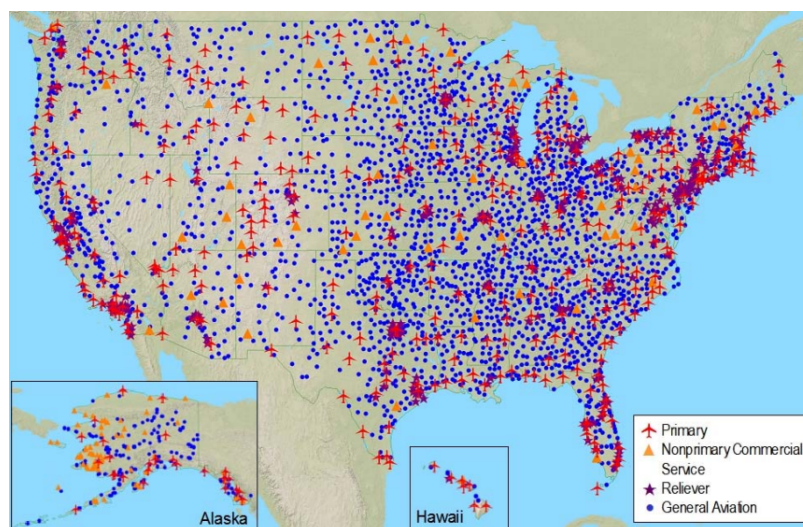


Figure 1-4: 2011 National Plan of Integrated Airport Systems (Image Source:[6])

Table 1.1: Number of Airports in the NPIAS by Category

Primary	382	11%
Nonprimary	121	4%
Reliever	269	8%
General Aviation	2,560	77%

The type of activity at an airport obviously affects the services that an airport provides, ranging from runway sizes to hangar space to passenger processing areas and so on. It is, therefore, also obvious the need to distinguish between types of operations when planning and operating an airport. The greater the understanding of how general aviation is evolving across the country allows airports to better plan for today and for the future.

Government

Along with local planners and governments, the federal government is very interested in the demand for airports, as it can base its decision on funding of airport projects on the expected utilization of their investments. The FAA is charged with the task of distributing grants across airports in the NPIAS so that the net benefit to the whole air transportation network and society as a whole is maximized. Those grants are distributed through the Airport Improvement Program (AIP), a pool of money that is funded through the collection of airline ticket taxes on all commercial flights [7].

In 2009, \$3.47 billion was distributed through 2,885 grants across the country [8]. Only 30.7% of the funds were given to the projects at the largest commercial airports, where a disproportionately larger amount of funds, (88.6%) are collected from all passenger enplanements. Other airports at which significant GA activity is present along with commercial activity collects 65.5% of those funds. The smallest of all airports, those designated as general aviation airports, receive the greatest amount of grants, 52.9%, and receive a significant 17.3% of the funds.

In addition to the importance at the airports, the FAA is interested in general aviation activities in planning for future workload at air traffic control towers and for the management of the National Airspace System (NAS).

American Public

Whether or not its importance is fully appreciated by society, general aviation provides importance service to the American people. General aviation includes activities that are crucial to small and large business, agriculture, law enforcement, flight training, medical evacuation, tourism, and travel to remote areas.

General aviation also contributes to the American economy. In 2009, general aviation generated 496,000 jobs and its total economic contribution to the U.S. economy was valued at \$76.5 billion [9]. However, a comparison of general aviation's impact

on jobs and on the economy between 2008 and 2009, shows a 20% decrease in jobs and a 21% decrease in total economic impact in the course of a year.

Aircraft Manufacturers

A significant portion of the economic impact of general aviation, 33.7% in 2009, comes from aircraft manufacturing. The aircraft manufacturing business relies on the levels of general aviation activity in the country and needs to know its future in order to conduct business efficiently.

The general aviation fleet clearly dominates commercial aircraft in terms of numbers. In 2008, 96% of the active fleet in the United States were general aviation aircraft with 228,662 aircraft versus 7,856 in the country's commercial fleet [10].

1.2 Study Overview

Given the current state of general aviation in the United States and the number of its unique stakeholders, a greater understanding of its drivers is of significant importance. The goal of this study is to gain a better understanding of the trends involving general aviation, including trends in its activity levels, drivers, and forecasting, as well as current attitudes and outlooks.

Chapter 2 overviews the major forecasts used in the US for general aviation activity. It examines old forecasts and analyses the accuracy of those forecasts and compares them to those of commercial aviation, in order to determine whether there is a gap in forecast error between the two groups. GA forecasts are described in general terms, along with a short summary of the FAA's 2011 forecast for general aviation over the next 20 years.

Chapter 3 is a survey of the historical and current trends in general aviation. It first looks at different measures of activity, including towered activity from the FAA's ATADS and hours flown data from the FAA's General Aviation and Part 135 Survey. It then goes on to characterize the factors affecting this activity including historical trends of fuel, socio-economic factors, pilot population, aircraft population, safety issues, and some other exogenous factors than may have an effect on national levels of activity.

In Chapter 4, a sample survey of general aviation pilots is introduced as a way to supplement the data analysis of Chapter 3 in understanding what drives activity levels. The details of the survey design and methods are discussed, along with any issues that may affect the interpretation of the survey results.

The details of the survey responses are presented in Chapter 5. An analysis is prepared at the aggregate level and then again within subgroups of the survey respondents.

Chapter 6 summarizes the findings of the paper.

Chapter 2

General Aviation Forecasts

Chapter 1 discussed the importance of general aviation to society and to its various stakeholders. Many, if not all, of those stakeholders are interested in the future of this subset of aviation, and many either utilize or develop forecasts of GA activity or demand to help make decisions, so as to prepare for the future or to make changes to alter the course that it may take.

This chapter is not meant to be an in-depth study of general aviation forecasting or of aviation forecasting in general. The goal, however, is two fold. The first goal is to help bolster the argument that further research into the drivers of general aviation activity is indeed warranted. The second is to look at and characterize the current forecasts for general aviation activity in the United States.

One of the main practical goals of identifying the drivers of general aviation is to use that information in the future. As with any phenomena, the forecaster's job of predicting the future is made easier when the system can be modelled as accurately as possible. While a forecast's realized inaccuracy may not necessarily indicate a lack of understanding of the phenomena, it can be the result of difficulties in predicting driving forces in a necessarily unpredictable world, an incomplete model of the process should most definitely have a negative impact on the accuracy. Therefore, analyzing the accuracy of general aviation forecasts, especially in comparison to other forecasts, can provide evidence bolstering the argument for further investigation of general aviation. To do this, the results of the FAA's 2006 Terminal Area Forecast are analyzed and the accuracy of the short term forecasts for GA and commercial activity are compared.

The last part of the chapter looks at the the FAA's Aerospace Forecast released in years 2001 to 2011. A comparison of the forecasts for the last 10 years helps characterize the general outlook on general aviation as seen by forecaster's at the FAA. In later chapters, trends and other qualitative data will be compared against the current forecast, in order to help qualitatively judge the reasonableness of the forecast.

2.1 Types of Forecasts

Forecasts of general aviation can include forecasts of hours flown, operations, total fleet, based aircraft or any other metric. They can be focused on aggregate levels across the nation or be focused on the regional, state or airport levels.

While airports, regional aviation authorities, and other stakeholder create forecasts of GA activity, the two biggest forecasts in the United States, the FAA's Aerospace Forecast and Terminal Area Forecast, are discussed below.

2.1.1 FAA Aerospace Forecast

The FAA Aerospace Forecast is a yearly report that presents a 20 year outlook on commercial and general aviation at the national level.

For general aviation, the reports includes forecasts for:

- Active aircraft
- Hours flown
- Active pilots by type of certification
- Aircraft fuel consumption
- Towered (local and itinerant) operations

The methodologies used to forecast these metrics are not explicitly described, however, the following points are made throughout the report and give some indication on the forecast methods:

- Growth rates are applied to current estimates of fleet size, hours flown and utilization from the General Aviation and Part 135 Activity Survey [2].
- The growth rate for the fleet is based on assumptions on fleet attrition in conjunction with General Aircraft Manufacturers Association (GAMA) aircraft shipment statistics.
- The growth rate of flight hours are based on assumptions on utilization in conjunction with the forecasted fleet.
- The forecast is formulated in a similar fashion year to year in hopes the error of the forecast in relation to realized levels can be estimated from year to year.

2.1.2 FAA Terminal Area Forecast

The FAA's Terminal Area Forecast (TAF) is an official activity forecast for all airports in the NPIAS and is used by many groups in the federal government, state governments, local airport authorities, and aviation operators for planning. The TAF is based on the results of the Aerospace Forecast.

The TAF consists of annual forecasts at the airport level for :

- total enplanements for air carriers and regional carriers
- total itinerant operations for air carrier, air taxi and commuter, general aviation, and military activity
- total local operations for general aviation and military activity
- total instrument operations

The methodology used to create the commercial and GA operations forecasts in the TAF is abstractly outlined [11] and summarized below:

- The TAF is an unconstrained forecast, meaning the forecast is independent of current capacities of airports or the national airspace system and is dependent only on the driving factors of aviation demand.
- Forecasts are formulated from historical relationships between activity and other local and national factors and are compared to an airport’s historical trend. Regression analysis and other growth rates are used as well. No specific models are identified.
- The historical data for activity at airports with tower service can be assumed to have negligible measurement error. For all other airports (a majority of GA airports), operations are taken from FAA Form 5010, which are estimates given by inspectors, or from other various sources.
- Thirty five airports that are included in the FAA’s Operation Evolution Plan (OEP), large commercial hubs of special significance to the air transportation system [12], are subject to a more thorough analysis which takes into account:
 - local socio-economic factors
 - growth rates of origin-destination and connecting passengers
 - prices into the airport
 - trends in load factors and aircraft sizes
 - future schedules from the Official Airline Guide (OAG)
- The forecast is constructed by the Office of Aviation Policy and Plans, sent out to FAA regional offices for reviews and suggestions are taken into consideration. The forecast also may utilize forecasts from local airport authorities or airport master plans, if the methods of forecasting are approved by the FAA.

The TAF is an important source of information for policy makers and planners, but it is clear that it has its limitations, and should be supplemented with more in depth analysis.

The documents accompanying the TAF for public release do not stress the methods used for non-towered airports. Also, the TAF presents a single forecasted value to the public, with no indication of confidence in those values. It does not give any

level of confidence in the presented forecast, nor does it make any other attempt to show a range of values the future could see (i.e. giving optimistic and pessimistic assessments). This may be due to political reasons or due to the fact that the TAF is utilized by many different parties, some of whom do not have in depth knowledge of forecasting issues.

Some smaller issues with the methodologies used to formulate the TAF include the fact that the TAF uses inputs from airport master plans and local airport authorities. This is a double edged sword. While local officials have a better intuition of where operations trends are headed and are more familiar with the issues facing the airport that can affect activity, it can also lead to bias towards optimism. One source of this bias is the competition within the AIP funding program itself, as airports will have to justify that its proposed projects are worthy of grants with levels of future activity worthy of the investments.

Another issue with the TAF and many other aviation forecasts is that since the forecasts are based on historical levels of activity, which can be constrained, regressing on the historical values may not reveal the true unconstrained level of demand.

2.2 Analysis of 2006 TAF Forecast

The 2006 forecast was chosen for this analysis, since it was the oldest forecast available for public query. For the purposes of studying the general accuracies of these forecasts, a forecast model that contains more than four realized time periods would have been ideal. This is because short term conditions (i.e. four years into the future) will most likely follow the levels and growth rates prevailing at the time of the forecast and then may be less of an indication of the underlying assumptions of the forecasting methods [13]. Unfortunately, the analysis is dictated by the information currently readily available to the public.

2.2.1 All Airports

The model has forecasts for 3,392 facilities and queries to this model will return with historical activity levels from fiscal years 2001 - 2006 as well as forecasted values at every year between fiscal years 2007 and 2025. The following analysis first looks at the national forecast and then looks at the characteristics of the towered airports separately.

Characteristics of Growth

Of the 3,392 facilities in the forecast, 59% served non-zero levels of commercial activity in 2006. It was also noted that no airports in the system were forecasted to accommodate commercial activity that did not do so previously. The types of growth for these airports, the percentage change from the base level in 2006 to projected levels in 2025, is shown in Figure 2-1. The most striking observation is the fact that the majority of airports are assumed to have no change in commercial operations. Of

those with projections for change from the 2006 levels, the majority were assumed to have positive growth in operations through 2025. Figure 2-1 also shows the relative frequency of those airports that were given positive or negative forecasts by the percentage growth they are assumed to have in the TAF. The distribution is somewhat of a bell curve, with a median of 22% growth over the two decades. There were a few outliers, that had growth in the thousands of percent. These outliers are the airports that were projected to serve an increased number of operations from a very low base level.

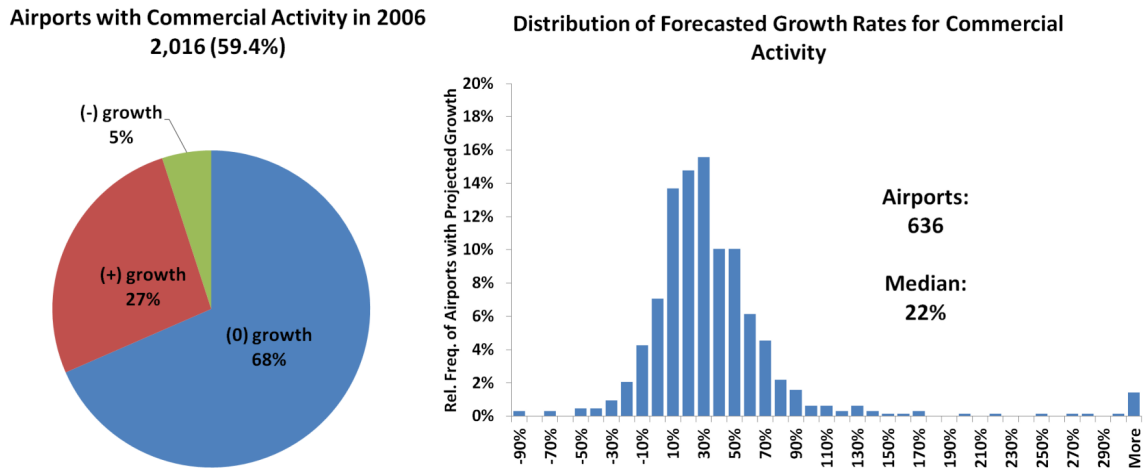


Figure 2-1: Commercial Growth Forecast [14]

Similarly, no airports in the system were forecast to accommodate general aviation that did not do so in 2006. Given that the portion of the NPIAS that serves general aviation is 95.6% in the baseline year, there isn't a large potential opportunity to spread. The expected growths for these airports that serve GA is summarized in Figure 2-2. The amount of airports with forecasted change in GA operations was only 25%, compared to the 32% for the same metric for commercial operations. Figure 2-2 also shows the histogram of non-zero growths for GA activity. It is interesting to note that the variability in growth is smaller than that for the same distribution for commercial activity and that the median of the distribution is slightly higher (29% vs. 22%).

Figure 2-3 corresponds to the subset of the NPIAS that had both commercial and GA operations. The forecast continues to expect that these 611 airports will serve both types of activity. The histogram tallies how GA percentage growth and commercial growth are related at a specific airport, for all the airports. The horizontal axis is the range of multipliers k , where $commercial\ growth = k * GA\ growth$. The distribution is centered around zero, indicating that at a majority of airports, assumed growth rates of commercial and GA operations were approximately the same.

National Forecast

The 2006 TAF projects a 40.9% increase in nationwide commercial operations, while GA operations are projected to grow by 17.3%.

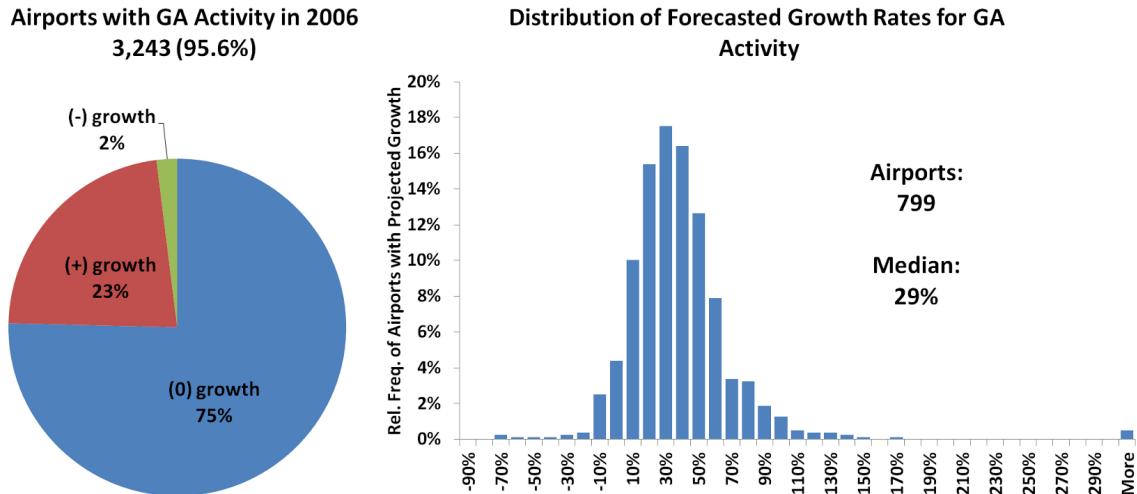


Figure 2-2: General Aviation Growth Forecast [14]

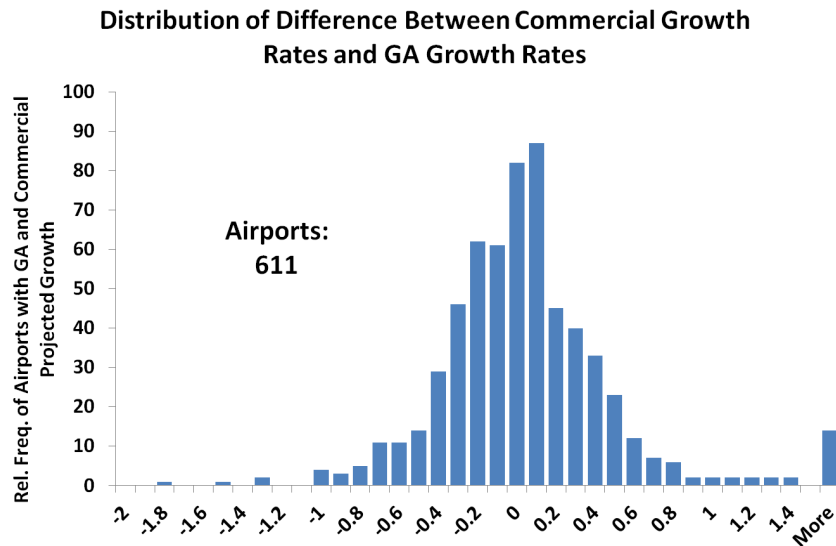


Figure 2-3: Comparison of GA and Commercial Projected Growths [14]

Figures 2-4, 2-5, and 2-6 plot the national forecasts for commercial operations, itinerant GA operations, and local GA operations. Along with the forecast, the historical data for each category of operations is plotted. The historical values from the 2006 TAF are plotted in green, while the historical values from the more recent 2010 TAF are plotted in red. The dotted line shows a best-fit curve of the forecast values. The insert boxes zoom into the realized and forecasted operations levels for the years 2007 to 2010, where above each year is the absolute difference and the percentage difference ($\frac{\text{realized} - \text{forecasted}}{\text{realized}}$) between the two curves.

All three categories of operations decreased in the 4 year period, while the corresponding forecasts have shown increasing levels of activity. The forecast for national commercial activity followed an exponential curve virtually perfectly, while GA fore-

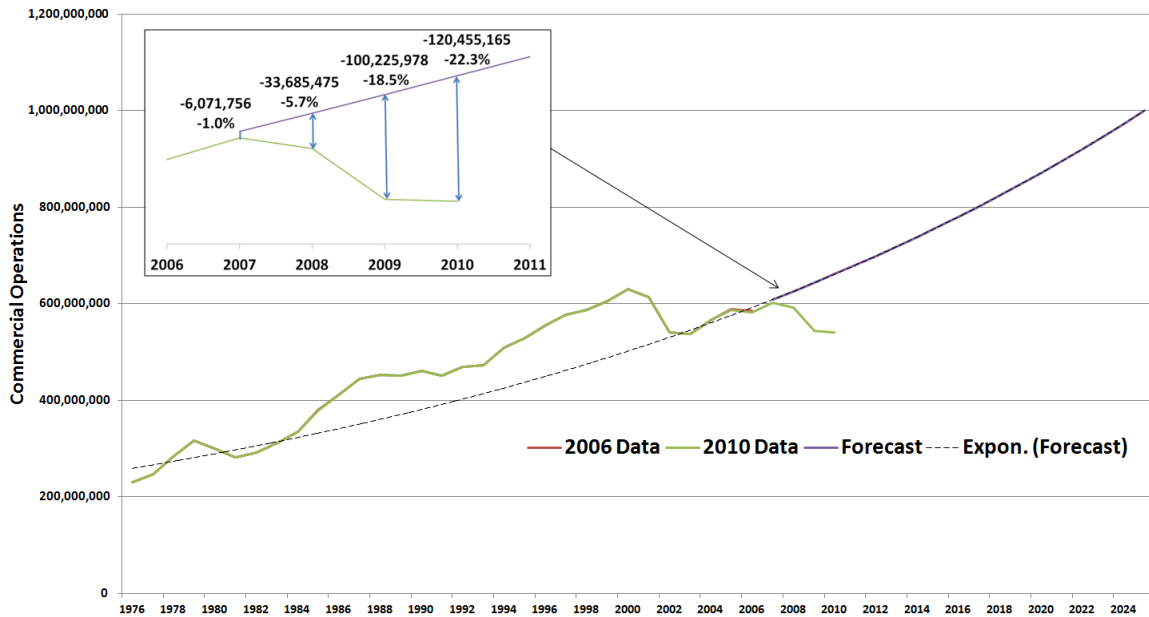


Figure 2-4: 2006 Commercial Operations Forecast [14]

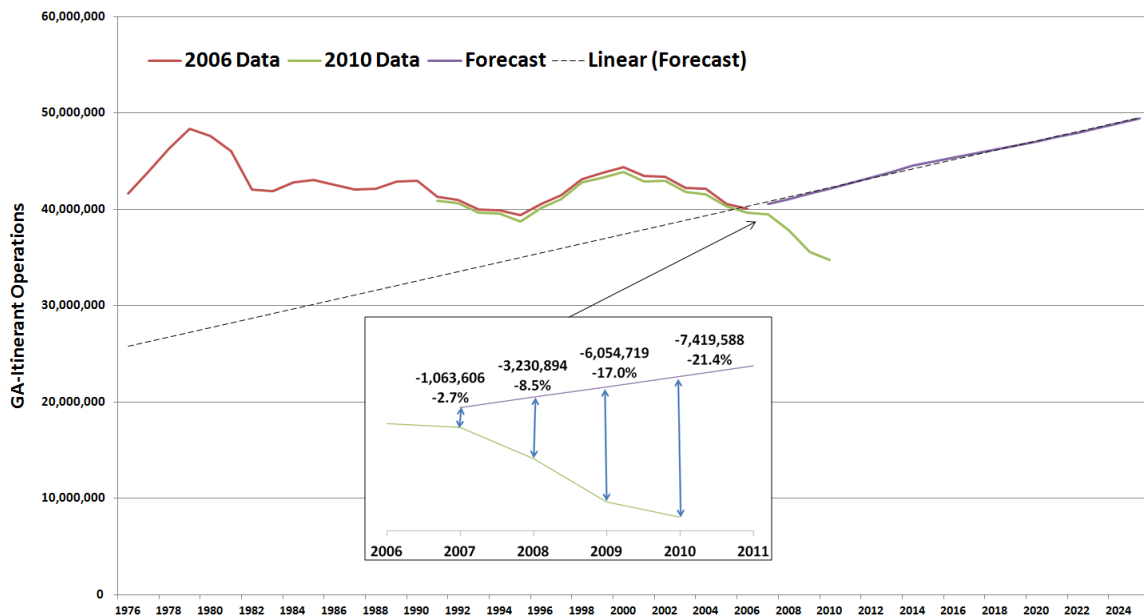


Figure 2-5: 2006 General Aviation Itinerant Operations Forecast [14]

casts mostly followed a linear trend. As stated before, the forecasts are especially optimistic for commercial operations, as compared to expected growth in GA.

For all categories, the forecasting error increases with time, confirming a priori expectations of forecasting behavior. The commercial forecast slightly performed better than the forecast for itinerant GA operations for the first two years, but then for the second two, the itinerant GA forecast was closer to observed values. From the perspective of strictly measuring the forecast error as compared to reported data, the

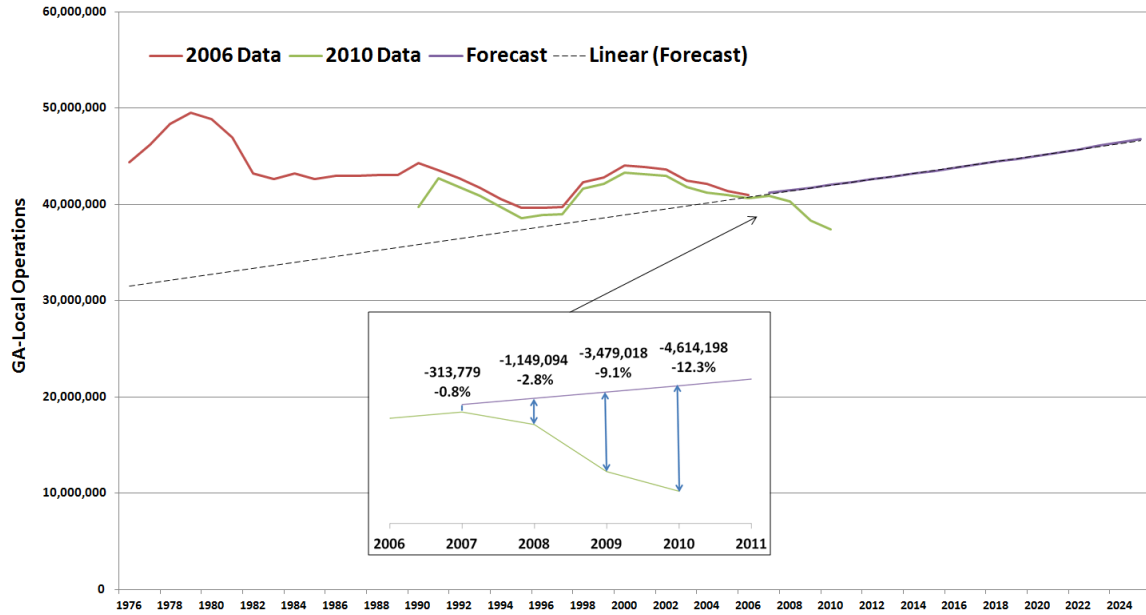


Figure 2-6: 2006 General Aviation Local Operations Forecast [14]

forecast for local operations appears to have outperformed the other two.

This perceived improved accuracy in the local operations forecast, however, may not be what it initially appears to be. While the 2006 and 2010 TAF data for historical values overlap for commercial activity, the curves are disjoint for itinerant GA operations data, and differ even further for the local GA operations. This is a symptom of the data reliability; as discussed previously, data for towered airports is more accurate than the estimates given for non-towered airports and commercial activity tends towards towered airports while local general aviation tends towards smaller, non-towered airports.

An inspection of historical data and the forecasts reported in the TAF for non-towered airports shows that a large majority of airports have a constant level of operations across past and future years. Not only did they have zero growth assumed, the historical values show no change for the years 2001-2005. This indicates a tendency in reporting to mirror previous years, predisposing the forecast to greater apparent accuracy.

2.2.2 Towered Airports

Because of the issues of reliability of forecast accuracy for non-towered airports, a subset of 515 airports was chosen for analysis of the accuracies of the forecasts. These airports are in the NPIAS and also have operations data available from the FAA's Air Traffic Activity System (ATADS) [4]. The forecasts of these towered airports are compared to the reported operations for fiscal years 2007-2011.

Figures 2-7, 2-8, and 2-9 compare the forecasts for towered commercial operations, itinerant GA operations, and local GA operations with their observed levels.

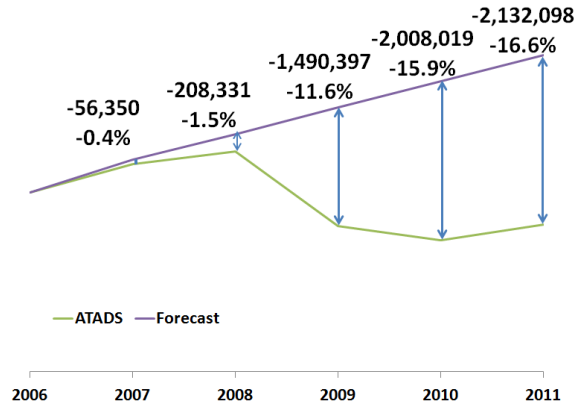


Figure 2-7: 2006 Towered Commercial Operations Forecast [14][4]

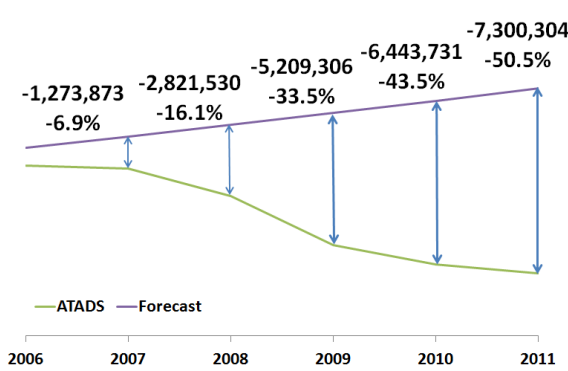


Figure 2-8: 2006 Towered General Aviation Itinerant Operations Forecast [14][4]

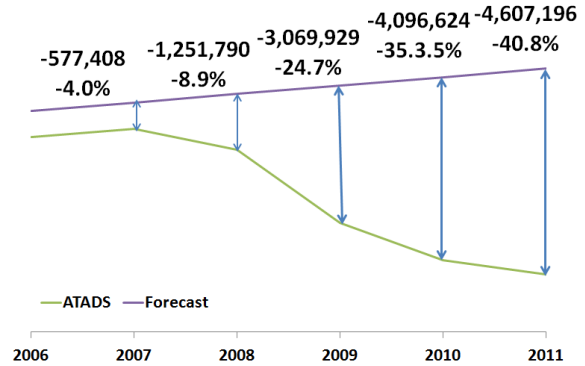


Figure 2-9: 2006 Towered General Aviation Local Operations Forecast [14][4]

The accuracy of the towered commercial operations forecast significantly improved as compared to the aggregate forecast. Conversely, the general aviation forecasts significantly deteriorated. This difference in forecasting accuracy demonstrates a very clear difference in the 2006 TAF's forecast of commercial and GA operations. It appears that the forecasting effort put into commercial activity, especially at the nation's biggest hubs, are more successful than that put into GA forecasts. The difficulty in forecasting GA activity may be due to the complexity of the drivers of general aviation.

Even though there has been a general trend downwards, starting even before 2006, the forecasts for much of the general aviation operations did not reflect a belief in the continuation of those trends. The forecast for general aviation is an optimistic one. The commercial forecast did perform much better in terms of short term forecast accuracy. Like the GA forecast, it is optimistic, but unlike the GA forecast, the optimism is more justifiable given the historical trend.

2.3 2001 - 2011 Aerospace Forecasts

Now, we shift our focus from evaluating the accuracies of general aviation forecasts to characterizing past and current forecasts, as reported in the FAA Aerospace Forecast.

2.3.1 Comparison of Past Forecasts

Figures 2-10 and 2-11 plot the observed and forecasted levels of activity for local and itinerant GA operations, respectively. Observed operations are included from 1994 to 2010, along with the the long term forecasts from the years 2000 to 2011 (note that the length of the forecasts have increased from 10 to 20 years across that time period). Clearly, a generalization can be made about these forecasts that the outlook on general operations are positive. All forecast years project nearly steady growth without any periods of decline, even when the observed trend for the previous years are negative. While there has been a continual optimism, the projected growth rates have slowly decreased from the 2000 to 2011 forecasts in response to the observed trend.



Figure 2-10: Local General Aviation Operations at All Towered Airports [15]

2.3.2 2011-2031 Forecast

Figures 2-10 and 2-11 show the forecast levels of local and itinerant operations until 2031. Local GA operations and itinerant GA operations are forecast to grow over the 20 year period by 27.1% and 28.2%, respectively.

The forecast posits that the general aviation fleet will increase from 224,172 aircraft in 2010 to 270,920 in 2031, growing at an average rate of 0.9% a year. Within

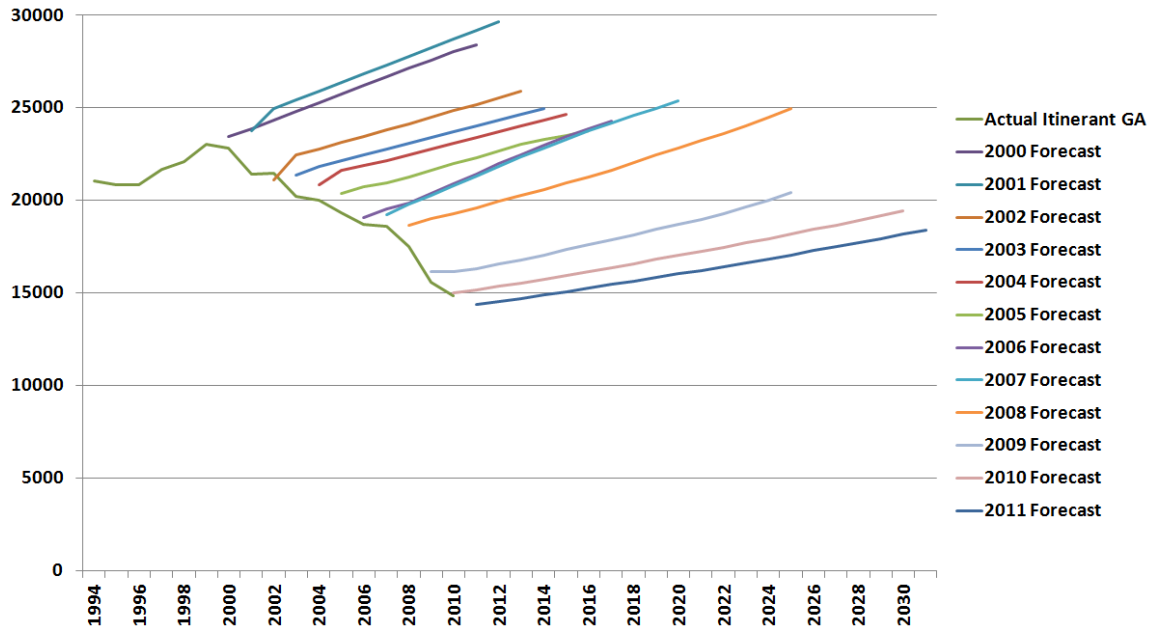


Figure 2-11: Itinerant General Aviation Operations at All Towered Airports [15]

this aggregate growth, the fixed-wing turbine aircraft fleet will grow at a rate of 3.1% per year, the fixed-wing piston aircraft fleet will grow at a rate of 0.2% per year, and the rotorcraft fleet will grow at a rate of 2.6% per year.

General aviation hours flown are forecast to increase from 24.1M in 2010 to 37.8M in 2031, an average annual growth rate of 2.2% a year. Forecasts for hours flown by aircraft type include fixed-wing turbine aircraft hours flown growing at a rate of 4.0% per year, fixed-wing piston aircraft hours flown growing at a rate of 0.7% per year, and rotorcraft hours flown growing at a rate of 3.0% per year.

2.4 Summary

Aviation forecasting is an imperfect science, and whether considering commercial or general or any other category of aviation, forecasting is a challenge. Both GA and commercial activities, driven by differing drivers, are dependent on conditions that are difficult to predict.

The 2006 TAF gives an indication that general aviation is either difficult to predict or is not given the amount of thorough formulation that commercial activity forecasting is given, yet GA plays a major role in the United States. While forecasting is only one part of the planning or evaluations by its stakeholders, it does give some weight to the importance of GA forecasts in relation to its more accurately projected commercial counterpart. While it could be simply be said that the "forecast is always wrong", more can always be done to improve forecasting methods. Looking at the past trends and better identifying what stimulates or hinders general aviation activity, in the context of the past and in the future may help better formulate forecasts

in the future.

In the past decade, general aviation forecasting work by the FAA has steadily remained positive, despite the almost consistent decline in activity, with the 2011 forecast being no different. In the next chapter, an examination of the current and past trends in America's general aviation activity and its drivers will put into perspective this optimistic outlook.

Chapter 3

Trends

A better understanding of past trends is necessary for forming better expectations of the future. This chapter takes a step back and explores some of the trends in activity over the past decades. Historical trends in fuel, socio-economic factors, pilot population, aircraft population, safety issues are also presented as factors that affect activity across the country.

3.1 Activity Trends

Some direct measures of general aviation activity in the United States include number of local and itinerant operations and hours flown.

3.1.1 Operations Trends

As discussed in Chapter 2, data on general aviation operations is most accurate and available for towered airports in the NPIAS. All trends presented in this section include only those related to towered general aviation operations, which are collected and published in the FAA's Air Traffic Activity Data System (ATADS) [4].

Figure 3-1 plots towered general aviation operations across the United States from 1969 to 2010. Trends for local operations, VFR itinerant operations, IFR itinerant operations, total itinerant (VFR and IFR) operations, and total (local and total itinerant) operations are plotted in the figure. Note that only the total itinerant data is available before 1991 and a breakdown of this total into VRF and IFR operations is available after that year.

In the decade between 1969 and 1979, general aviation operations grew at a rapid rate, with total operations doubling in the short time span. The majority of this growth resulted from an increase in itinerant operations in this time span. After this initial ramp up period, both local and itinerant operations followed similar aggregate trends.

After the decade of growth, general aviation operations dropped dramatically by 32% from peak levels in 1979 to 1982, just in three years. This sharp decline is the most drastic change that general aviation experienced in the past 4 decades.

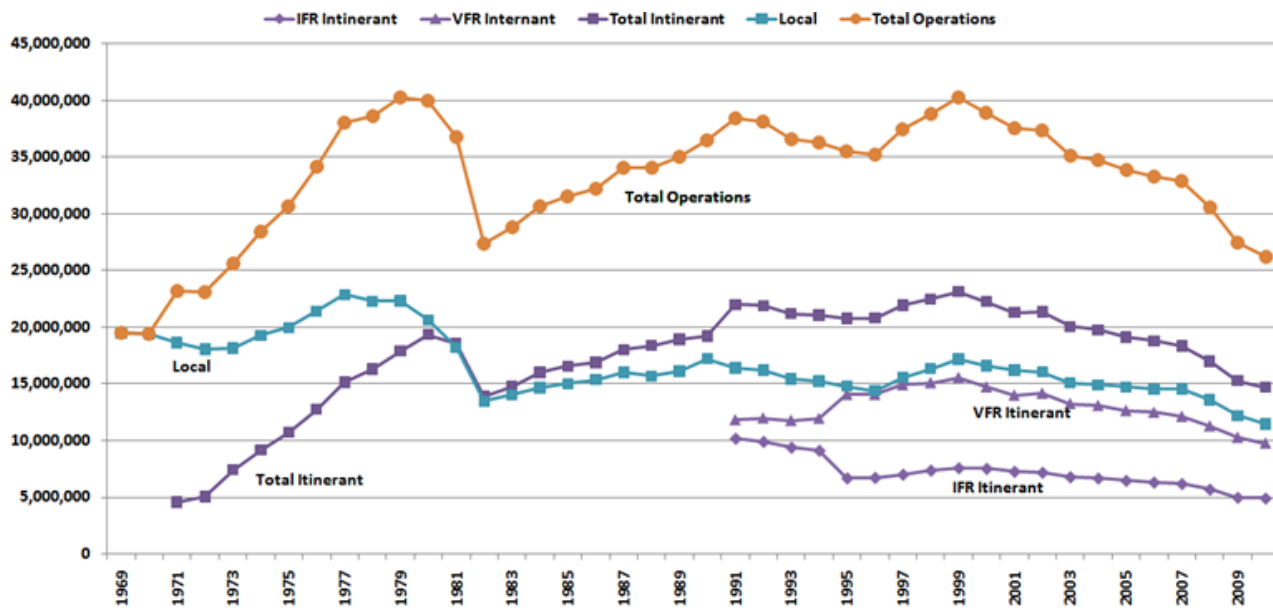


Figure 3-1: Towered Operations[4]

After that decline, operations began to climb again, albeit at a rate slower than that in the 1970s. Operations slowed again for five years beginning in 1991, before increasing again to the peak levels of the late 1970s in 2000.

Beginning in 2000, total operations have experienced their longest period of historical decline. Between 2000 and 2010, total towered operations across the country had monotonically decreased by 35%. Within this declining trend in recent years, a significant drop occurred between 2007 and 2009.

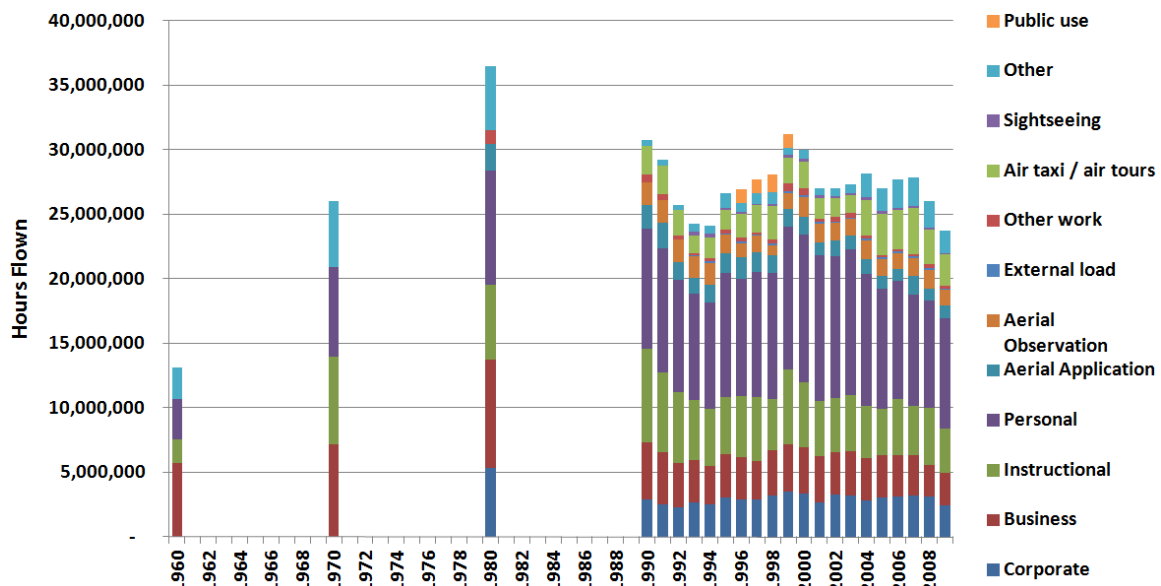


Figure 3-2: Hours Flown by Use [2]

3.1.2 Hours Flown Trends

Another source of activity measures comes from the FAA's General Aviation and Part 135 Activity Survey which reports estimates of total hours flown in general aviation operations every year that the survey has been administered. Figure 3-2 shows how hours flown by category of use has changed throughout this time. The downward trends found in towered operations are also echoed in the estimates of hours flown.

3.1.3 Spatial Trends

Figure 3-3 gives an indication of how those total operations in recent years have been distributed across the country. The top 50 general aviation airports, with respect to total GA operations, are shown on the map of the United States, with the size of the markers relating to the number of operations at the respective airports. The map is also overlayed with average annual precipitation in the United States for the years 1961-1990, where the red end of the color spectrum indicates low levels of precipitation and the purple end of the spectrum indicating high levels of precipitation.

These 50 airports account for 33% of all towered general aviation operations in the country. The airports also occur in clusters, indicating a link between spatial locations and activity levels. A strong concentration of operations are in the southwest, where average rainfall is at a minimum in the country. The airports are generally clustered in the southern half of the country, in Southern California, Arizona, and Florida where unfavorable winter conditions aren't as prevalent.

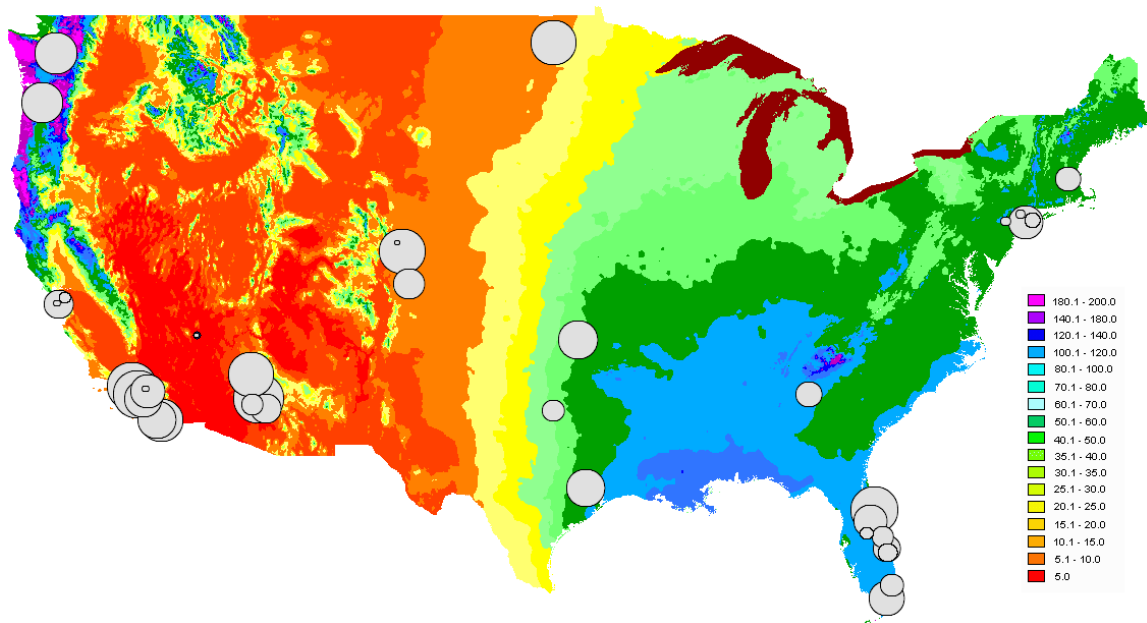


Figure 3-3: General Aviation Airports and Weather [4]

3.2 Drivers and Related Trends

3.2.1 Pilot Population

The pilot population in the United States, shown in Figure 3-4, has declined since its peak in the 1980s across all categories of certification. It decreased by 28% from a peak of 827,071 certificates in 1980 to 594,285 in 2009. An increase in total certificates occurred in 2010 and it could partially be the result of an increase in student certificates due to the validity of those certificates being extended by the FAA to 60 months.

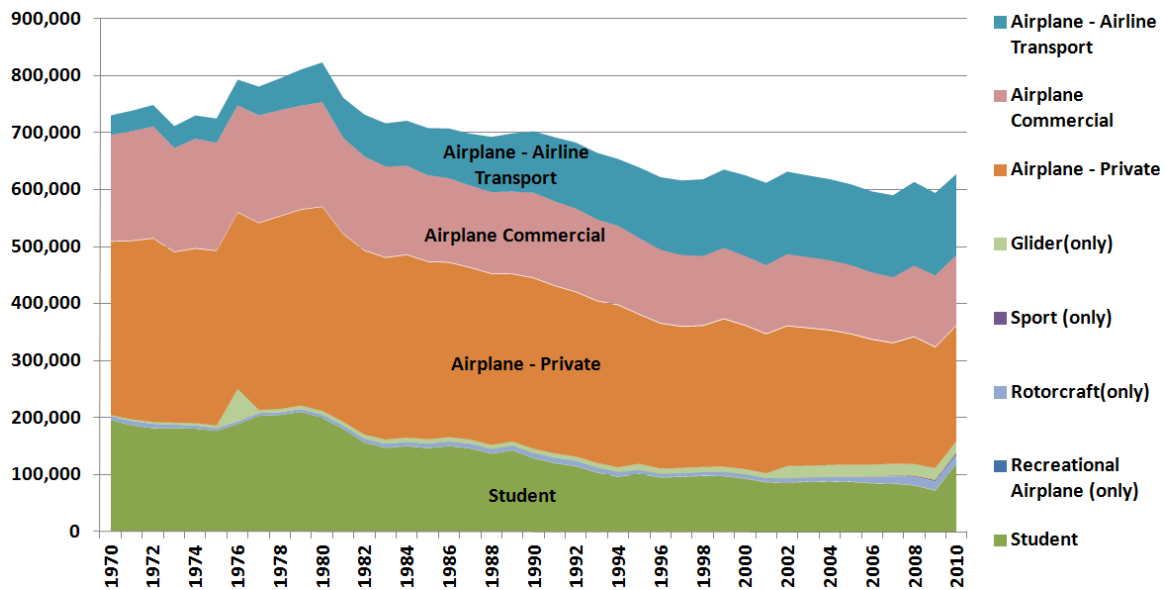


Figure 3-4: Pilot Certificates Held by Category [16]

The decline is even more evident in Figure 3-5, which considers the number of certificates as a proportion of the U.S. population in a given year. This percentage dropped from 0.36% in 1970 to 0.20% in 2010.

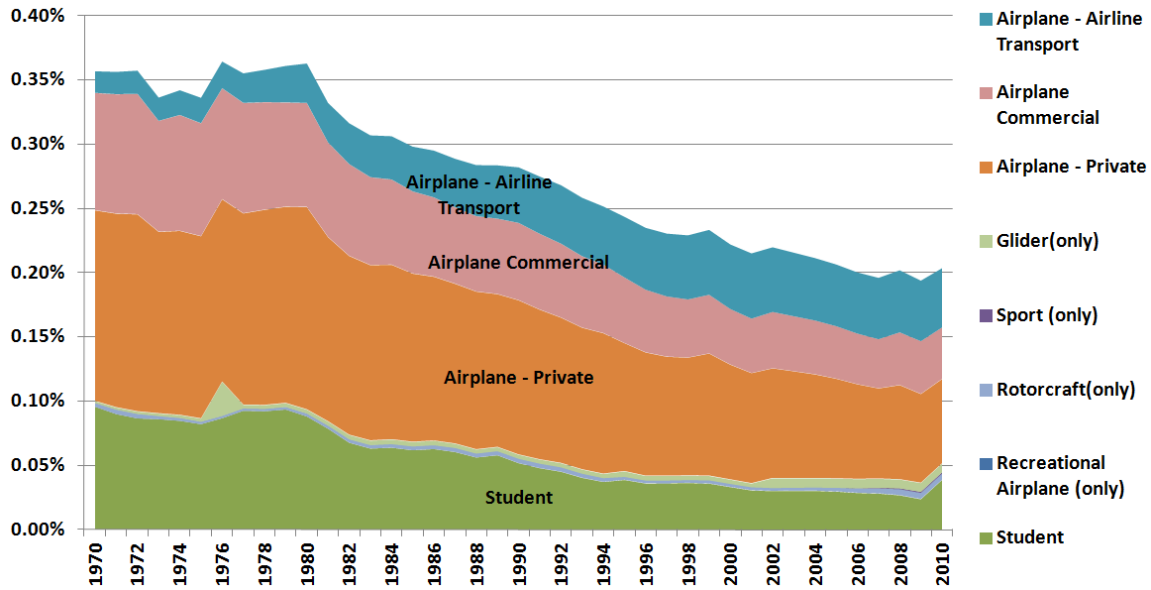


Figure 3-5: Percentage of Pilot Certificates Held in the U.S. Population, by Category [16]

This decline in population indicates that pilots are retiring at a rate higher than the rate at which student pilots are beginning to fly and become certificated. This trend can be seen in the data collected from the FAA's General Aviation and Part 135 Activity Survey. Figure 3-6 shows how the number of instructional flight hours has decreased by a significant 53% from 1990 levels.

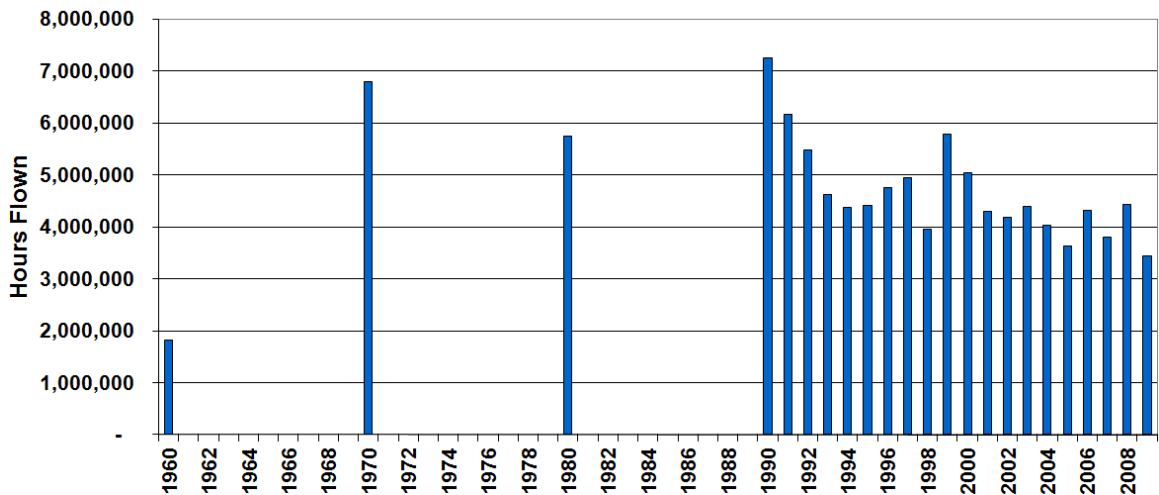


Figure 3-6: Instructional Hours [2]

As could also be expected from the slow addition of new pilots into the pilot population of the country, the average age of those left in the population are increasing. Figure 3-7 shows how the average age of pilots has steadily increased from 37.8 years in 1981 to 44.2 years in 2010.

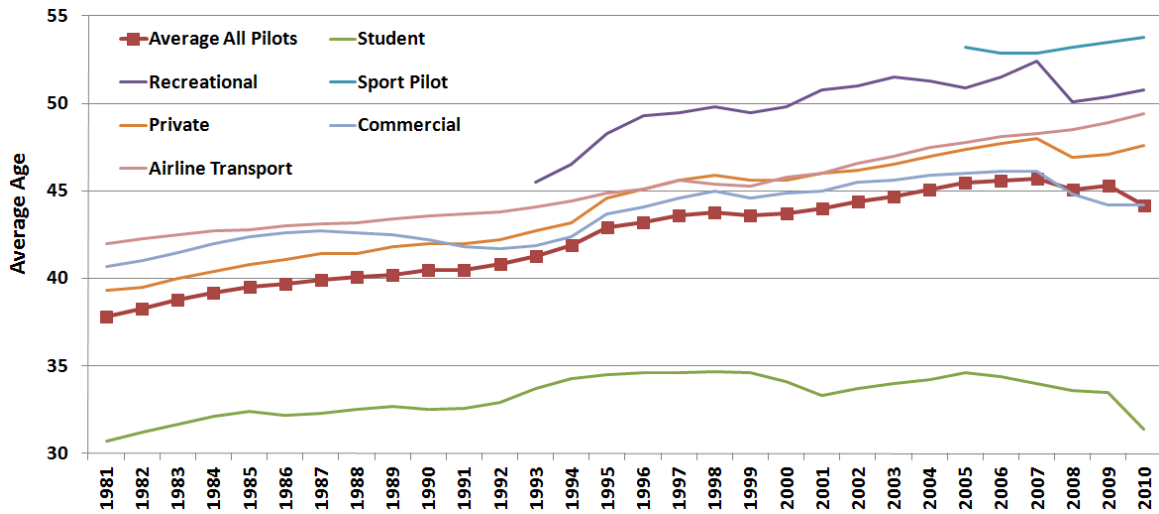


Figure 3-7: Average Age of Active Pilots by Category [16]

3.2.2 Aircraft Population

Along with the decline in pilot population, there has been a decrease in the manufacturing of general aviation aircraft in the United States and an over all aging of the aircraft fleet.

Figure 3-8 shows the numbers of general aviation aircraft shipments by US manufacturers from 1960 to 2010.

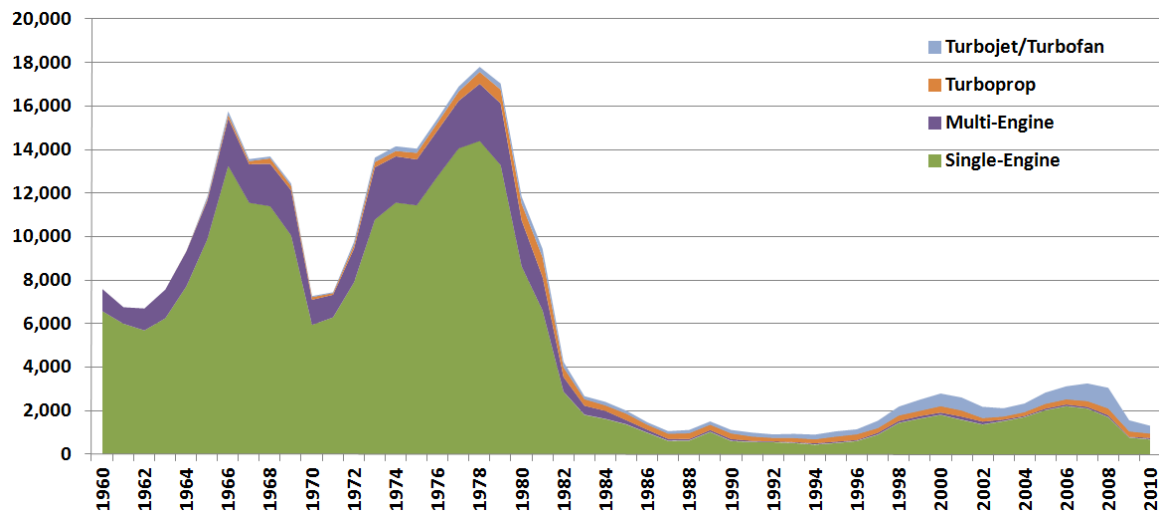


Figure 3-8: General Aviation Shipments by Type of Aircraft Manufactured in the United States [16]

General aviation aircraft manufacturing experienced a strong boom in the 1970s, which flooded the country's active fleet. Figure 3-9 shows how this boom corresponds to the rapid growth in towered operations in the same time period. However, by the early 1980s, the aircraft manufactures were significantly hindered by rising insurance

costs brought on by product liability lawsuits as aircraft aged and resulting accidents were brought into litigation through tort law. From the peak of production in 1979 to its low in 1993, the number of shipments decreased by a staggering 94%.

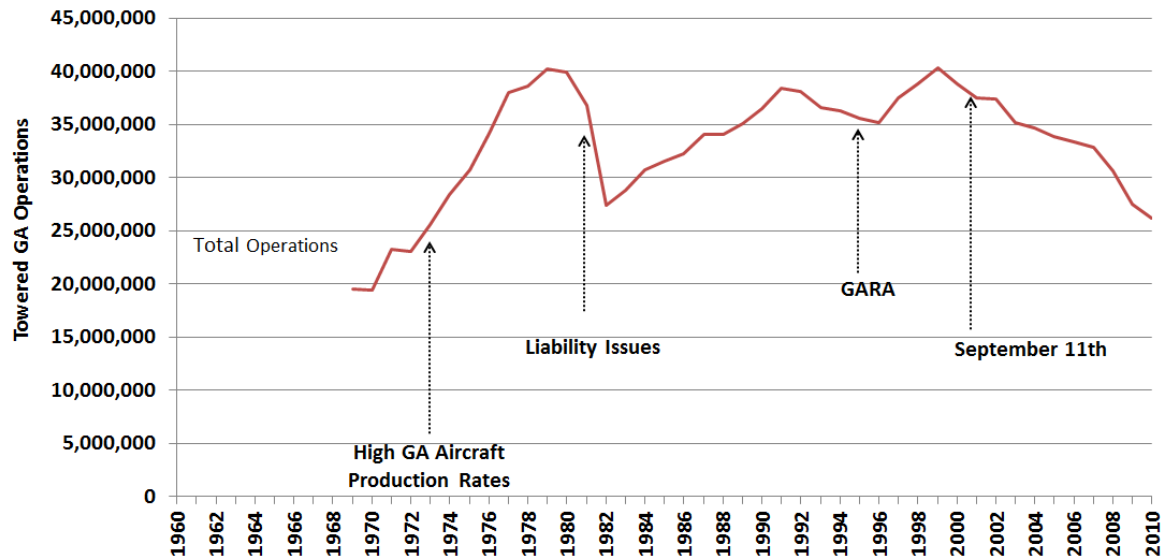


Figure 3-9: Towered General Aviation Operations and Events Affecting Aircraft Population

Shipments again began to grow after more than a decade of stagnation when the General Aviation Revitalization Act (GARA) was passed into law in 1994. The new statute limited the liability of aircraft manufacturers to accidents involving their aircraft in less than 18 years after the delivery of the aircraft [20]. This removed the crippling financial burden on aircraft manufactures and allowed for a more aircraft production. Also during this time, an increase in fractional ownership programs, benefiting from the favorable tax treatment for co-ownership, stimulated demand for aircraft. A dip in shipments observed from 2000 to 2003 is most likely a result of economic recession and the 9/11 terrorist attacks. Shipments resumed growth until 2008, until the economy was hit with another significant recession [23].

Although there has been a slow recovery of growth in the past two decades, the percentage of of general aircraft exported to foreign countries has increased from 20.3% in 1978 to 51.6% in 2010. Figure 3-10 adjusts the number of total aircraft shipments to account for those aircraft that are exported out of the country from 1978 to 2010. It is now clearer that of the small increases in shipments in the 2000s, only around half of those have stayed in the country.

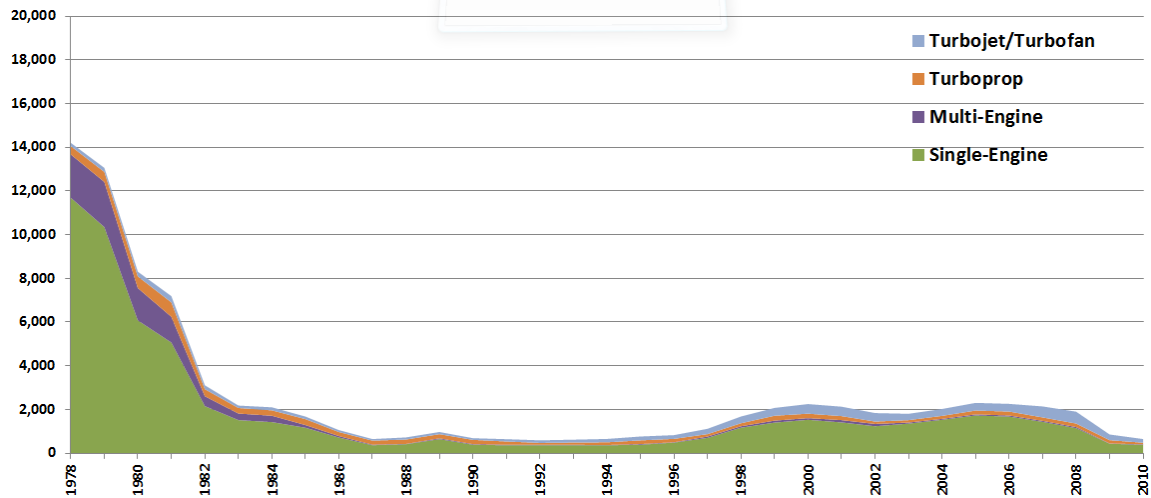


Figure 3-10: General Aviation Total Shipments, Less Foreign Exports, by Type of Aircraft Manufactured in the United States [16]

The decrease in shipment levels are accompanied by an increase in billings as seen in Figure 3-11. Given the significant reduction in aircraft production, the increase in total billings suggest high increases in aircraft costs, even in constant dollars.

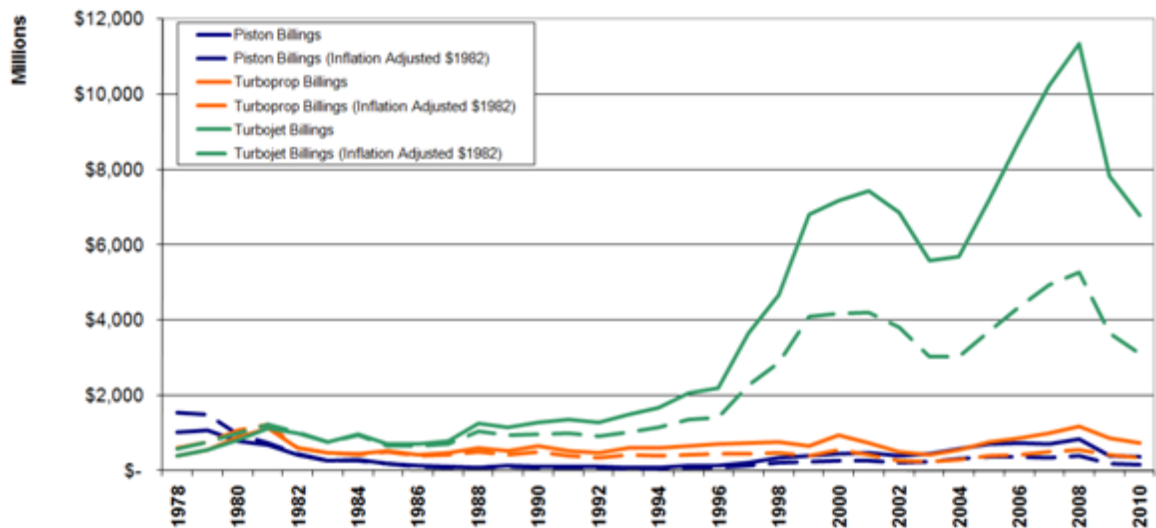


Figure 3-11: General Aviation Total Billings by Type of Aircraft Manufactured in the United States [16]

More expensive and fewer new aircraft entering lead to the domination of older aircraft in the population. The resulting increase in maintenance costs and new acquisition costs imply that operating costs in general aviation have been on the rise, which could contribute significantly to the decrease in activity.

3.2.3 Fuel

Fuel cost is one of the most basic, easily tracked, and understood drivers of aviation activity. As fuel prices increase or the volatility of prices increases, it should be expected that flying activity levels will be affected negatively.

Figure 3-12 shows how fuel consumption has changed since the 1980s. Aviation gasoline used to fuel piston type aircraft has experienced steadily decreasing sales over this time period, while jet fuel has increased.

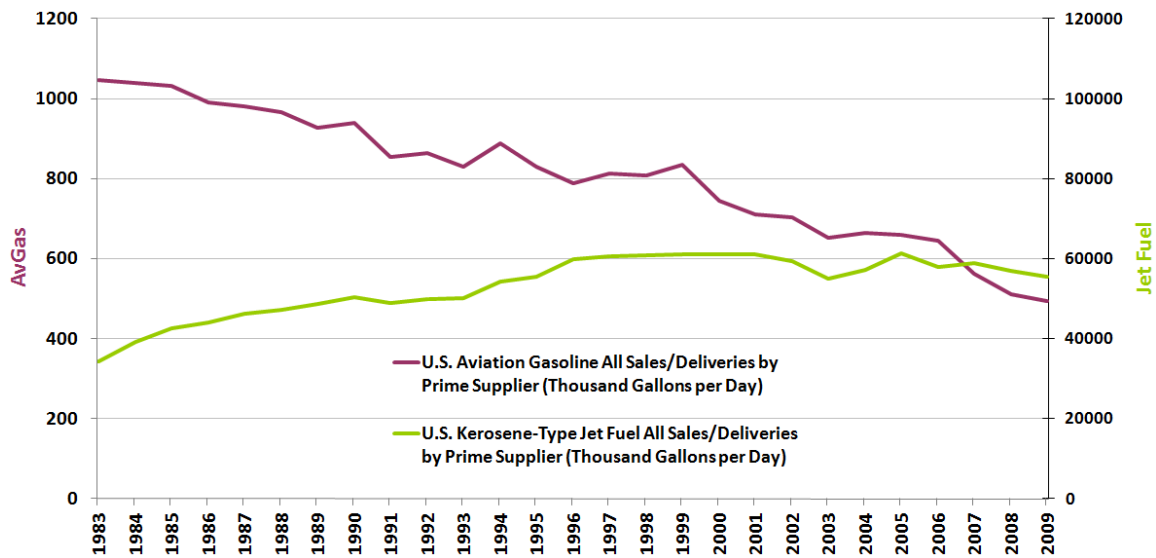


Figure 3-12: Prime Supplier Sale Volumes [17]

Figure 3-13 shows how fuel prices have changed since 1978 in constant 2005 dollars. The shaded regions on the graph show periods of significant increase in fuel prices and they correspond to the shaded regions in Figure 3-14. During the periods of high fuel price increases, towered operations are in significant decline.

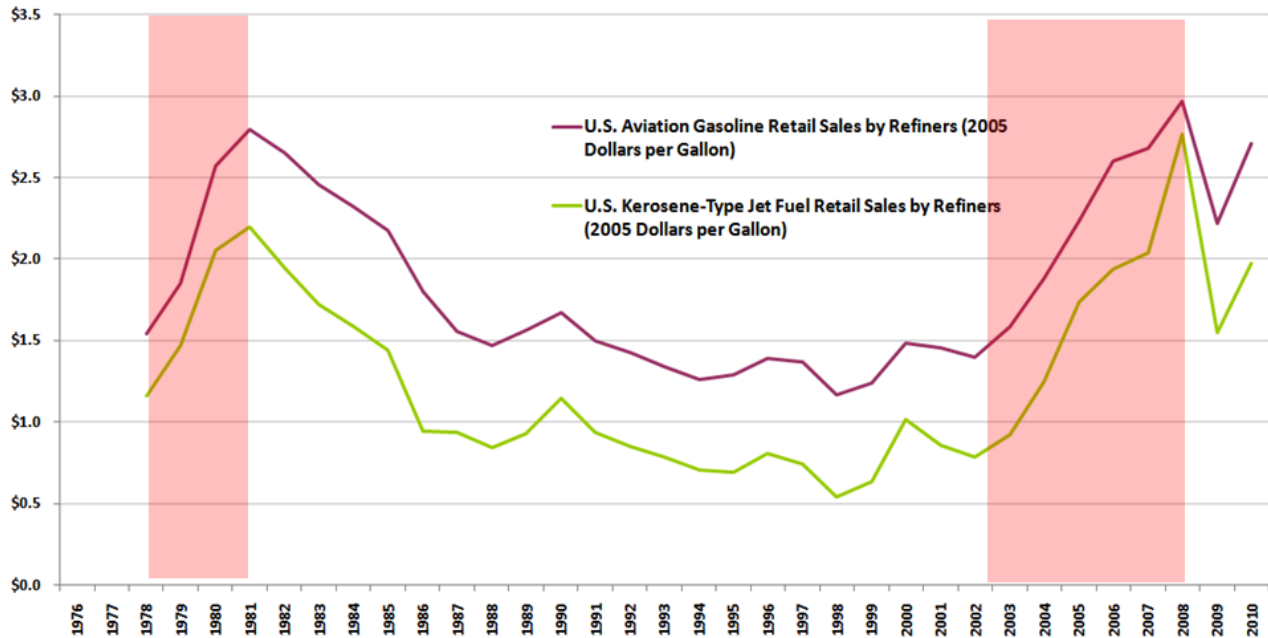


Figure 3-13: Fuel Sale Prices [18]

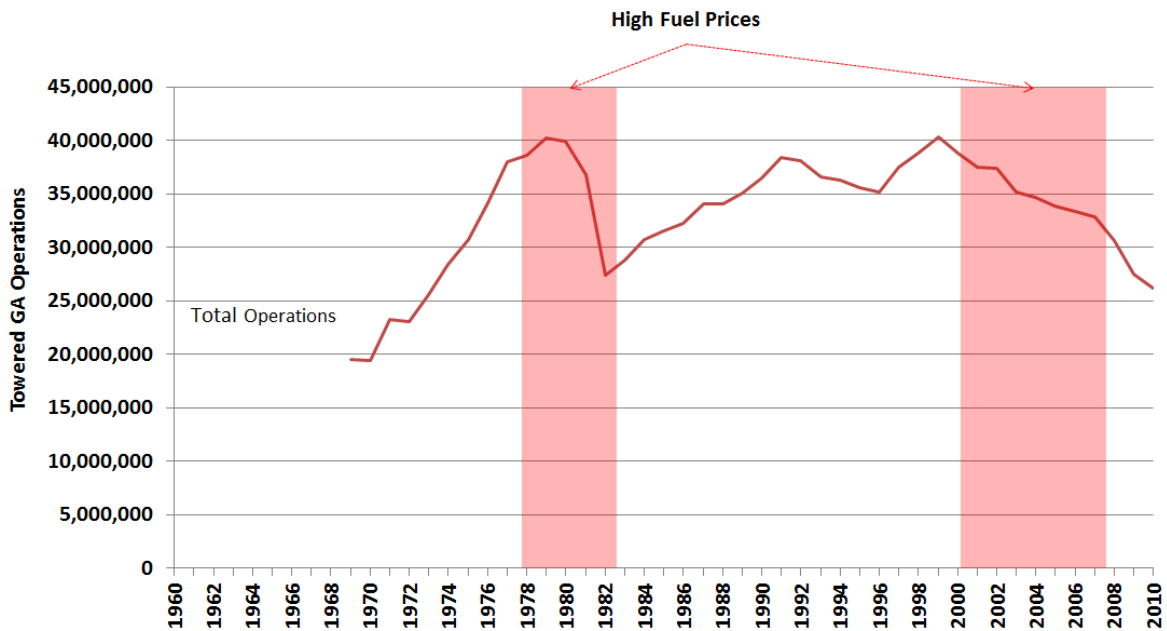


Figure 3-14: Towered General Aviation Operations and Rising Fuel Prices

Along with increased fuel prices, the availability of fuel threatens operations in the future. The future of the most widely used aviation gas used by piston aircraft, 100LL, is currently in question because of decreasing levels of demand limiting the available supply delivered to airports and because of environmental agencies working to eradicate the leaded fuel. In 2010, the U.S. Environmental Protection Agency

issued an Advance Notice of Proposed Rulemaking (ANPR) which announced an investigation into current emission engine standards. This action was in response to pressure from the environmental advocacy group Friends of Earth to regulate or eliminate the leaded gas. The group argued that half of all lead found in the atmosphere can be attributed to piston-engine aircraft emissions and that the public's exposure to this lead may lead to serious health effects, especially in children [19].

3.2.4 Socio-economic factors

As discussed in Chapter 1, the national GDP alone is not a strong indicator of aggregate general aviation activity in the country. Figure 3-15 and Figure 3-16 show the trends of other socio-economic factors, disposable personal income per capita, in chained 2005 dollars, and the unemployment rate in the United States, respectively.

Again, disposable personal income alone does not appear to be a good indicator of activity. Its positive and mostly steady trend does not track the patterns in activity levels. While increasing levels of disposable income are expected to correlate with higher levels of flying activity because of its relation to how much pilots can spend on flying, the trend alone does not take into account costs associated with flying and therefore cannot alone give an indication of activity.

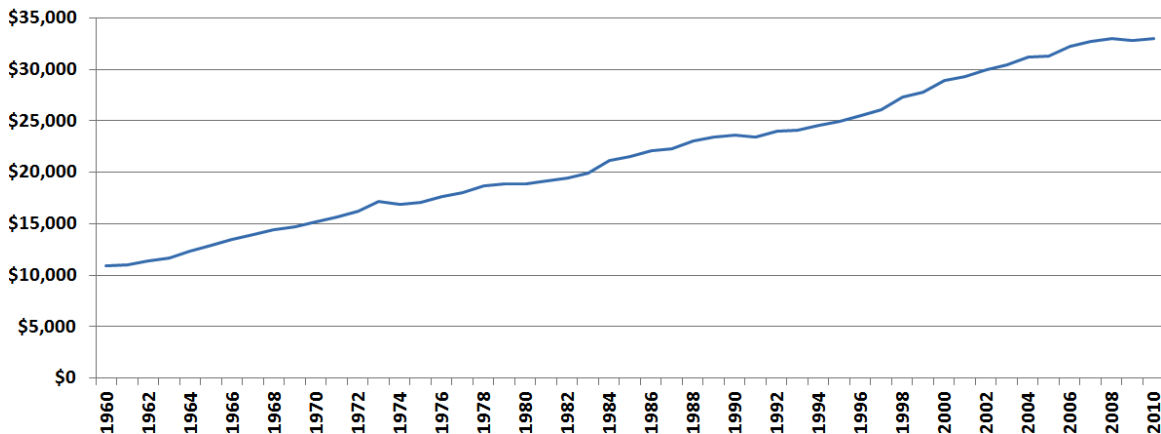


Figure 3-15: Disposable Personal Income Per Capita Chained 2005 Dollars [21]

Unemployment is hypothesized to affect activity levels in the country as lower levels of unemployment indicate better economic conditions for businesses, more pilots involved in aviation related jobs, and more pilots or potential pilots being able to financially support their flying activities. The peaks of unemployment between 1970 and 1985 did in fact coincide with periods of increase in towered GA activity. The most recent spike in unemployment, from 2008 and 2010 related to a strong economic recession, coincides with the begin of the steeper drop-off in activity beginning in 2008. The beginning of the two declines in activity starting in 1991 and in 2000 also coincides with two periods economic recessions in the country, as seen in Table 3.1. Figure 3-17 illustrates how periods of economic recession, shaded green, relate to periods of decline in activity.

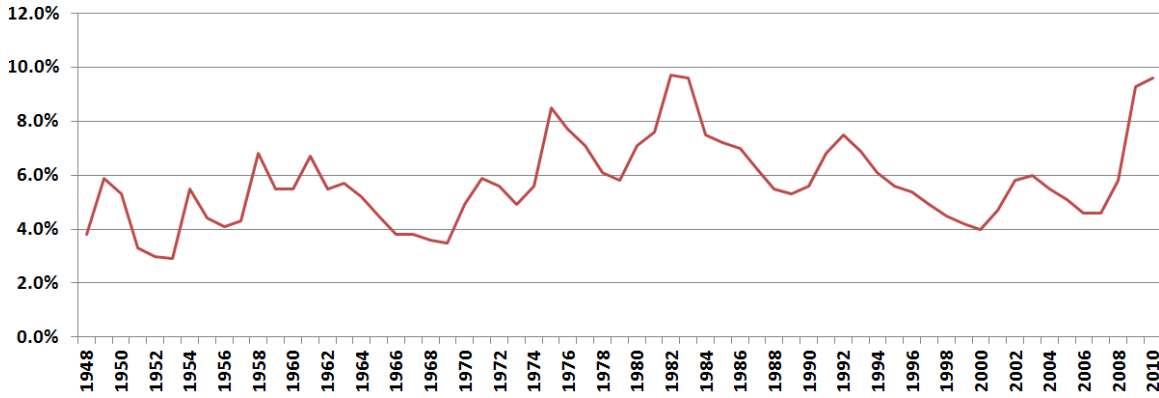


Figure 3-16: Unemployment [22]

Table 3.1: Economic Recessions in the United States [23]

<i>Recession</i>	<i>Length</i>	<i>Peak Unemployment Rate</i>	<i>GDP Decline</i>
July 1990 - March 1991	8 months	7.8%	-1.4%
March 2001 - November 2001	8 months	6.3%	-0.3%
December 2007 - June 2009	1 year, 6 months	10.0%	-5.1%

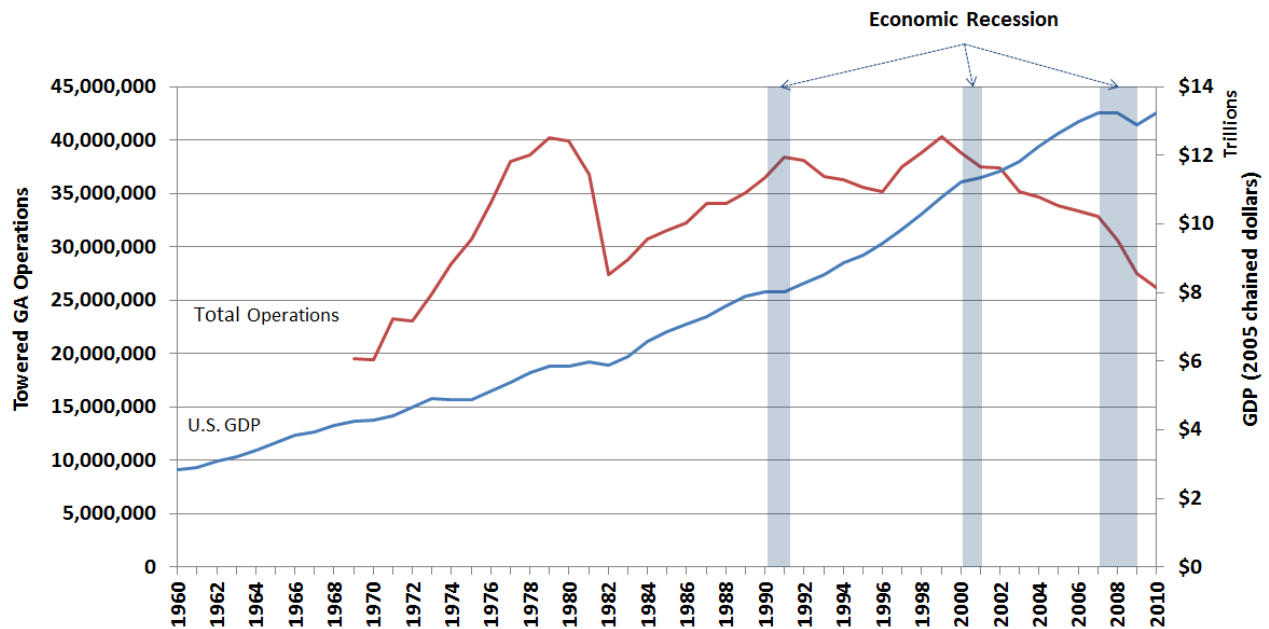


Figure 3-17: Towered General Aviation Operations and Economic Recessions

3.2.5 World Events

As also noted in Figure 3-18, downturns in aggregate general aviation levels have also coincided with events occurring in the United States, other than those directly related to economics or the aircraft production rates discussed previously.

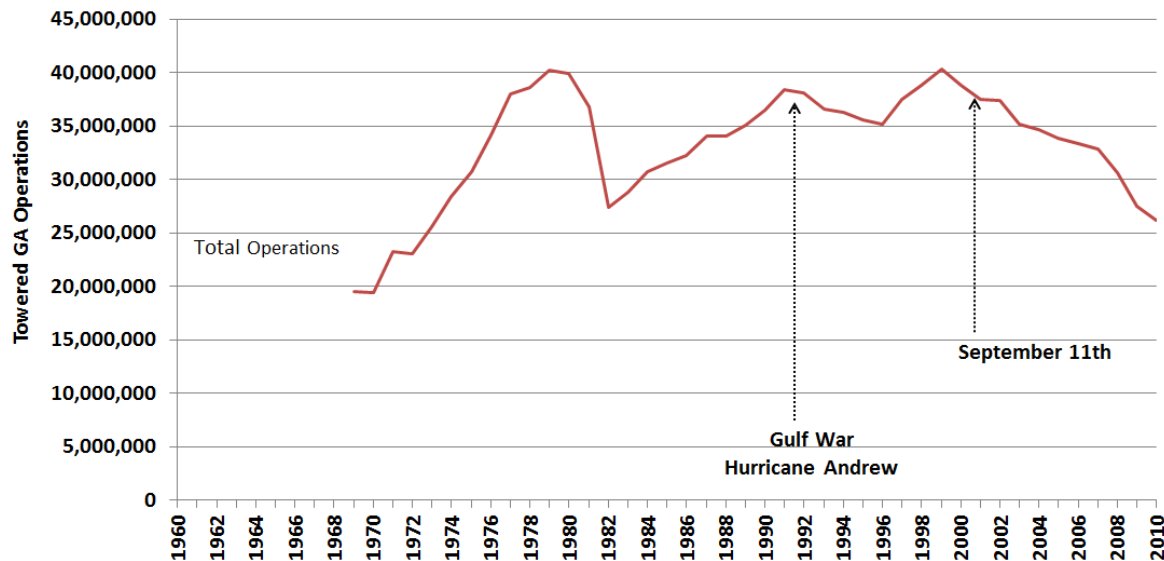


Figure 3-18: Towered General Aviation Operations and World Events

Along with the economic recession of the early 1990s, the decline in activity in the first half of the 1990s may also be linked to the country's involvement in the Persian Gulf War (August 1990–February 1991) and to Hurricane Andrew (August 1992), the costliest natural disaster in Florida's history that destroyed airport facilities and aircraft in one of the nation's most active area of general activity [24].

The current decline in activity that began in the early 2000s that coincided with economic downturn was further compounded by the terror attacks of September 11, 2001. The attack resulted in the immediate halt of all activity for days and its more prolonged effects came in the form of poor perceptions of aviation in the public, increased security procedures at airports, and tighter regulation of the airspace [25].

3.2.6 Safety

As with any type of aviation, safety or perceived safety is an issue that can affect how the public, users, or potential student pilots view general aviation and, therefore, affect activity.

The number of fatal and non-fatal general aviation accidents in the United States along with the number of accidents per 100,000 flight hours, as reported by the Bureau of Transportation Statistics, are presented in Figure 3-19. Since the late 1960s, the number of general aviation accidents has been on an almost steady decline. An even more dramatic trend is seen in the number of accidents per 100,000 flight hours, which

has followed a near exponential decline since 1938. It dropped from over 30 accidents per 100,000 flight hours in the late 1960s to 5 accidents per 100,000 flight hours in 2010.

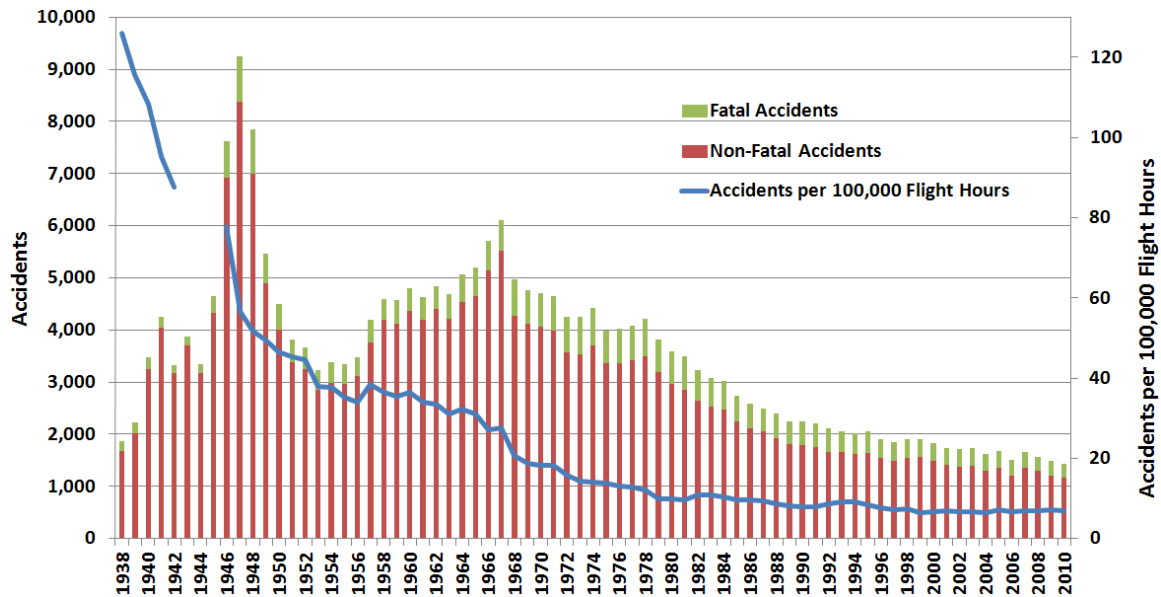


Figure 3-19: General Aviation Accidents [26]

Figure 3-20 shows that the absolute number of fatal accidents has been generally decreasing since the beginning of the 1980s. A decrease of 1,000 fatal accidents occurred over the past two decades. The total fatalities per accident, however, has not dropped at the same rate as the number of accidents and is quite less steady, fluctuating between 0.4 and 0.3 fatalities per fatal accident.

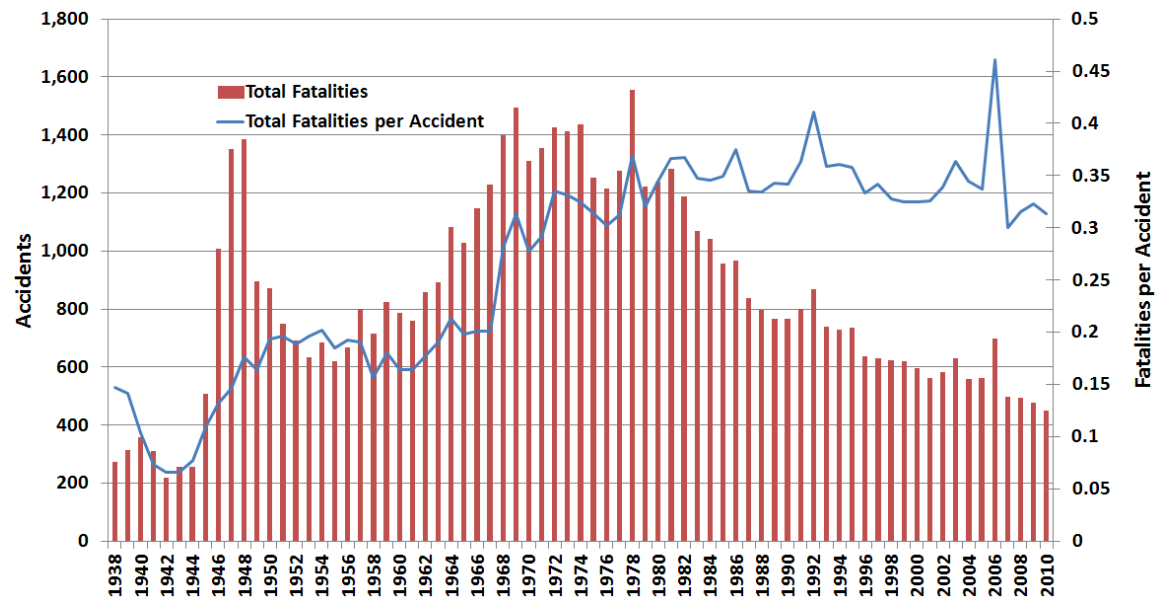


Figure 3-20: General Aviation Fatalities [26]

Accidents and accident rates have been on the decline for the past 50 years, while total fatalities per accident have stagnated in recent years. There is no strong correlation between the measures of activity discussed in the first section of this chapter and the measures of general aviation safety. The more positive indication of an advancement in safety does not seem to be a primary driver of higher aggregate activity levels.

3.3 Conclusions

Despite the optimism in the forecasts seen in Chapter 2, general aviation activity, whether measured by local operations, itinerant operations or by hours flown, has dropped since its peak in the late 1970's. There have been periods of growth and decline in activity since then that allowed activity to reach those levels again by end of the 1990s, but a steady decline has persisted for next two decades.

General aviation activity grew to peak levels in the 1970s, accompanied by high production rates of new general aviation aircraft, until it was set back by liability issues faced at the end of the decade and volatile fuel costs. Operations levels slowly recovered, until the 1990s, when war, natural disasters, and economic downturn, resulted in decline. Activity was only allowed to ramp back up for five years before economic downturn marked the inflection point in the trend, which was further compounded by the 9/11 terrorist attacks, rising fuel prices throughout most of the decade, and world wide economic recession at the end of the decade. Concurrently, there has been a decline in the pilot and aircraft populations, with less student pilots, on average an older pilot population, more expensive new aircraft, and an older active aircraft population.

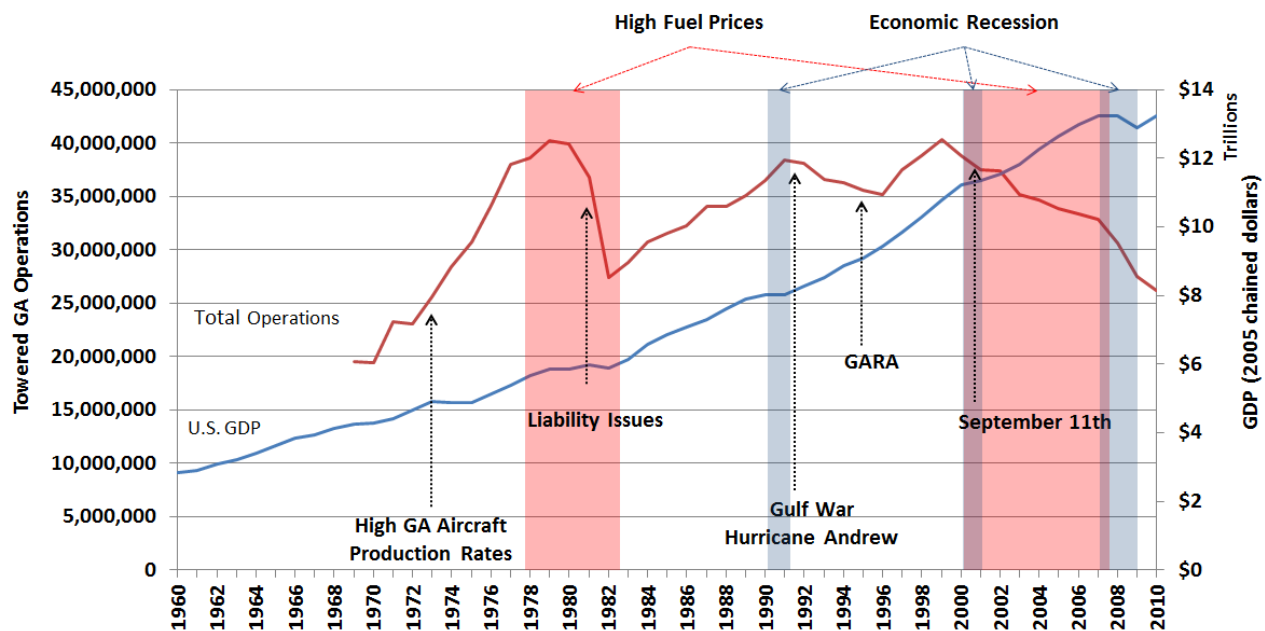


Figure 3-21: Factors Affecting General Aviation

The drivers and related trends explored in this chapter work in both independent and confounding ways to produce the levels of activity realized. While however some major factors affecting activity presented themselves, they are also by no means the only factors at play. In Chapter 4, a survey of general aviation pilots is presented as a way to further clarify these complicated relationships and to shed more light on what affects an individual's flying activity and on what they believe is in store for the future of general aviation.

Chapter 4

Survey

The data presented in the previous chapter gives insight into aggregate trends in general aviation across the country. While major drivers or related trends presented themselves in this data, we seek to gather a deeper understanding of what factors affect a given pilot's flying activity on an individual level. To help achieve this goal, an exploratory survey of general aviation pilots was employed to gather the experiences and opinions of a sample of active and inactive pilots.

The chapter begins with a discussion of the motivation behind using a survey to collect more data on general aviation activity. The design and sampling method of the survey are then presented. This is followed by a discussion of the methodological issues facing this design and any implications that it may have on the analysis of the survey's results. Then a profile of the survey respondents is presented, along with discussion of how well it fits the population of interest. The chapter concludes with a brief commentary on the effectiveness of the survey in achieving its methodological goals.

4.1 Goals

An important step in understanding the state of general aviation in the U.S. is to characterize it numerically, through the analysis of the trends in easily quantified data, as was done in the previous chapter. However, subtleties in the drivers of an individual's flying activity can be lost when aggregating information across the entire population of pilots that produce the activity in the country. Therefore, we look for other information that will provide another perspective that will either compliment the findings in the data or to provide new insight.

In order to compliment the current available data and to paint a more complete picture of the state of general aviation, an exploratory survey of general aviation pilots was developed and administered. A survey is used as an efficient tool in learning more about the opinions and experiences of a group of people which is too large to survey in full. The survey aims to gather information from a population as large as the hundreds of thousands of pilots in the United States, including those who may or may not be currently active.

The purpose of the survey is to two fold. The first is for information gathered from the survey to either confirm or dispute the hypothesized relationships presented in the previous chapter. The results can help to separate correlation from causation in the data analysed, making clear what in fact drives or hinders activity. In addition to this role, it is also aimed at obtaining information that are not directly reflected in the data. It asks for experiences, and in particular, *opinions* on the past, current, and future issues in general aviation.

Goals of the survey include answering questions such as:

- What are the experiences of pilots in terms of when they started flying, why they began flying, and what factors hindered or bolstered their flying activity throughout their flying careers.
- Are the experiences or opinions of GA pilots more or less the same across population groups or do they differ significantly? If they differ, do they change with factors such as a pilot's age or where they live or fly?
- What do pilots expect in the future and what do they think are the biggest challenges facing general aviation?

The hope is that the information provided directly by GA users will add another dimension to the data analysis and will make the results of this research more useful to those who have an interest in GA's future.

4.2 Design

4.2.1 Survey type

The survey is self administered survey hosted on the internet. The survey includes a combination of open ended, multiple choice, interval scale, and ratio scale questions.

Content

The pages of the survey, as seen by the participant, are in Appendix A.

- The survey begins with an explanation of what the survey is about, who is administering the survey, and what the goal of the survey is. The terms of participation and confidentiality, along with contact information for any questions regarding the survey are presented to the participant.
- The participants are then asked to best describe their current certification and ratings. Total flight time, age, gender, and occupation are also collected. This demographic information is used to gauge how well the survey respondents represent the pilot population of interest and also to group respondents by similar characteristics in the analysis of the findings.

- The participants are asked when they began flying and whether or not their activity increased or decreased since that time. They are also presented with a list of potential reasons a person might learn to fly and are asked to select the reasons that applied to themselves.
- The participants are then asked if they flew in 2011. If they did, they are asked to describe their activity in 2011 by providing hours flown, the state based from, the regions flown in, and the primary aircraft type flown.. If they did not fly in 2011, they are asked to describe why they did not fly in 2011 in an open response format.
- The participants are asked to identify the period of time, in 5 year increments, that they were most actively flying. If 2011 was the peak of their flying activity, are asked to describe why 2011 was their peak year of flying. If they choose any other period, they are asked to characterize their flying during their indicated peak year of flying by providing hours flown, the state based from, the regions flown in, and the primary aircraft type flown.
- If 2011 was not their peak flying period, the participants are asked to describe why their flying decreased from their peak year to 2011 in an open response format. They are then asked to indicate how significantly changes in different factors (including costs, income, employment, enjoyment, available time, etc.) contributed to their decline in flying hours.
- The participants are asked to select how much they agree or disagree with a set of given statements relating to general aviation issues. These statements were formulated to test the validity of a number of hypotheses of what affects flying activity that emerged from the data analysis in Chapter 3. In these questions, they are providing their opinion on issues including aviation careers, flying activity and economic issues, enjoyment of flying, the affect of the internet on flying, increased regulations, fuel costs, and new technologies.
- Finally, the participants are asked to characterize their outlook on their personal flying and on the future of general aviation in the U.S. They are asked how they expect their flying to change over the next few years and also if there is any fuel price that would significantly hinder their flying activity. Free response questions also ask what would stimulate their activity and what they believe to be the biggest challenges facing the general aviation community.

Best Practices

The survey was developed with the approval of MIT's Institutional Review Board for adherence to best practices in social sciences research. In the goal of protecting the rights and welfare of the participants, the questions and survey methods were designed to be minimally invasive, with only enough detail to make meaningful conclusions. Along this vein, the participants answers were collected with SSL encryption, so that

responses are encrypted securely to the survey host's servers. The participants were informed that no email addresses or IP addresses would be collected, that they would not be contacted afterwards, and that demographic information provided could not be used to identify the participants. They were also informed that their participation was voluntary, they would not be provided compensation for their participation, and that they could choose not to answer questions. The participants were provided with the email addresses of the survey administrators if they had any issues or concerns.

4.3 Sampling Method

Given cost and time constraints, a non-probability method of sampling was used for the survey presented here. To obtain data in a time frame acceptable to the project and within the constraints of the research budget, the method used was combination of methods defined as convenience and snowball sampling. Convenience sampling involves sampling those in the population who are readily available or are easy to access for the survey. Snowball sampling relies on people who have participated in the survey to refer the study to others who they seem fit to participate.

The survey was hosted online. Numerous general aviation groups and news sources were contacted about the research project and the survey, where they in turn informed their readers of the survey either through articles or newsletters. The biggest of these groups was AVweb, an independent aviation news source, with over 225,000 general aviation pilots and aircraft owners, OEM's, suppliers and related businesses who subscribe to AVweb's e-newsletters and visit the website. AVweb ran an sponsored advertisement in its two weekly e-newsletters for four weeks, which called for the input of general aviation pilots and was linked to survey. It is also assumed that some number of respondents were referred to the survey by other pilots who participated.

4.4 Sources of Error

In the previous section, it was discussed that the sampling method used was not an ideal random sampling method and therefore the prerequisites for utilizing most familiar statistical analysis relating the results of the survey to the total population are not met. The survey results are subject to greater sampling error, the amount of inaccuracy in estimating a value (average, proportion, etc.) intended to represent an entire population from the value obtained from a sample.

Inaccuracy occurs not only due to the fact that the sample is not random, but also on account of coverage, sampling, nonresponse, and measurement errors [27].

- **Coverage Error:** Coverage error occurs when every person in the population of interest does not have a known and non-zero chance of being included in the sample. The very design of this survey limits it to those who are familiar with using a computer and have access to the internet. The method of distribution of the survey also limits coverage to those who are subscribed to general aviation

online newsletters or are referred to the survey by another survey taker. Coverage error encompasses not only issues with oversampling of this subset of the population, but also the over- or under-sampling of different sub-populations with specific characteristics. For instance, the mode of distributing the survey over the internet may lead to the exclusion of some age groups that could be less likely to subscribe to online newsletters (an issue that is explored in the next section). It can also be expected that pilots who are currently very active in general aviation, as opposed to another period of time in their flying careers, are the pilots who subscribe to such online newsletters and will be exposed to the survey.

- **Sampling Error:** Sampling error occurs due to the fact that responses are only collected from a sample and not from the entire population.
- **Nonresponse Error:** Nonresponse error refers to the possible bias survey results present due to the fact that not all individuals who are invited to participate actually do. This bias will not exist if the nonresponse occurs in a random fashion, but this is usually not the case. Nonresponse can be correlated with an indifference to the survey goals and this may then lead to attracting a larger than proportional number of participants with survey responses tending toward extreme values of the population. Since participation is voluntary and in the privacy of one's home (or elsewhere not under supervision), it can be expected that those with stronger opinions on the subject of interest (the state of GA) to agree to participate. The hope is that the GA community, is one in which interest is more or less uniform across the board, i.e. everyone cares about its state.
- **Measurement Error:** Measurement error is usually separate from errors related to sampling and is the result of not measuring what is intended. This can be attributed to many different sources that can come from both the survey and the survey taker. The survey questions were written clearly and in a neutral tone in order to minimize misunderstanding of the intended question and to minimize a projection of desired outcome. To this goal, the statements in which the survey taker has to indicate how much they agree or disagree with the statement alternated between sentences written in a positive tone and a negative tone. The survey respondents may themselves introduce more measurement errors that the survey cannot prevent, such as inaccurate answers due to faulty memory or inaccurate comprehension of actual behaviors. Survey responses are also subject to policy response bias, where a survey respondent will give answers that they believe will result in survey conclusions that they favor. For example, it is possible that a respondent to exaggerate hardships that affect their flying activity in order to push for specific regulation changes.

The effects of these errors are not independent of each other and, unfortunately, there is no systematic way to quantify the total effect of these errors on the total inaccuracy of a population estimate. It is just important to note that these errors

are present, some of which would be present even in a random sample, and that they limit the power of applying the results of the survey to the population of active and inactive GA pilots. It is important to keep in mind that this is an exploratory survey which aims to gain general information about the pilot experiences.

Some aspects of the errors involving coverage have been evaluated after the completed sample was collected. In the next section, some aspects of how well the sample respondents represent the population of interest are evaluated.

4.5 Response Profile

A total of 1,250 responses were collected for analysis over a period of 6 weeks. The demographics of this response pool are summarized in this section.

In light of the discussion in the previous sections on issues in representing the population of interest and on known sources of errors, the proportion of respondents that fall into a given demographic category are computed in this section and are compared to what is known about the population a priori. It is important see if the survey results are over (or under) representing any one segment of the total population of interest (all pilots active in GA in the United States) in order to put the results of the survey in some context.

However, problems arise even in trying to compare some basic demographics of the survey respondents with that of the population. Certain demographics cannot be compared simply because there is no prior data indicating the proportion of the population of certain segments within the total population. For instance, given available data it is not possible to determine the proportion of pilots in a given occupation. For the other demographic strata, such as certifications, age, and gender, it is possible to get data on active airmen, pilots who hold an airmen certificate and have a current medical certificate. This has to serve as a close proxy for the population of interest in this survey, which includes active and non-active pilots who are active in general aviation activity.

4.5.1 Certifications and Ratings

Figure 4-1 summarizes the pilot certifications of the survey respondents where respondents are grouped according to their highest certification. In the same figure is the distribution of highest certifications held by active airmen, as estimated by the FAA for the year 2011 [28]. The general shape of the distributions are the same, however it can be seen that the percentages of students and airline transport pilots surveyed are lower than in the population of active airmen while the percentages of private and commercial pilots surveyed are higher than in the population of active airmen. This is where it needs to be stressed that the comparisons are being made between the pilots who participated in the survey because they are or were involved in general aviation and between all active airmen. It is probable that those with private or commercial certifications are more involved in general aviation flying activity than air transport pilots. If that is the case, the respondents may represent the population

of interest more than what this comparison indicates. There may also be a lower number of students than what would be expected from the population because the students are just becoming involved in the general aviation community and may not have been equally exposed to the presence of the survey. Also, they may not have enough interest or experience with the issues in the survey that would compel them to participate.

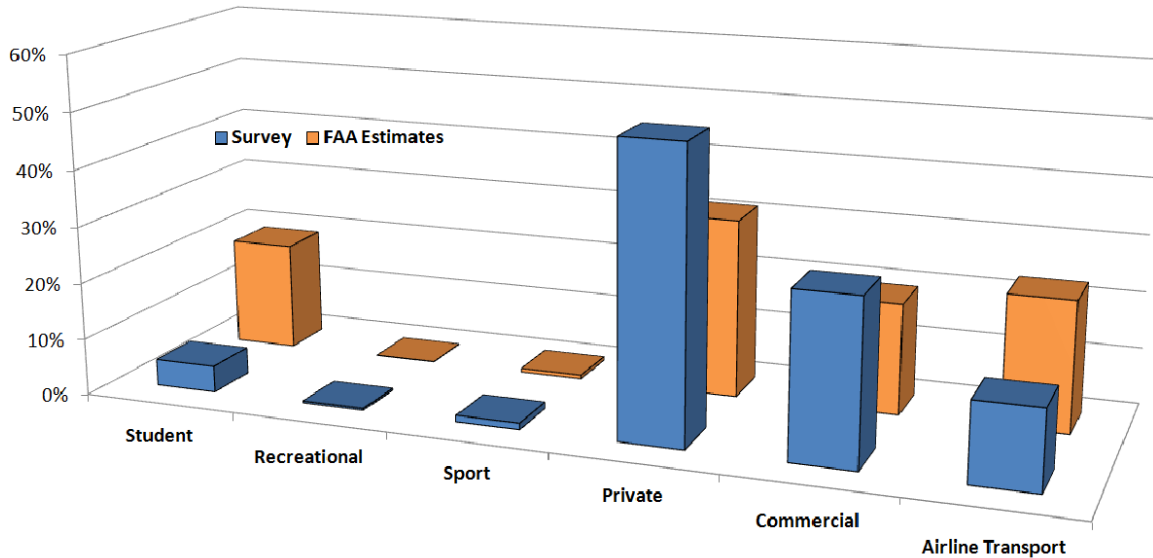


Figure 4-1: Survey Respondents' Certification vs. FAA Active Airmen Certification Estimates

It is also noted that 20% of survey respondents indicated that they are flight instructors, a percent not too far off from the 16% of active airmen categorized as flight instructors by FAA estimates.

4.5.2 Age

The average age of the respondents was 56.6 years old. Figure 4-2 shows the relative frequency of age groups in 5 year bins; the distribution is approximately bell curved and skewed upwards about the mean. The second distribution shown on Figure 4-2 corresponds to FAA estimates of active airmen by age group for 2011 [28]. It is clear from the comparison of the two distributions that survey respondents represent a generally older portion of the active pilot population.

This shift in the mean population age also is present when accounting for differences in pilot category. Table 4.1 shows the FAA's estimates of average age for active pilots by certification category, where pilots with multiple ratings are included under the highest rating. Along with those values are the average ages for the survey respondents by certification. Other than the average for the sport category, which is equal to the average age estimated by the FAA for the population of active pilots, the survey averages are higher than their corresponding population.

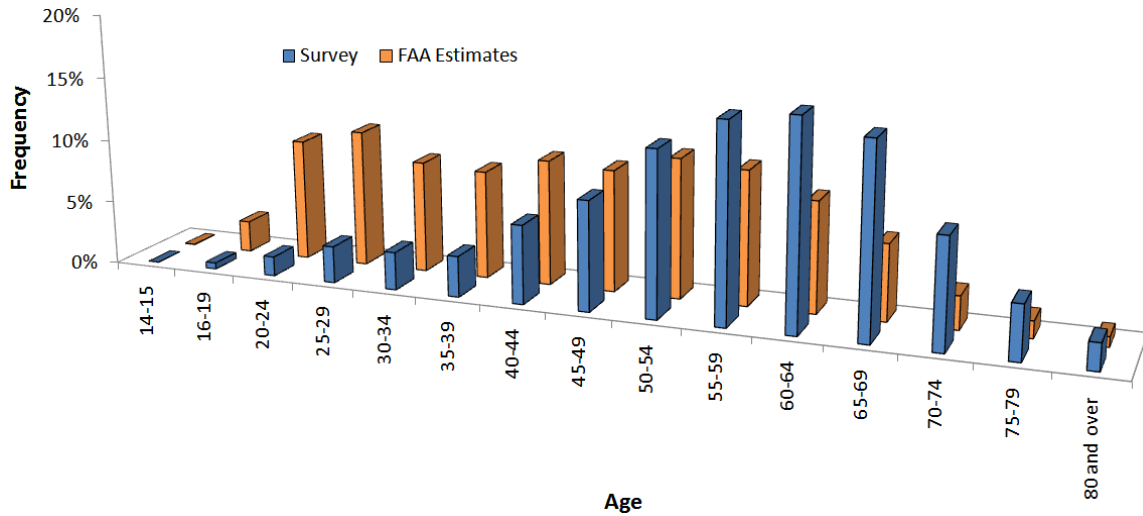


Figure 4-2: Survey Respondents' Age Distribution vs. FAA Total Active Airmen Age Distribution Estimates [28]

Table 4.1: Average Age of Active Pilots by Category

	FAA Estimate	Survey Respondents
Total	44.4	56.6
Student	31.4	48.4
Sport	54.4	54.4
Recreational	48.8	54.5
Private	47.9	56.4
Commercial	44.4	57.4
Airline Transport	49.7	57.1

It should also be noted that the survey called for participants who are either active or inactive general aviation pilots, therefore the FAA estimates in the second distribution do not exactly represent the population of interest. However, the estimates still act as a good benchmark of how well the survey respondents' age characteristics mirror those across their corresponding population, especially because a large majority of the respondents (86.6%) were active in 2011.

4.5.3 Gender

A total of 4.8% of respondents identified themselves as female. FAA estimates for 2011 place total female airmen at 6.7% of all active airmen [28], so the survey's gender distribution is not significantly skewed from the population.

4.5.4 Regions

Figure 4-3 shows the distribution of responses indicating in which states the respondents were primarily based in 2011. Significant numbers of respondents come from Texas, California, and Florida, which is expected given the sizes of the states and their levels of GA activity. Massachusetts stands out as having more respondents than expected, which possibly can be attributed to the fact that the survey originates in the Boston area and partially relied on snowball sampling.

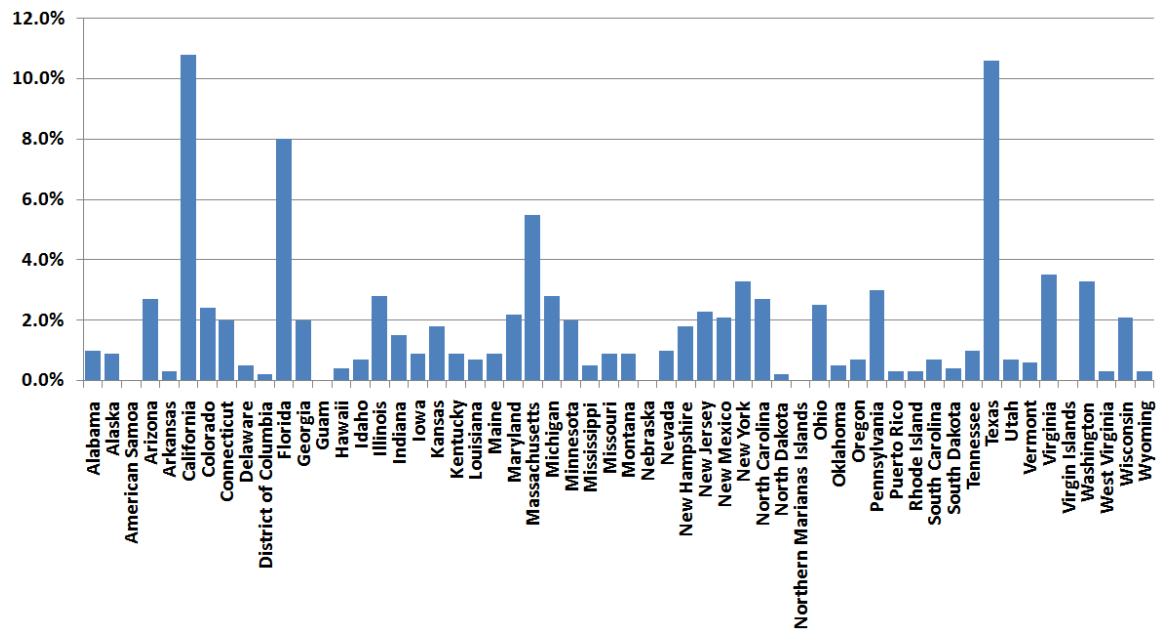


Figure 4-3: States in which Respondents were Primarily Based in 2011

In Figure 4-4, the regions in which the respondents indicated that they flew were compared to the share of towered activity in those regions. Of course, a direct comparison cannot be made between the proportion of pilots and the proportion of operations that is attributed to a given region. It should also be noted that that a given participant could chose more than one region, therefore the proportions will not sum to 100%.

Similar distributions are found when looking at the corresponding answers for peak flying activity.

4.5.5 Occupation

A total of 16.3% of respondents' answers to the question of occupation are categorized as being aviation related. Jobs falling under this category include responses such as pilot, flight instructor, air traffic controller, aircraft sales related, flight operations managers and aviation safety inspectors.

Another 63.1% of respondents occupations were categorized as currently holding non-aviation related jobs. The remaining 20.6% of respondents indicated that they

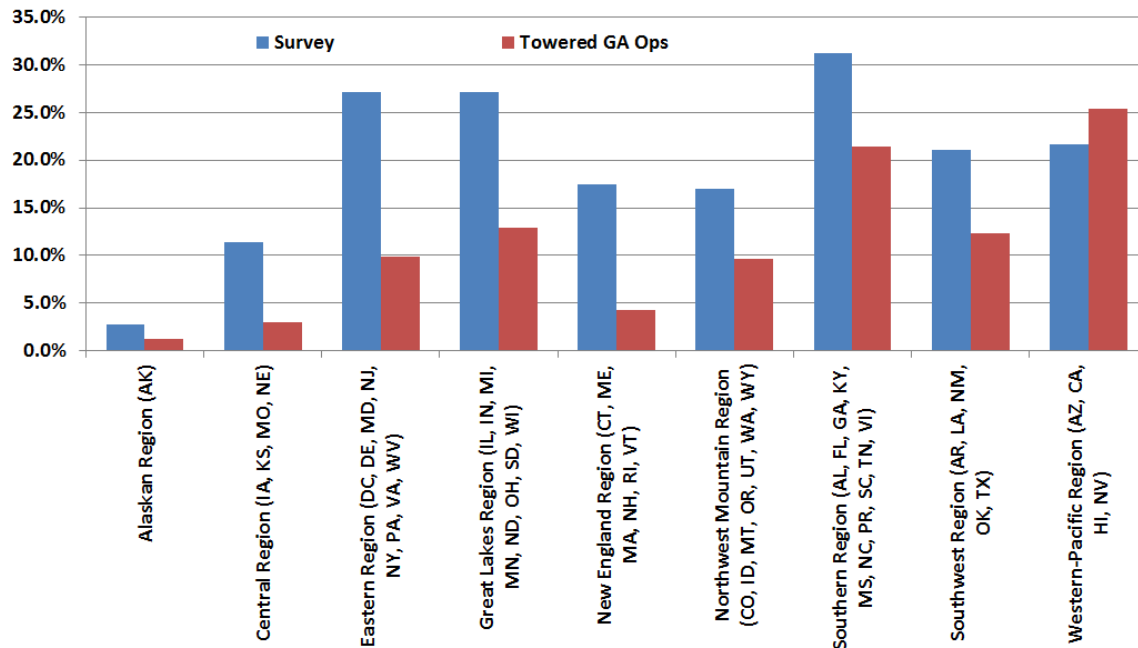


Figure 4-4: Regions in which Respondents Flew in 2011

were currently retired, a significant percentage, but not surprising given the average age.

4.6 Summary

An exploratory survey was designed to give context to the trends in general aviation outlined and discussed in Chapter 3. It was distributed online, with the help of general aviation news outlets, and was completed by 1,250 active and non active pilots involved in general aviation.

There are limitations to the sampling method used and the most significant issue assumed to be the coverage error in the responses. While it is impossible to accurately quantify the errors present in aggregating the responses to portray the population, an effort was made to compare the profile of the respondents with that of the population in order to put this error within a qualitative context. Given that the response profile did not indicate any worrisome deviations from the proportions of the population belonging to the various sub populations, the expectation is that this source of error, along with the other sources, are small enough for the responses to still be of significant interest.

In Chapter 5, the results of the survey are summarized. It is assumed that it is valid to apply these results to make general observations about general aviation in the United States, always keeping in mind the limitations of the survey. The survey can be considered an exploratory one, the results of which can give general insights and can lead to the development of more scientific surveys with statistics that can be applied to the entire population.

Chapter 5

Survey Results

The results of the survey presented in Chapter 4 are discussed in this chapter.

5.1 Flight Hours

Figure 5-1 is the distribution of total flight hours reported by the respondents. The distribution shows 58% of respondents reporting their total flight time between 500 and 2,000 hours.

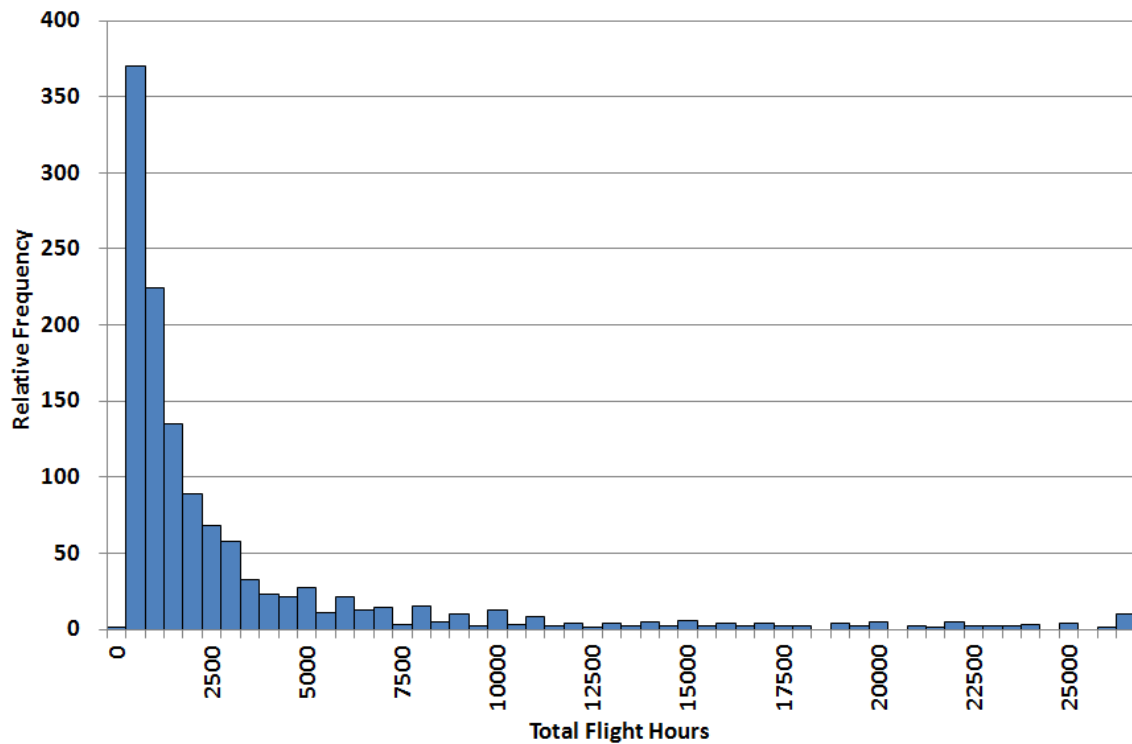


Figure 5-1: Survey Results - “What is your total flight time?”

5.2 Flying Beginnings

Figure 5-2 is the distribution of years that the respondents selected as being the year that they began flying.

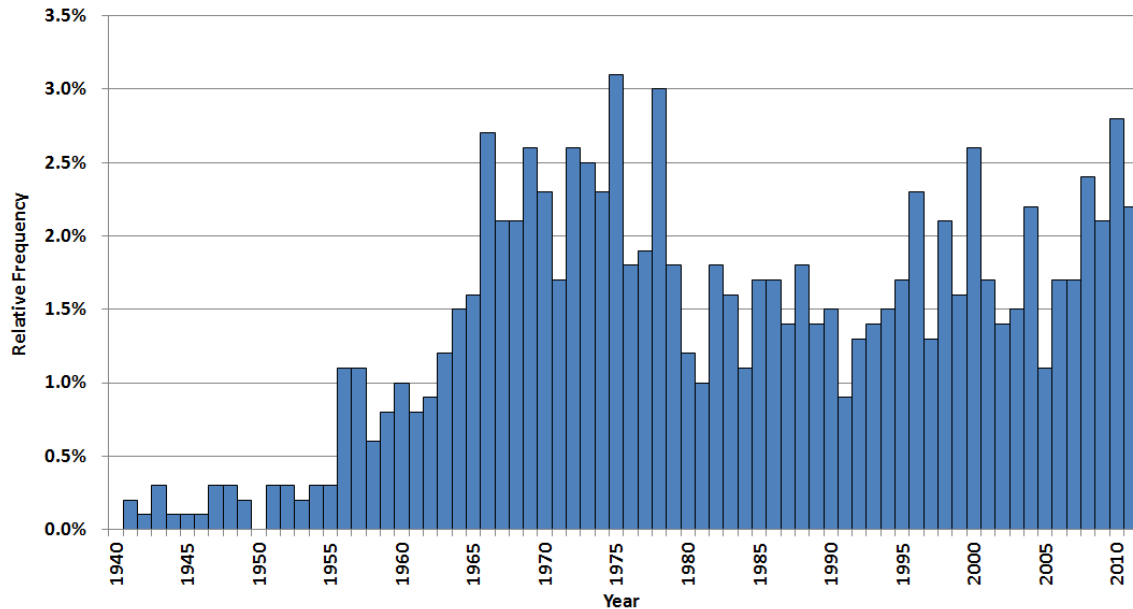


Figure 5-2: Survey Results - “When did you start flying?”

Figure 5-3 shows the percentage of respondents who selected a given reason to why they started flying. The most popular response, with 81.9% of respondents selecting it, was “I always wanted to fly.” Personal travel was the second most popular, followed by flying as a leisure activity as the third. About a quarter of respondents indicated that a career in aviation was a motivating factor in initially learning to fly. Recall from Chapter 4 that about 16% of respondents currently hold an aviation related job, indicating an approximate 10% of respondents who were attracted to aviation careers but are not employed in the aviation sector. However, this gap may be even smaller in reality, assuming that a portion of the 20% of retired respondents previously held an aviation related job.

The responses to this question on the reasons for learning to fly do not all follow the same aggregate level proportions when accounting for the year that the respondents began flying. Two of the eight reasons provided, “I always wanted to fly” and “I was in the military,” appeared to have clearly differing importance across the groups of years. Figure 5-4 shows the proportion of respondents, grouped by the year that they began flying, who chose “I always wanted to fly” as a reason they began. There is a trend downwards in the proportion of respondents who selected this motivator, and may indicate a slow shift in the allure of flying over generations. Also in the figure, are the proportions determined for “I was in the military,” which also has decreased from the 1940s onward.

The responses indicated that 27.3% of pilots had decreased levels of activity just after they initially learned to fly. The overwhelming majority of those who indicated

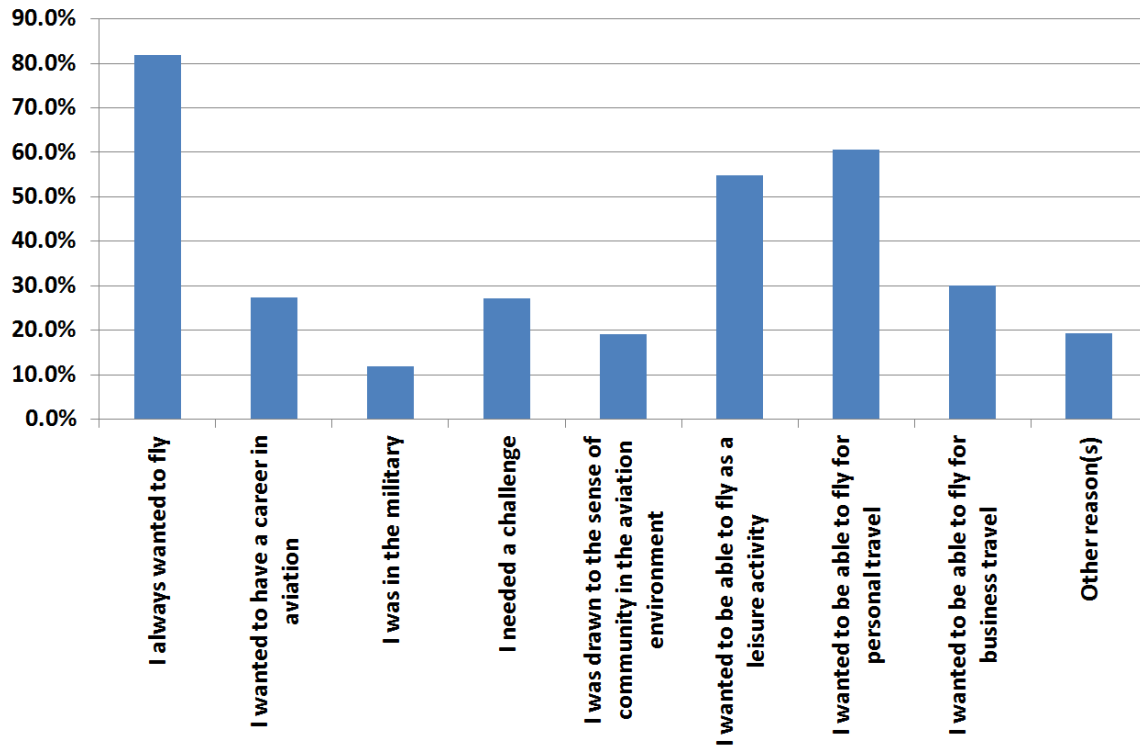


Figure 5-3: Survey Results - “There are many reasons why someone makes the decision to learn to fly. Please select all of the following that applied to you.”

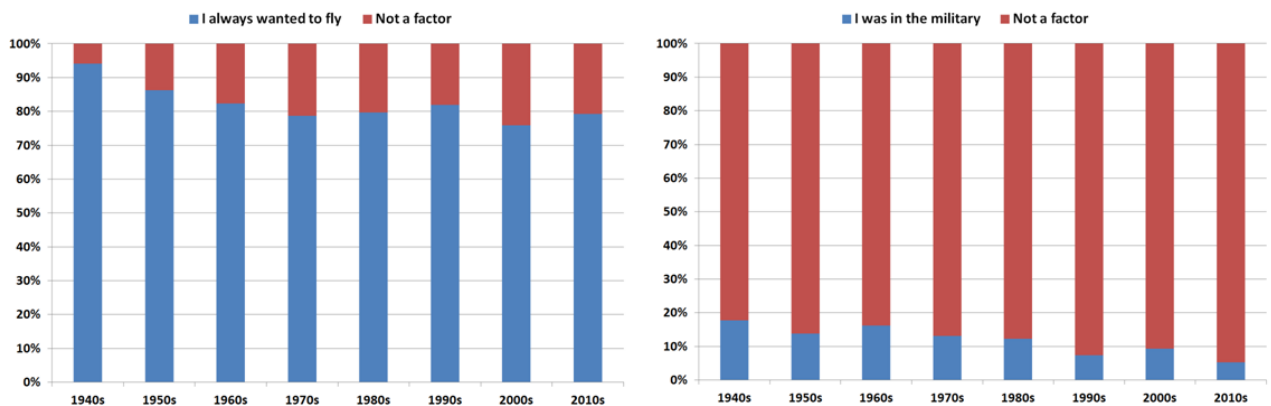


Figure 5-4: Survey Results - Reasons for respondents began flying by years they began flying

this cited cost issues and/or time constraints due to family commitments, school, or work as the reason for decline. One respondent who indicated that his flying decreased explained that “work and family obligations seem to take priority when there are no regularly scheduled lessons.” Access to an airplane was another significant issue; one that seemed to be resolved as soon as an airplane was purchased years later. In comparison, the number of respondents who cited other reasons for the decline in

activity was small and included those who either lost interest in flying or who lacked confidence in their flying abilities.

5.3 2011 Activity

5.3.1 Not Active

A total of 13.4% of the survey respondents indicated that they did not fly in 2011. There were no significant differences in the distributions of demographic characteristics between those who answered “yes” to the question “Did you fly in 2011” and the group that said “no.” For instance, the average age for those who said “no” was 58 years, while it was 56 years for those who indicated “yes”).

Those who indicated that they did not fly in 2011 were asked, “Please explain why you did not fly in 2011?” The questions were posed in a free response format and the resulting answers were categorized afterwards. Figure 5-5 shows the proportion of those who did not fly in 2011 that cited a given reason for not flying in 2011. More than half of the responses indicated that costs were a significant reason for why they did not fly; a result that echoes the hypothesis posed in Chapter 3 that increasing costs are affecting activity in recent years. A quarter of the respondents cited medical issues while lack of free time to fly and a loss of plane or access to plane were also reasons cited. A few respondents complained that over regulation and government bureaucracy have made flying more of a burden than what it is worth. A few others cited that there was no or a diminished demand for their aviation services in 2011, which may be linked to the trends relating activity decline and economic downturns shown in Chapter 3.

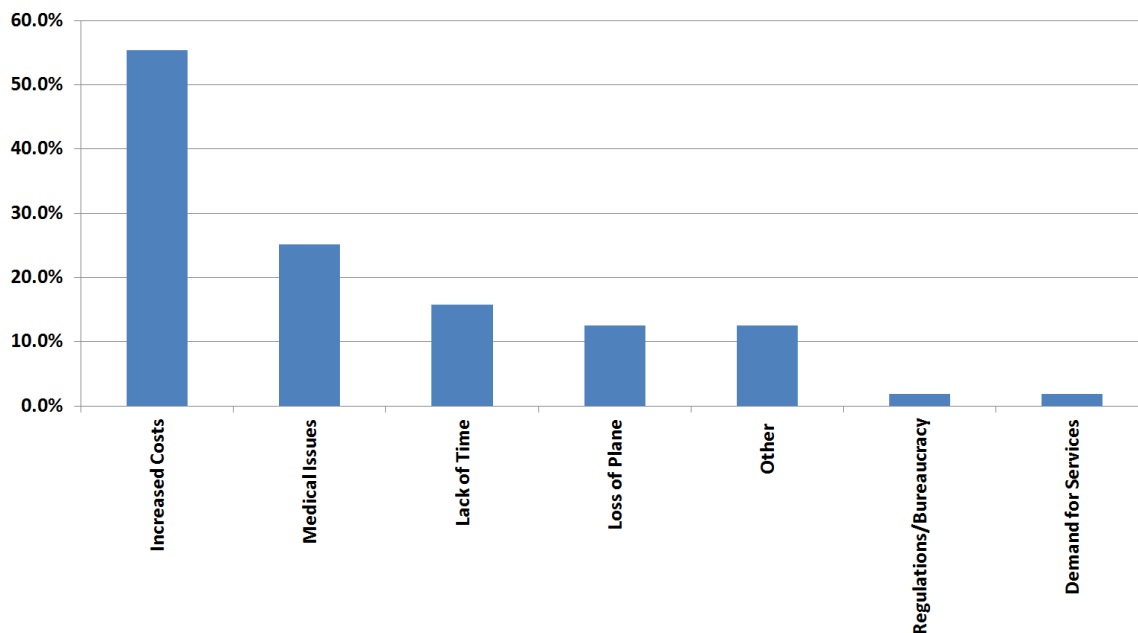


Figure 5-5: Survey Results - “Please explain why you did not fly in 2011?”

5.3.2 Active

The 86.6% of respondents who did fly in 2011 were asked to provide details about their flying activities in that year.

Figure 5-6 is a distribution of hours flown in 2011 by those who indicated that they did indeed fly in 2011. Figures 4-3 and 4-4, in Chapter 4, show location information provided by the respondents. Figure 5-7 charts the type of aircraft primarily flown, with 79% of respondents indicating that their primary aircraft was a single engine piston type.

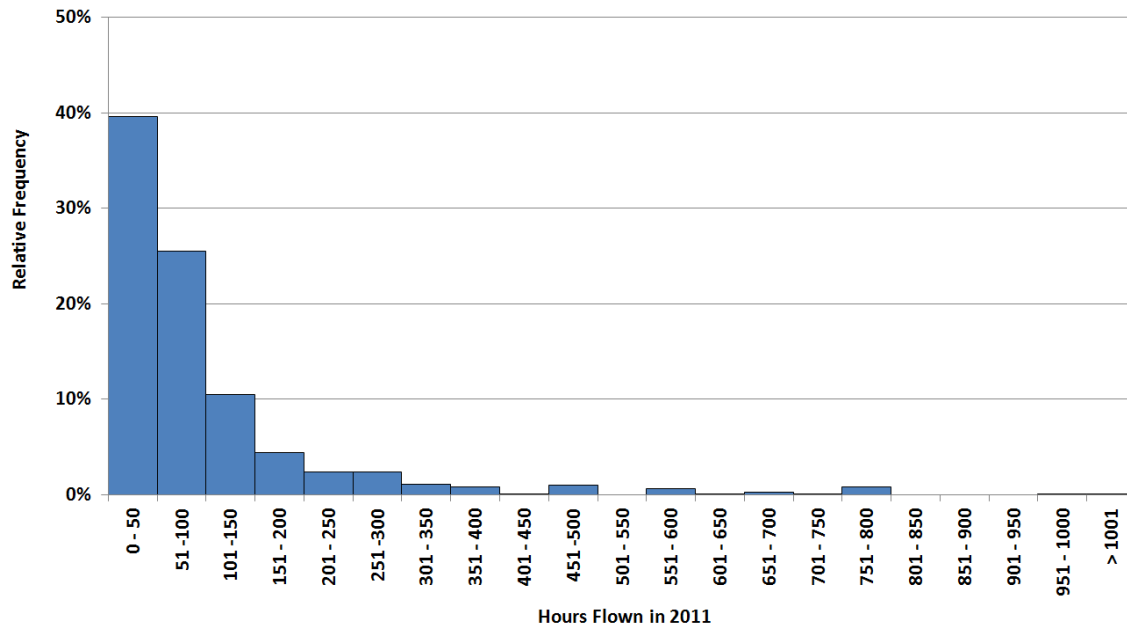


Figure 5-6: Survey Results - “Approximately, how many hours did you fly in 2011?”

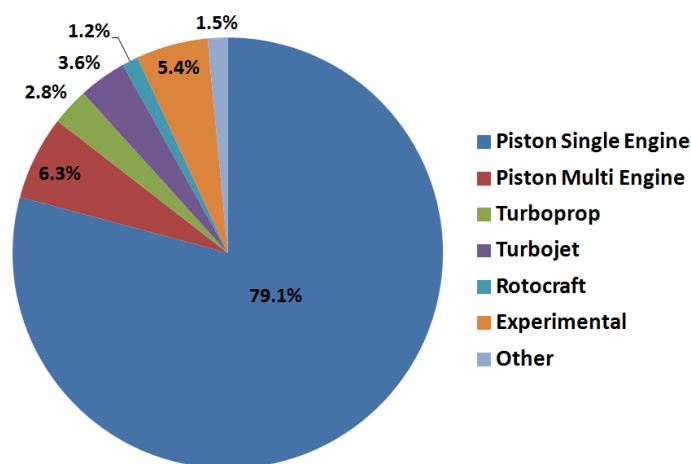


Figure 5-7: Survey Results - “What type of aircraft did you fly the most during 2011?”

5.4 Peak Activity

All of the survey participants were asked to identify the time period in which their flying activity was the highest. Figure 5-8 shows that periods of peak activity increases in frequency in the sample as the periods approach the current year. Nearly 50% of respondents indicated that they flew the most between 2005-2011. This high percentage may be a consequence of the limitations of the sampling methods used, as discussed in Chapter 4. It is plausible to assume that a disproportionate amount of pilots in the population were sampled from those pilots who are more likely to be at or around their peak of activity at the time the survey was conducted, since the survey was distributed through general aviation interest web outlets.

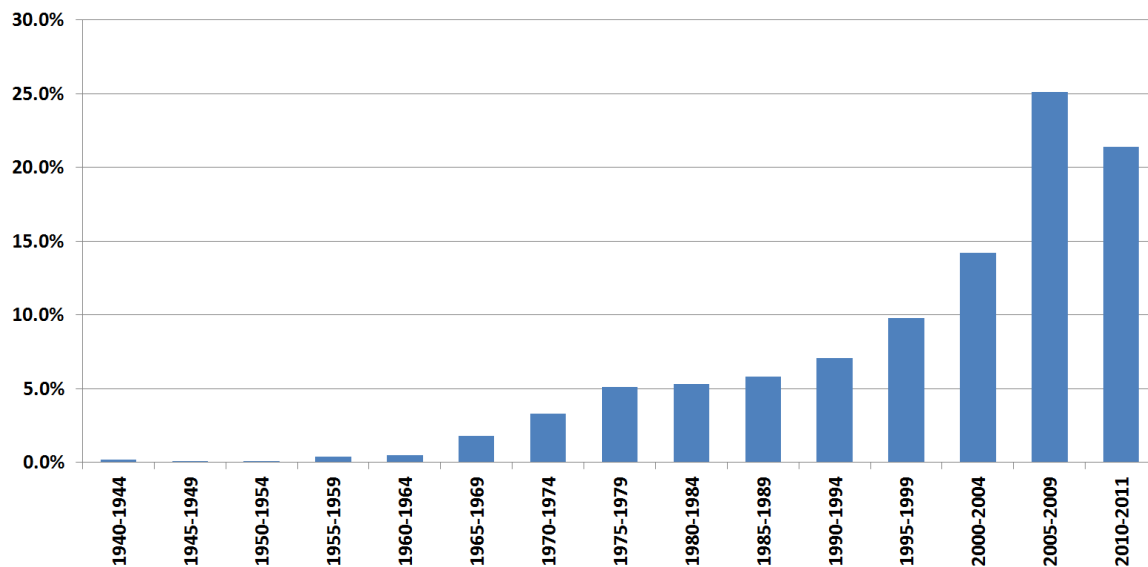


Figure 5-8: Survey Results - "During what time period was your flying activity at its highest?"

Of all the respondents, 21% of indicated that their period of peak activity was the 2010-2011 period. This group of the respondents were asked to explain why the most recent years was the period of peak activity and the responses were categorized and presented in Figure 5-9. A 45% of this group said that this period was their peak due to the fact that they are training for their private pilots license or for higher ratings. Increased career and business flying was also frequently mentioned in the explanations, however, not all of these were attributed to growth in business. Interestingly, a few of the respondents stated that their employers reduced personnel in the flight department, therefore creating more flying for themselves. New or improved access to an airplane was mentioned by 18%, most of whom bought new aircraft recently. More free time was also mentioned by just over 10% of respondents; many of them recently retired or now have adult children. An increase in disposable income was also a factor but only one respondent attributed reduced costs for his increase in activity. This pilot recently moved from Europe to United States in this period, and explained that flying in Europe was prohibitively expensive and now could afford flying when in

America. There was also some mention of an increase in personal travel, participation in a flying club, and favorable weather conditions as positive drivers of activity in this period.

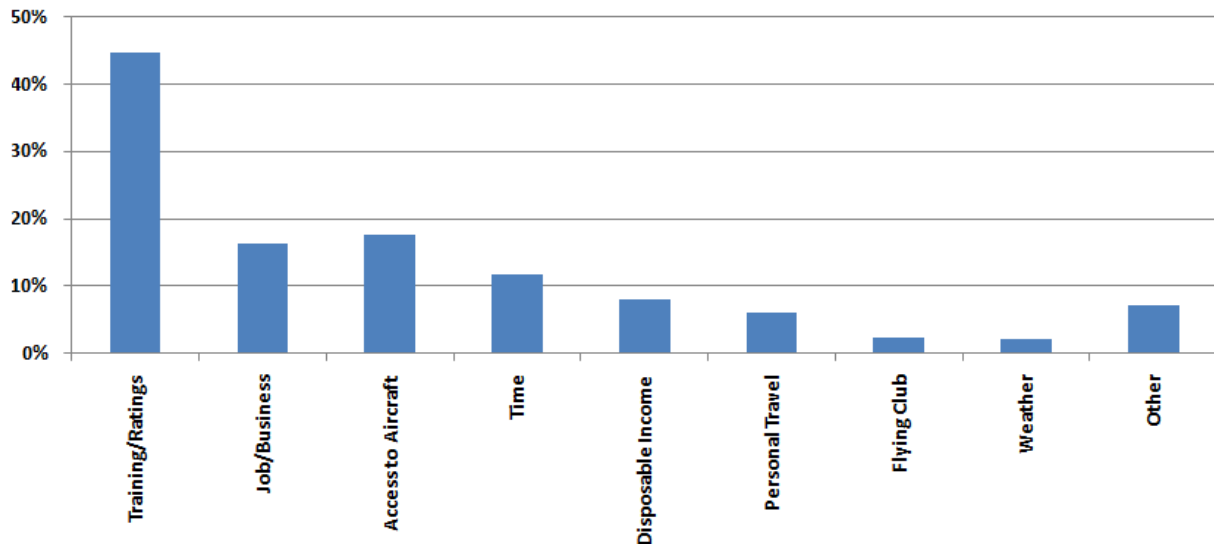


Figure 5-9: Survey Results - "Please explain why 2010-2011 was the time of your highest flying activity?"

The respondents who indicated a time period other than 2010-2011 were asked to provide details about their flying activities in their time of peak activity. Respondents gave estimates of the hours they flew in a year and the responses are aggregated in Figure 5-10. As expected the distribution shows that the flight times overall shifted higher from those in 2011 (Figure 5-6).

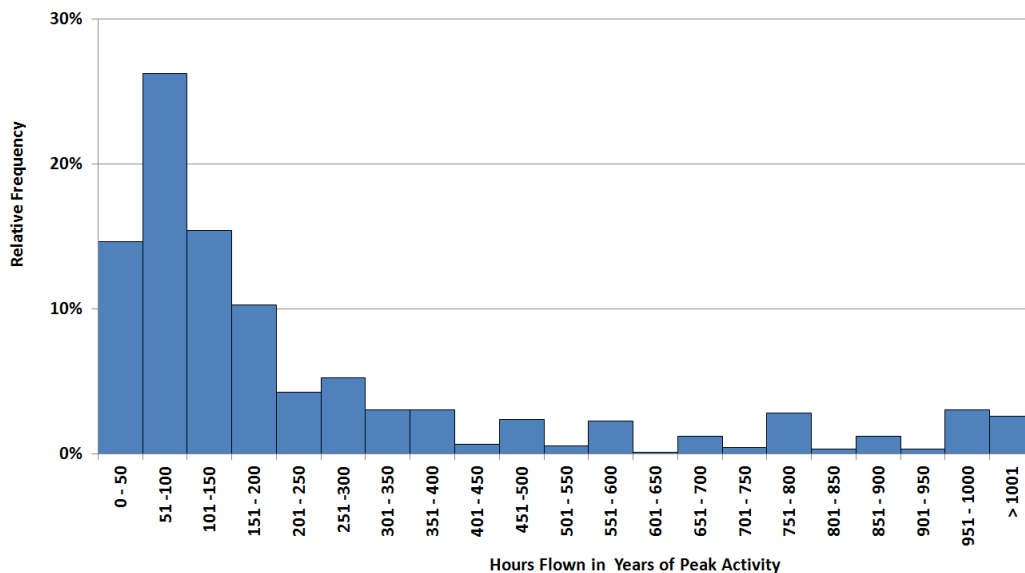


Figure 5-10: Survey Results - "Approximately, how many hours did you fly in a year during your period of peak flying activity?"

The respondents also indicated the place where they were primarily based in their peak year. From the respondents who did not indicate that their peak year was in 2011, the number of respondents who were in a given state during their peak year, but were primarily based in another state in 2011 were calculated. The results show that the biggest changes come from Florida and Texas, indicating that moving out of those states are linked to decreases in flying activity. This is not surprising given the spatial trend in operations shown in Figure 3-3. As discussed in Chapter 3, these states are in areas of higher GA activities.

There is also a shift in the primary aircraft flown in the times of peak activity which can be seen in Figure 5-11. The percentage of single engine piston aircraft decreased from 2011 by approximately 4 percentage points, because of an increase in multi engine piston and turbojet aircraft as the primary aircraft in the peak years.

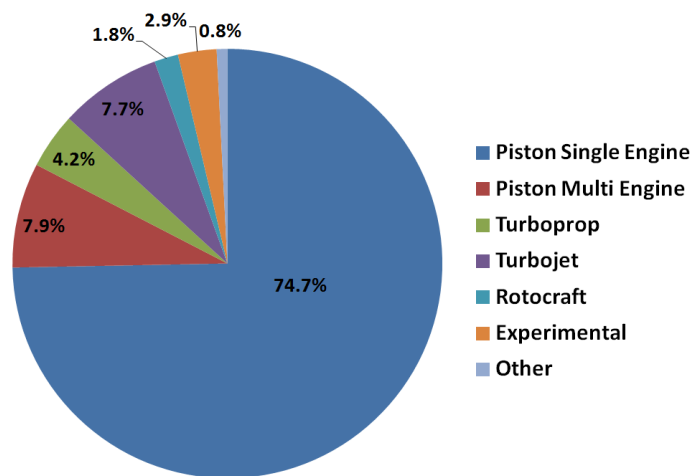


Figure 5-11: Survey Results - “What type of aircraft did you fly the most during your period of peak flying activity?”

The survey participants were also presented with 14 different potential causes for a decline in flying activity and were asked to indicate how much of a factor each was in influencing the pilot’s activity starting in their peak years to 2011. The responses are summarized in Figure 5-12 and are presented in order of how many respondent’s cited the factor as having a negative impact on their activity.

The responses indicate that change in fuel costs was the most significant driver of decline across all the respondents, with 41% of pilots stating that it had a significantly negative impact. Change in fuel costs also had the least percentage of respondents, 18%, saying that it had no effect on their flying. This result echoes the data from Chapter 3 that rising fuel costs are one of the biggest indicators of decline in aggregate activity in the country. Fuel costs proved to be the most significant factor in the decline of activity at the individual pilot’s level in this group of pilots surveyed.

More than 50% of the respondents had a decrease in their free time that negatively affected the amount of time they could fly. This is a significant find given that the relation between available time and activity can not directly identified as a factor affecting activity in the aggregate analysis of Chapter 3.

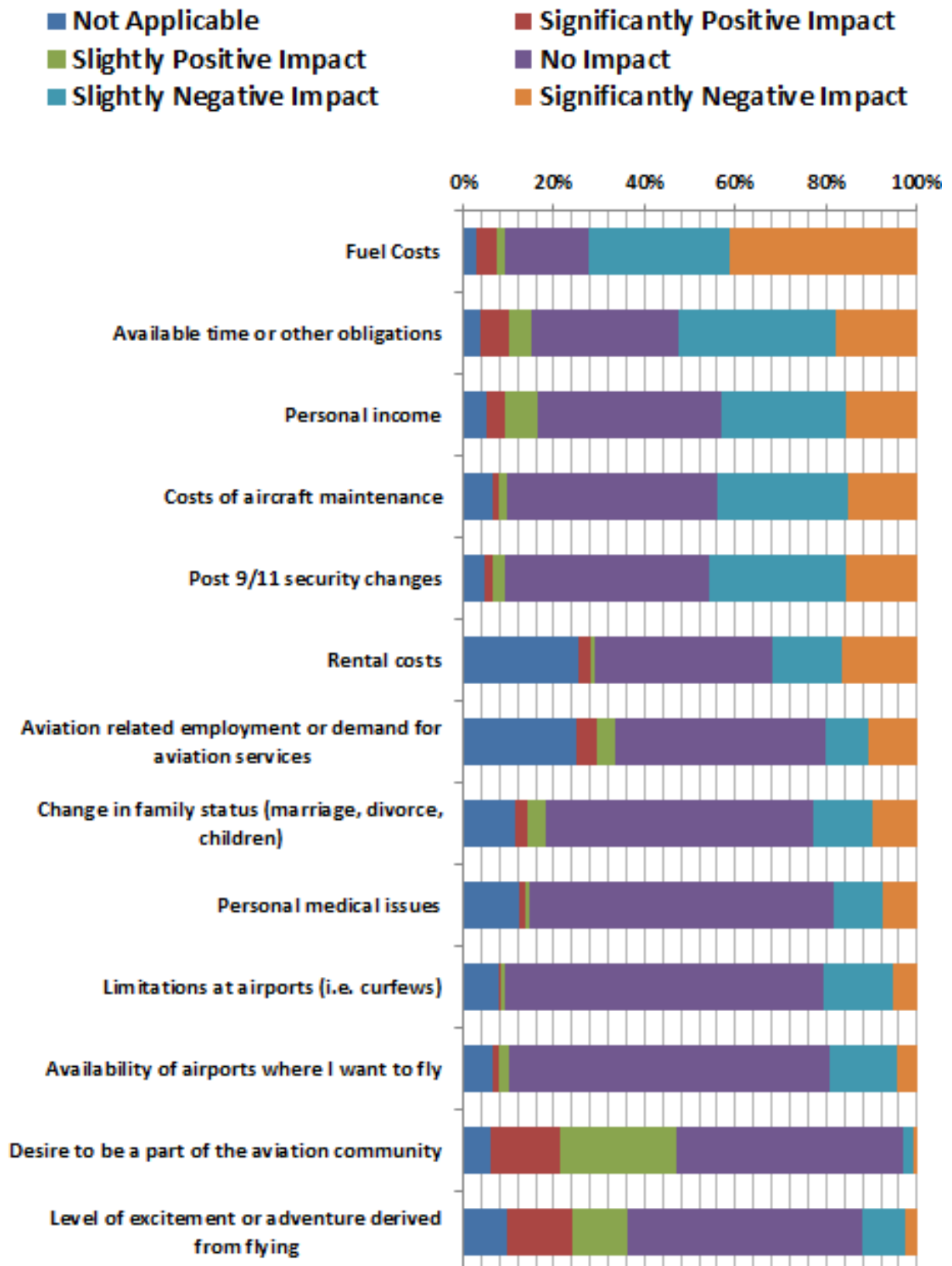


Figure 5-12: Survey Results - “What impact did the change in the following factors have on your flying between 2011 and your peak flying years?”

The costs of keeping current, personal income, costs of aircraft maintenance, again echoing the hypothesis of rising maintenance costs in part due to the aging aircraft fleet. Post-9/11 security changes were selected by approximately half the participants of having a real negative impact on their flying, indicating that a portion of the post-9/11 trend downwards in operations may be a persisting, rather than transient, force.

Medical issues, availability of airports, and limitations at airports had the least effect on the flying activities of the respondents; that is, they did not seem to be factors that influenced them in one way or another. Only a very small percentage of respondents indicated that they lost the desire to be a part of the aviation community or that a decrease in the level of excitement that they derived from flying.

5.5 Opinions

The survey respondents were also presented with a list of statements relating to different aspects of general aviation or aviation in general and were asked to indicate to what extent they agreed or disagreed with the statements. The list of statements and the percentages of respondents who indicated a given level of agreement with the statement are listed in Figure 5-13.

Four of the statements had the strongest responses. This means that in addition to most respondents being not neutral to the statement, a high percentage of those were in strong agreement with the statement. Most respondents agree that despite the length of time they have been flying, being a pilot has not lost its appeal that led them to learn to fly, the internet has made flying easier and safer, new technologies have made flying safer and more efficient, and new navigation tools have made flying easier or safer.

Two statements were clearly neutral on an average level, where the number of respondents who agreed or strongly agree were approximately equal to those who disagreed or strongly disagreed. The respondents were equally split on whether flying is a good career choice and on whether aircraft ballistic parachutes have made flying easier.

However the availability of fuel at airports was only an issue for 18% of respondents, and only a significant issue for 4%. Similarly, the impact of the internet as a technology decreasing the need to fly was only an issue for 7% percent of the respondents.

Only 2% of respondents strongly disagreed with the notion that their flying activity decreases in times of economic recession or that their activity increases when their income increases or that increased fuel costs lead them to fly less. The majority of respondents, 59%, 66%, and 67%, respectively, agree with these statements. Again, these results echo the hypotheses posed by the data in Chapter 3 that economic recessions, increasing fuel costs, and decreases in personal income are strong barriers to activity.

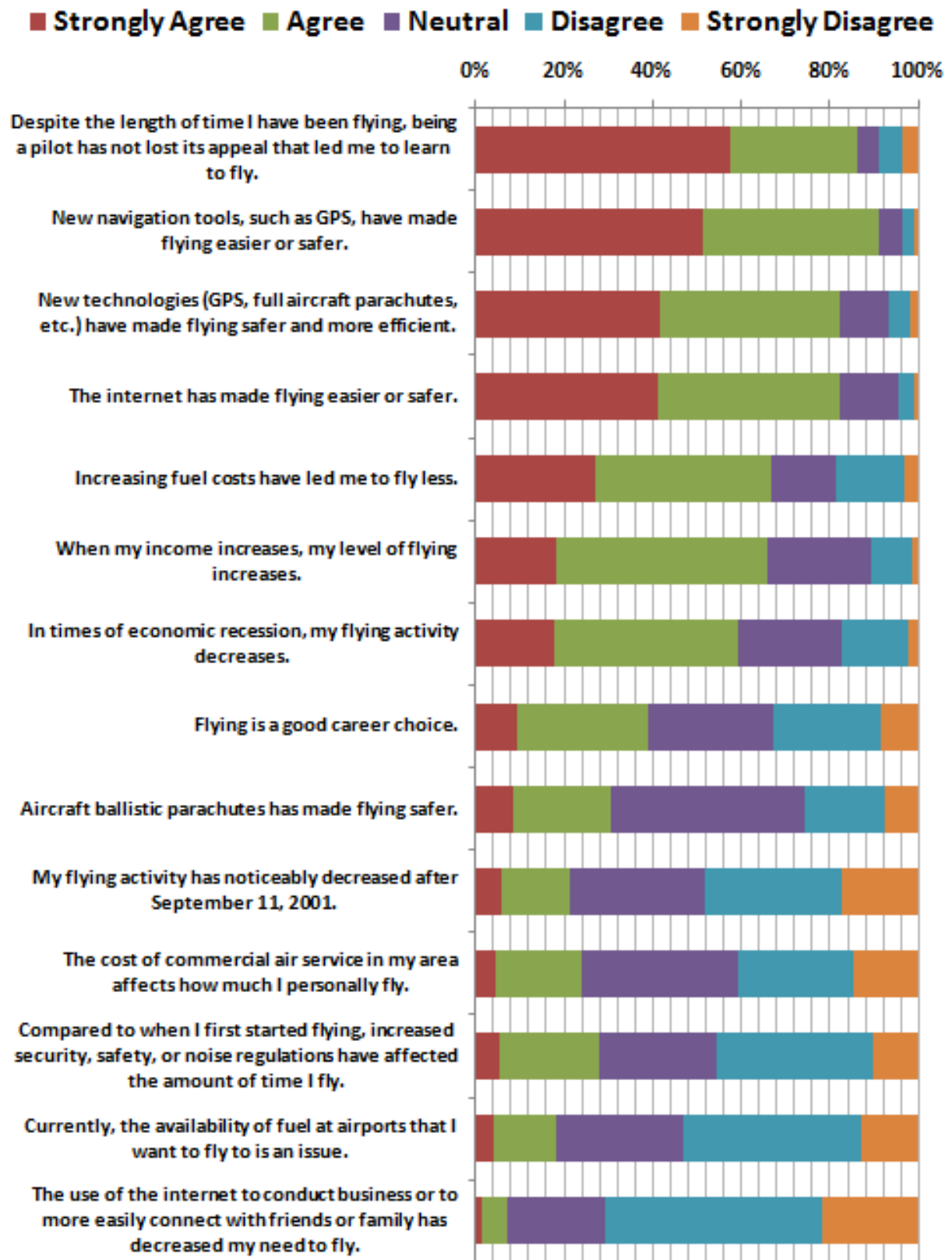


Figure 5-13: Survey Results - "To what extent do you agree or disagree with the following statements?"

5.6 Future Outlook

5.6.1 Levels of Activity

The survey participants were asked to indicate how their levels of flying activity would change in the near future and the results are presented in Figure 5-14. Only a quarter of the respondents expect their activity to decrease, while about one third are expecting that their activity will stay at 2011 levels. A majority of respondents, 44%, were fairly optimistic about the immediate future and indicated that their activity would slightly increase or significantly increase.

Most of those who indicated that their activity would significantly decrease or slightly decrease explained that they would no longer be in training or do not have as much free time as they did in the previous year, with no respondents citing financial issues as a reason. Respondents who indicated that they did not expect any change in their flying activity cited either having access or owning new planes, having just obtained new licenses or ratings, or expected workload in their business or job as the reasons. Of the respondents that just obtained new licenses or ratings, half indicated that their activity will stay steady, while the other half belonged to the group that expected a slight increase in their activity. Many of those who also indicated an increase in activity wrote about how their retirement and/or having adult children allow them to have the time and financial means to fly more often.

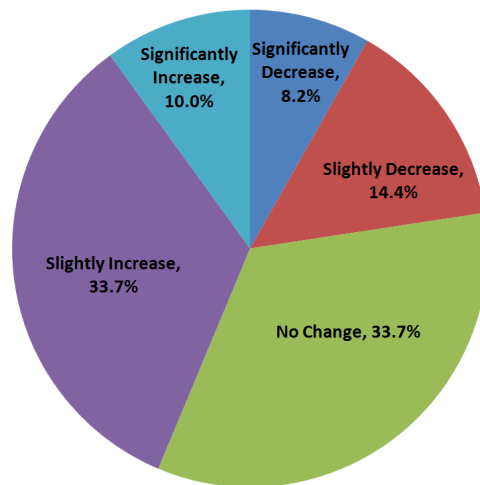


Figure 5-14: Survey Results - “How do you expect your level of flying activity to change over the next few years? ”

Figure 5-15 disaggregates the responses from Figure 5-14 and groups them by the age group of the respondents. As expected, the graph shows that as the respondents’ age increases, the frequency of those who expect their activity to increase decreases. While only 10% of those less than 30 years old expect their activity to decrease, more than twice that percentage of 50-70 year olds expect declines in their activity and 39% of those over 70 expect a decline. Concurrently, the frequency of those who

expect their activity to stay relatively constant increases with age. This result, along with the increasing average of the pilot population seen in Figure 3-7, does not give indication of a positive future impact on the growth of operations in the country.

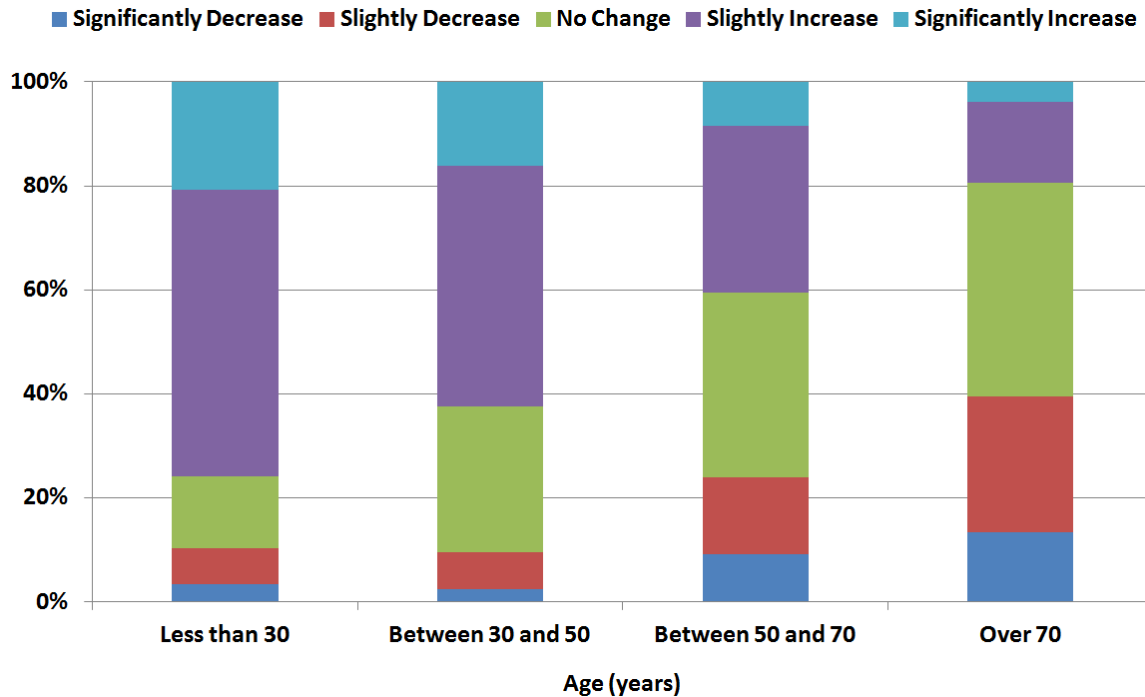


Figure 5-15: Survey Results - “How do you expect your level of flying activity to change over the next few years? ”

5.6.2 Fuel

Fuel price has proved to be an important driver found in both the aggregate trends and in the responses of the survey participants. Due to its importance, survey participants were asked to identify a price of fuel that would result in a significant decrease in their flying activity. About 20% responded that they did not know and another 13% said that changes in fuel prices would not affect their flying. The cumulative distribution of fuel prices for the remaining 68% is shown in Figure 5-16, where the bar corresponding to a fuel price indicates the proportion of respondents who chose that fuel price or lower as their tipping point. About 50% indicated that \$7.00 would hamper their activity and the majority, a 90%, would significantly reduce flying if fuel rose to \$10.00.

5.6.3 Activity Stimuli

The respondents were asked “What factors would stimulate an increase in your flying activity?” The responses contained references to a large number of issues relating

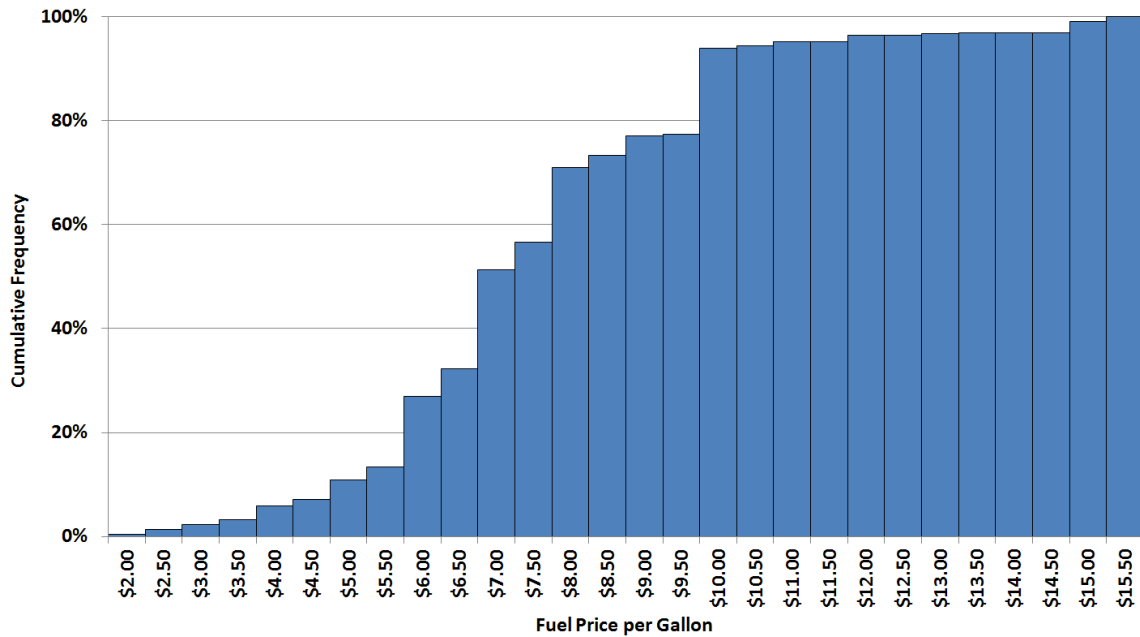


Figure 5-16: Survey Results - “Is your flying activity dependent on fuel costs? At what fuel price (per gallon) would your flying activity significantly decrease or stop completely?”

to general aviation, but there were some common themes that were echoed in many responses.

The most referenced factor across all responses was fuel cost, which was mentioned in 31% of the total responses. reduced operating costs in a general sense was cited in 22% of responses. Another 11% of respondents did not mention reduced fuel costs or costs in general, but implicated that an increase in disposable income would stimulate their activity. In addition to these major factors, 4% of respondents talked about job-related issues, another 4% mentioned an increase in business, and another 3% simply said, “better economy.”

A related theme in the responses is access to or ownership of aircraft. A total of 5% of the respondents said that owning their own, new aircraft, which would be made possible by lower prices, would lead them to fly more. Another 6% of respondents alternatively wished for more easily available planes, through rentals or clubs. A few respondents said specifically that they would like access to light sport aircraft. Many of those who wanted more access to the rentals were also in the 4% of those who stated that lower rental costs would help stimulate their flying activity.

Many respondents, about 11%, indicated that less restrictive regulations would stimulate their activity. Many complained about the Transportation Safety Administration (TSA), Temporary Flight Restrictions(TFR), access to airspace, and about government over regulation in general. Others, a 4% of the respondents, specifically wished for changes in the current medical regulations, many of whom wanted to relax or eliminate the 3rd class medical requirements for the operation of specific types of aircraft, including light sport aircraft.

Safety and technology was another topic discussed, where 4% of respondents wished for new technologies to become available, or more readily available to them, in aircraft. Technologies that were mentioned included more fuel efficient engines, aircraft not dependent on 100LL, improved and simplified instrumentation, and aircraft with glass cockpits and parachutes.

Other significant issues were not related to costs or regulations. Of the all the respondents, 11% said that their activity will increase if they had more available free time. Another 6% stated that if they had more friends or family to fly with, or if there was a greater community interest in flying, they would fly more.

Other factors that were mentioned included better weather, better ground transportation at destination airports, more ratings, more air shows or fly-ins, better fuel availability at airports, better information about TFRs on the internet, increases in commercial flying ticket prices, and new challenges.

A percentage of respondents, 4%, said that no changes would lead to an increase in their activity.

5.6.4 Current Challenges

At the end of the survey, the participants were given the opportunity to share what they believe are the biggest challenges facing the general aviation community. Many of the responses echoed what was already discussed in the previous question on what would stimulate their flying activity, but with a greater focus on costs, fuel, regulations, public perceptions, and the declining pilot population.

More than half of the respondents, 52%, noted high costs as one of the biggest challenges to general aviation in the future. Many mentioned that flying, especially in the recreational sense, is becoming prohibitively expensive. One respondent answered the open ended question with:

“Costs. Period. Nothing recreational is as expensive or as regulatory. I have owned and own both sailboats, powerboats and an airplane and the airplane is far and away the more expensive hobby.”

The second most mentioned issue facing general aviation involved regulations. 34% of respondents responded with concern about government regulations in general aviation. Responses included references to the TSA, complicated, changing or outdated rules, and increasing number of TFRs. One pilot responded that there are “too many people/organizations making the process overly complicated.” He went on to explain how this can hinder the recreational pilot:

“When I learned to fly it was like a boat on a lake – free to roam. I enjoy the precision of flying but only if it is for work – it’s not a job for amateurs or novices anymore.”

The public’s interest or perception of general aviation was an issue for 18% of respondents. These respondents believed that the general public most often has wrong impressions of what general aviation is, what purpose it serves, and who is involved.

A respondent stated that, “public perception of general aviation flying as being for reckless adventurers with more money than sense, and that they are subsidizing the activity.”

Often coupled with the concern about costs, regulations, and public perception was mention of the declining pilot population, as seen in Figure 3-4. 22% of respondents mentioned that lower levels of new interest in general aviation along with poor student retention rates are threatening the future of general aviation in America. One respondent noted that “most new pilots think the cost to learn to fly and continue flying has shifted out of the range of normal middle income people.” Another posited that as the pilot population declines, in part due to increasing costs, the economies of scale in all aspects of cost in general aviation will diminish and will push costs up even more, creating a crippling positive feedback loop.

Impending federal air traffic service user fees are of concern to 11% of the survey participants, while 7% are concerned about finding a replacement for 100LL fuel, and 5% worry about the increasing numbers of smaller airports closing.

Other issues included references to medical requirements, safety issues, aging general aviation fleets, and outdated aircraft technologies.

Chapter 6

Conclusion

General aviation is an important component of aviation in the United States. In 2011, general aviation and air taxi operations represented 63% of all towered operations in the United States, while commercial aviation was responsible for 34% of those operations. It is clear that GA is a considerable component of the national airspace and airport system, even when only towered operations are considered. Because of this significant presence, insight into GA is relevant to issues in air traffic management, air transportation infrastructure, and aviation safety, among others. Beyond the operational aspect, general aviation is of significance to society as a whole and to other stakeholders, including pilots groups, aircraft manufacturers, and the work force. All of these groups are interested in what drives general aviation activity in order to help support the activity or to forecast its future.

Forecasting general aviation activity has proved to be an imperfect science. An example of how general aviation forecasting has been less accurate than its commercial counterpart can be seen in the comparison of the results of the 2006 TAF with the realized levels of activity. This forecast was a positive one, and indeed, all of the forecasts of general aviation have remained positive for the past decade, even in the face of continually declining activity throughout that time period. The apparent difficulties of forecasting general aviation activity give rise to the need for a better understanding of the factors that affect this activity in the country. Greater understanding can also benefit general aviation stakeholders by identifying what hinders and what promotes the activity across the country.

Looking at past levels in general aviation operations in the context of other related trends and historical events has shed light on what drives GA activity. General aviation in terms of towered activity reached its peak by the late 1970s, supported by strong production rates of general aviation aircraft. However, aging aircraft, liability issues causing drops in production rates, and increasingly volatile fuel costs stalled the activity significantly in the early stages. Activity slowly grew back, again approaching peak levels until war, natural disasters, and economic downturn resulted in a decline in the early 1990s. The recovery from this decline followed for five years until another economic downturn in the 2000s stopped the growth and they activity began its continual decline, compounded by the effects of 9/11 terrorist attacks, rising fuel prices, and world wide economic recession at the end of the decade. Throughout this

time, general aviation continued to suffer from aging fleets and declining numbers in the pilot population.

An exploratory survey of 1,250 general aviation pilots was conducted as a way to give context to these trends and to help shed light as to what factors affect an individual pilot's flying activity. As also seen in the historical trends, fuel costs and costs in general have had a major influence on the activity levels of those surveyed. The results of the survey echoed what the trends implied - economic recessions and fuel costs are major factors that impede the growth of activity. An interesting result of the survey that was not clearly evident in the data indicated that available free time has also been a major factor in affecting activity levels.

Another goal of the survey was to gain perspective on the future of general aviation. When asked what would help stimulate their activity in the future, pilots wished for less cumbersome regulations, better access to aircraft through rentals or flying clubs, and an overall decrease in costs. In the responses of the surveyed pilots, increasing costs, increased regulation, lack of public understanding of the role of general aviation, and the declining pilot population stand out as the biggest challenges that general aviation faces.

Appendix A

Survey of Active and Inactive General Aviation Pilots on Factors Influencing Flight Activity

The following pages show the survey questions as they appeared to the respondents online. There is a skip logic built into the online survey so that depending on the responses of particular questions, the survey taker will proceed to or skip certain pages of the survey. This logic is summarized in Figure A-1 which describes the flow of the survey. The survey is divided into different pages that cover different sets of questions and different participants will see different pages of the survey depending on the answers to specific questions. The page labels in Figure A-1 are representative of the types of questions asked on that page.

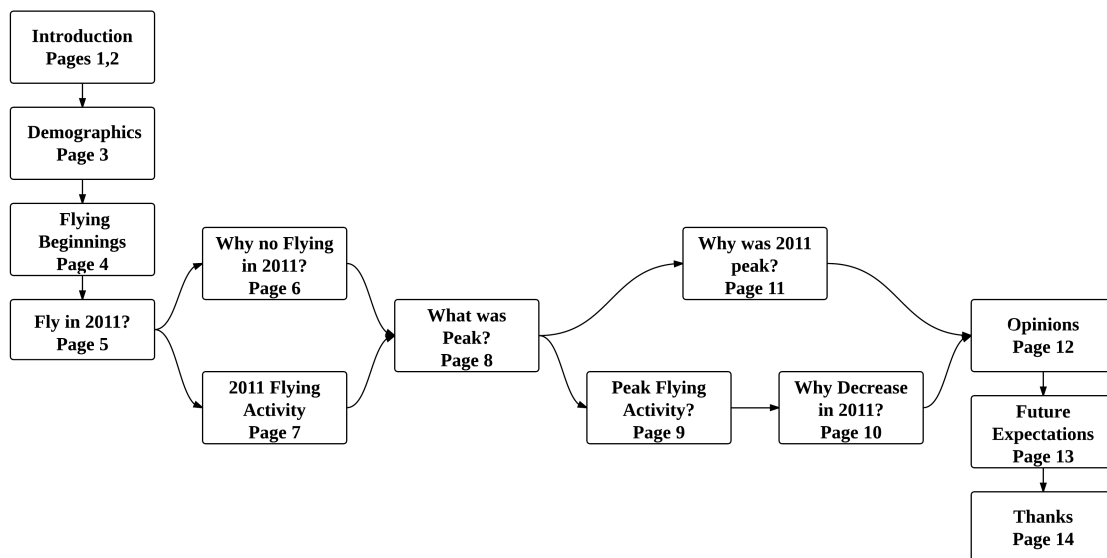
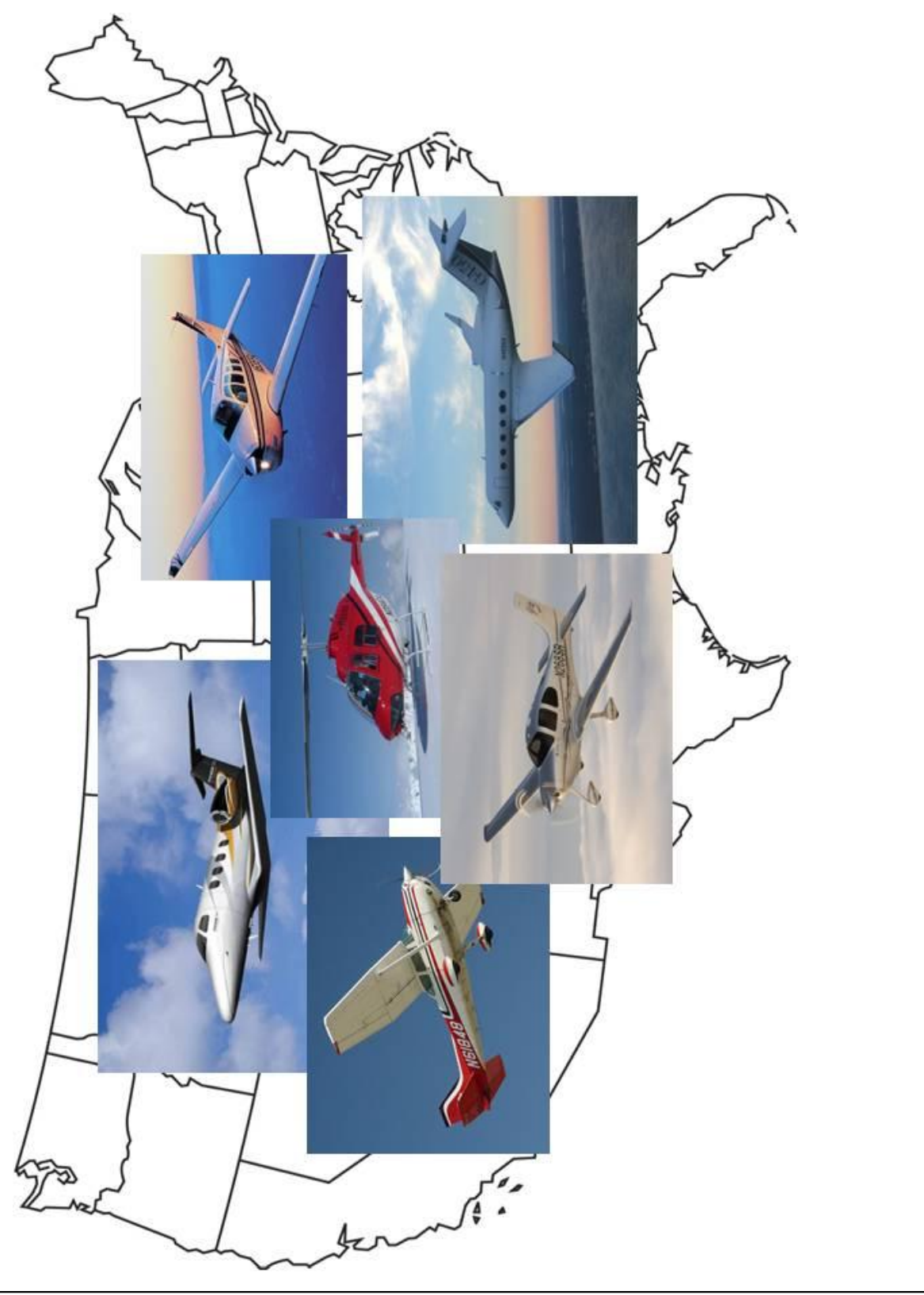


Figure A-1: Survey Flow



We are looking for active and inactive general aviation pilots to participate in a short survey.

The International Center for Air Transportation at the Massachusetts Institute of Technology is conducting a study of general aviation trends. The goal of this study is to gain a better understanding of the factors that drive general aviation activity in the United States. This includes identifying any challenges facing the growth of general aviation and its role in the greater aviation community as well as identifying what may promote activity in the future.

We are interested in collecting the experiences and opinions of pilots like you that are active or have been active in general aviation. General aviation is now faced with many challenges and your participation and invaluable insight will further the understanding of these issues and ultimately shed more light on what can be done to support your community.

- PARTICIPATION AND WITHDRAWAL

Your participation in this study is completely voluntary and you are free to choose whether to be in it or not. If you choose to be in this study, you may subsequently withdraw from it at any time without penalty or consequences of any kind.

- CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be directly or indirectly identified with you will remain confidential.

The results of the survey will not be linked to you or your IP address. Any demographic information and information about your pilot certification that is collected is for research purposes only and will not be used to identify you.

- CONTACT

If you have any questions or concerns about the survey, please feel free to contact Kamala Shetty at kshetty@mit.edu or Prof. R. John Hansman at rjans@mit.edu.

Please select all options below that best describe your certification and ratings

	Airplane Single Engine Land	Airplane Single Engine Sea	Airplane Multi Engine Land	Airplane Multi Engine Sea	Rotocraft Helicopter	Other	Airplane Instrument	Rotocraft Instrument
Student	☐	☐	☐	☐	☐	☐	☐	☐
Recreational	☐	☐	☐	☐	☐	☐	☐	☐
Sport	☐	☐	☐	☐	☐	☐	☐	☐
Private	☐	☐	☐	☐	☐	☐	☐	☐
Commercial	☐	☐	☐	☐	☐	☐	☐	☐
Airline Transport	☐	☐	☐	☐	☐	☐	☐	☐
Instructor	☐	☐	☐	☐	☐	☐	☐	☐

What is your total flight time?

Hours:

What is your age?

Years:

What is your gender?

☐ Male
☐ Female

What is your occupation?

When did you start flying?

After you learned to fly, did your activity increase or decrease and why?

There are many reasons why someone makes the decision to learn to fly. Please select all of the following that applied to you.

- ☐ I always wanted to fly
- ☐ I wanted to have a career in aviation
- ☐ I was in the military
- ☐ I needed a challenge
- ☐ I was drawn to the sense of community in the aviation environment
- ☐ I wanted to be able to fly as a leisure activity
- ☐ I wanted to be able to fly for personal travel
- ☐ I wanted to be able to fly for business travel

☐ Other reason(s)

Did you fly in 2011?

☐ Yes

☐ No

Please explain why you did not fly in 2011?

Approximately, how many hours did you fly in 2011?

Hours:

In which state were you primarily based in 2011?

In which regions did you normally fly? (Choose all that apply)

- ☐ Alaskan Region (AK)
- ☐ Central Region (IA, KS, MO, NE)
- ☐ Eastern Region (DC, DE, MD, NJ, NY, PA, VA, WV)
- ☐ Great Lakes Region (IL, IN, MI, MN, ND, OH, SD, WI)
- ☐ New England Region (CT, ME, MA, NH, RI, VT)
- ☐ Northwest Mountain Region (CO, ID, MT, OR, UT, WA, WY)
- ☐ Southern Region (AL, FL, GA, KY, MS, NC, PR, SC, TN, VI)
- ☐ Southwest Region (AR, LA, NM, OK, TX)
- ☐ Western-Pacific Region (AZ, CA, HI, NV)

What type of aircraft did you fly the most during 2011?

- ☐ Piston Single Engine
- ☐ Piston Multi Engine
- ☐ Turboprop
- ☐ Turbojet
- ☐ Rotocraft
- ☐ Experimental
- ☐ Other

During what time period was your flying activity at its highest?

Approximately, how many hours did you fly in a year during your period of peak flying activity?

Hours:

In which state were you primarily based during your period of peak flying activity?

In which regions did you normally fly during your period of peak flying activity? (Choose all that apply)

- ☐ Alaskan Region (AK)
- ☐ Central Region (IA, KS, MO, NE)
- ☐ Eastern Region (DC, DE, MD, NJ, NY, PA, VA, WV)
- ☐ Great Lakes Region (IL, IN, MI, MN, ND, OH, SD, WI)
- ☐ New England Region (CT, ME, MA, NH, RI, VT)
- ☐ Northwest Mountain Region (CO, ID, MT, OR, UT, WA, WY)
- ☐ Southern Region (AL, FL, GA, KY, MS, NC, PR, SC, TN, VI)
- ☐ Southwest Region (AR, LA, NM, OK, TX)
- ☐ Western-Pacific Region (AZ, CA, HI, NV)

What type of aircraft did you fly the most during your period of peak flying activity?

- ☐ Piston Single Engine
- ☐ Piston Multi Engine
- ☐ Turboprop
- ☐ Turbojet
- ☐ Rotocraft
- ☐ Experimental
- ☐ Other

Why did your flying activity decrease from your peak years to 2011?

What impact did the change in the following factors have on your flying between 2011 and your peak flying years?

	Significantly Negative Impact	Slightly Negative Impact	No Impact	Slightly Positive Impact	Significantly Positive Impact	Not Applicable
Fuel Costs	☐	☐	☐	☐	☐	☐
Cost of keeping current	☐	☐	☐	☐	☐	☐
Personal medical issues	☐	☐	☐	☐	☐	☐
Personal income	☐	☐	☐	☐	☐	☐
Rental costs	☐	☐	☐	☐	☐	☐
Aviation related employment or demand for aviation services	☐	☐	☐	☐	☐	☐
Level of excitement or adventure derived from flying	☐	☐	☐	☐	☐	☐
.						
Desire to be a part of the aviation community	☐	☐	☐	☐	☐	☐
Available time or other obligations	☐	☐	☐	☐	☐	☐
Change in family status (marriage, divorce, children)	☐	☐	☐	☐	☐	☐
Costs of aircraft maintenance	☐	☐	☐	☐	☐	☐
Post 9/11 security changes	☐	☐	☐	☐	☐	☐
Limitations at airports (i.e. curfews)	☐	☐	☐	☐	☐	☐
Availability of airports where I want to fly	☐	☐	☐	☐	☐	☐

Please explain why 2010-2011 was the time of your highest flying activity?



To what extent do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Flying is a good career choice.	☐	☐	☐	☐	☐
In times of economic recession, my flying activity decreases.	☐	☐	☐	☐	☐
When my income increases, my level of flying increases.	☐	☐	☐	☐	☐
My flying activity has noticeably decreased after September 11, 2001.	☐	☐	☐	☐	☐
The cost of commercial air service in my area affects how much I personally fly.	☐	☐	☐	☐	☐
Despite the length of time I have been flying, being a pilot has not lost its appeal that led me to learn to fly.	☐	☐	☐	☐	☐
The internet has made flying easier or safer.	☐	☐	☐	☐	☐
.					
The use of the internet to conduct business or to more easily connect with friends or family has decreased my need to fly.	☐	☐	☐	☐	☐
Compared to when I first started flying, increased security, safety, or noise regulations have affected the amount of time I fly.	☐	☐	☐	☐	☐
Increasing fuel costs have led me to fly less.	☐	☐	☐	☐	☐
New technologies (GPS, full aircraft parachutes, etc.) have made flying safer and more efficient.	☐	☐	☐	☐	☐
New navigation tools, such as GPS, have made flying easier or safer.	☐	☐	☐	☐	☐
Aircraft ballistic parachutes has made flying safer.	☐	☐	☐	☐	☐
Currently, the availability of fuel at airports that I want to fly to is an issue.	☐	☐	☐	☐	☐

How do you expect your level of flying activity to change over the next few years?

- ☐ Significantly Decrease
- ☐ Slightly Decrease
- ☐ No Change
- ☐ Slightly Increase
- ☐ Significantly Increase

Please explain why you believe the amount you fly will change (or not change)?

Is your flying activity dependent on fuel costs? At what fuel price (per gallon) would your flying activity significantly decrease or stop completely?

Comments

What factors would stimulate an increase in your flying activity?

What do you think are the biggest challenges facing the general aviation community?

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