4 Aviation Trends and Issues

Recent trends, both national and statewide, are important considerations in the development of an aviation system plan, as these trends can influence the supply and demand for aviation services. Fluctuating trends regarding aviation usage and economic swings resulting from the nation's business cycle and previous periods of record high oil prices have all impacted aviation demand. Many of these national trends are reflected within Kentucky, along with aviation developments that are unique to the state.

This chapter examines trends relating to general aviation, air cargo, multimodal issues, and technology that are expected to have an influence on aviation in Kentucky. Note that this chapter is based on the best available data as of the first quarter of 2016.

General Aviation Trends

There are a number of components that can be examined to gain an understanding of general aviation (GA) trends. Key among these are the number and type of new GA aircraft entering the fleet, the number of active GA aircraft, and the number of pilots flying in the U.S. The following sections examine each of these aspects of GA, starting with new GA aircraft produced by year since 1975. The analysis of new aircraft provides an overview of how GA has performed over the long term, while the assessment of active GA aircraft and pilots focuses on the trends since 2010.

In addition to these activity trends, this chapter will also summarize what is being done to address lead in aviation fuel, and how that could impact GA activity.

New General Aviation Aircraft

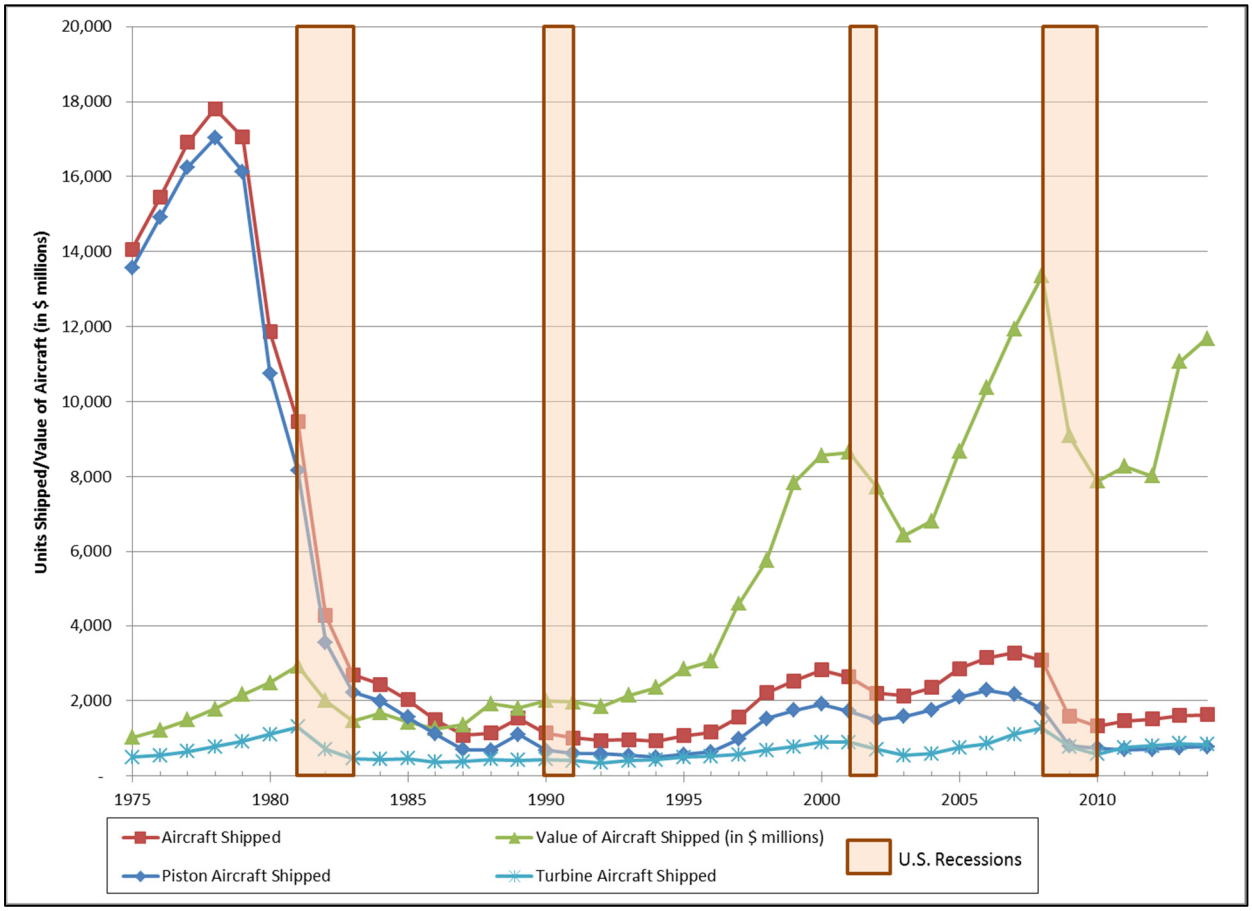
One indicator of the how the GA industry is performing is the number of aircraft delivered per year and their total value. **Figure 4-1** shows this data starting in 1975. As with any industry, GA is subject to the ups and downs of the business cycle. However, GA is an industry that is among the first to suffer the effects of an economic downturn and the last to recover from it. This can clearly be seen in Figure 4-1, where aircraft shipments can be seen tailing off before each major U.S. recession and not recovering until well after the recession ends.

The number of aircraft sold was dominated by piston aircraft from 1975 until the early 1980s, when increasing product liability costs resulted in a contraction of the manufacturing of these aircraft. A prime example of this manufacturing retrenchment is Cessna Aircraft Company, which ceased production of all its single-engine piston aircraft in 1986, primarily due to liability concerns. By the mid-1990s, deliveries of single-engine piston aircraft had fallen from its 1978 peak by 97 percent, and was now on par with the number of turbine aircraft shipped.

In 1994, legislation went into effect that shielded GA manufacturers from lawsuits on aircraft and aviation parts that were more than 18 years old. With this protection in place, GA shipments of both piston and turbine GA aircraft began a slow but steady rise, with piston aircraft growth outpacing turbine aircraft. This lasted until the tech bubble burst in early 2001, followed by the terrorist attacks of September 11th. GA manufacturing recovered briefly, but then was hit by the recession precipitated by the housing collapse that started in December 2007.

The sale of turbine aircraft has followed a pattern similar to that of piston aircraft only at smaller volumes, mirroring the rise and fall of the business cycle. Beginning in the mid-1990s, the number of jet aircraft sold began exceeding the number of turboprop aircraft sold, resulting in a significant rise in the value of aircraft sold. The increased use of business aviation, especially the growth of fractional ownership through companies such as NetJets and Flight Options, has helped spur the growth in turbine aircraft sales.

Figure 4-1
U.S. Aircraft Shipped and Sold



Source: 2014 General Aviation Statistical Databook & 2015 Industry Outlook.

It is clear that the number of aircraft shipped annually has not recovered to the levels seen prior to the 2008 recession. The slow recovery from the recent recession is a major factor driving recent trends in GA, as the following sections will also demonstrate.

Active General Aviation Aircraft

The number of new aircraft entering the fleet is only a partial indicator of the health of the GA industry. The level of activity of existing aircraft also provides a sign of how the industry is performing. The FAA tracks the number of active aircraft annually, which is defined as an aircraft that is registered and flew for at least one hour during the year. The FAA records the data using the following nine categories of general aviation aircraft.

- **Single-Engine Piston** – These are fixed-wing aircraft powered by a single piston engine.
- **Multi-Engine Piston** – These are fixed-wing aircraft, generally powered by two, but sometimes more, piston engines.
- **Turboprop** – These are fixed-wing aircraft powered by one or more turbine engines that drive one or more propellers.
- **Turbojet** – These are fixed-wing aircraft powered by one or more jet engines.
- **Piston Rotorcraft** – These are single-engine rotorcraft, either helicopters or gyroplanes, that are powered by a piston engine.
- **Turbine Rotorcraft** – These are rotorcraft, either helicopters or gyroplanes, that are powered by one or more turbine engines.
- **Experimental** – Generally, these aircraft, sometimes called kit-built aircraft, are aircraft that the original owner built from kits supplied by a manufacturer.
- **Sport** – These are single-engine piston-powered aircraft that meet the requirements of the Light Sport Aircraft regulation. They are limited in a number of areas, including weight and number of seats.
- **Other** – This category of aircraft captures an assortment of flying machines that do not fit into the other categories. This includes aircraft such as gliders, airships, and balloons.

As shown in **Figure 4-2**, the total number of active aircraft in the U.S. has declined since 2010 by approximately 20,000 aircraft, or about 9 percent of the GA fleet. The piston fleet is largely responsible for driving this decline. Both single- and multi-engine piston aircraft declined during this period, with single-engine piston aircraft accounting for the loss of more than 14,000 aircraft, or about 10 percent of the single-engine piston fleet. Piston rotorcraft also fell by about 10 percent over the period.

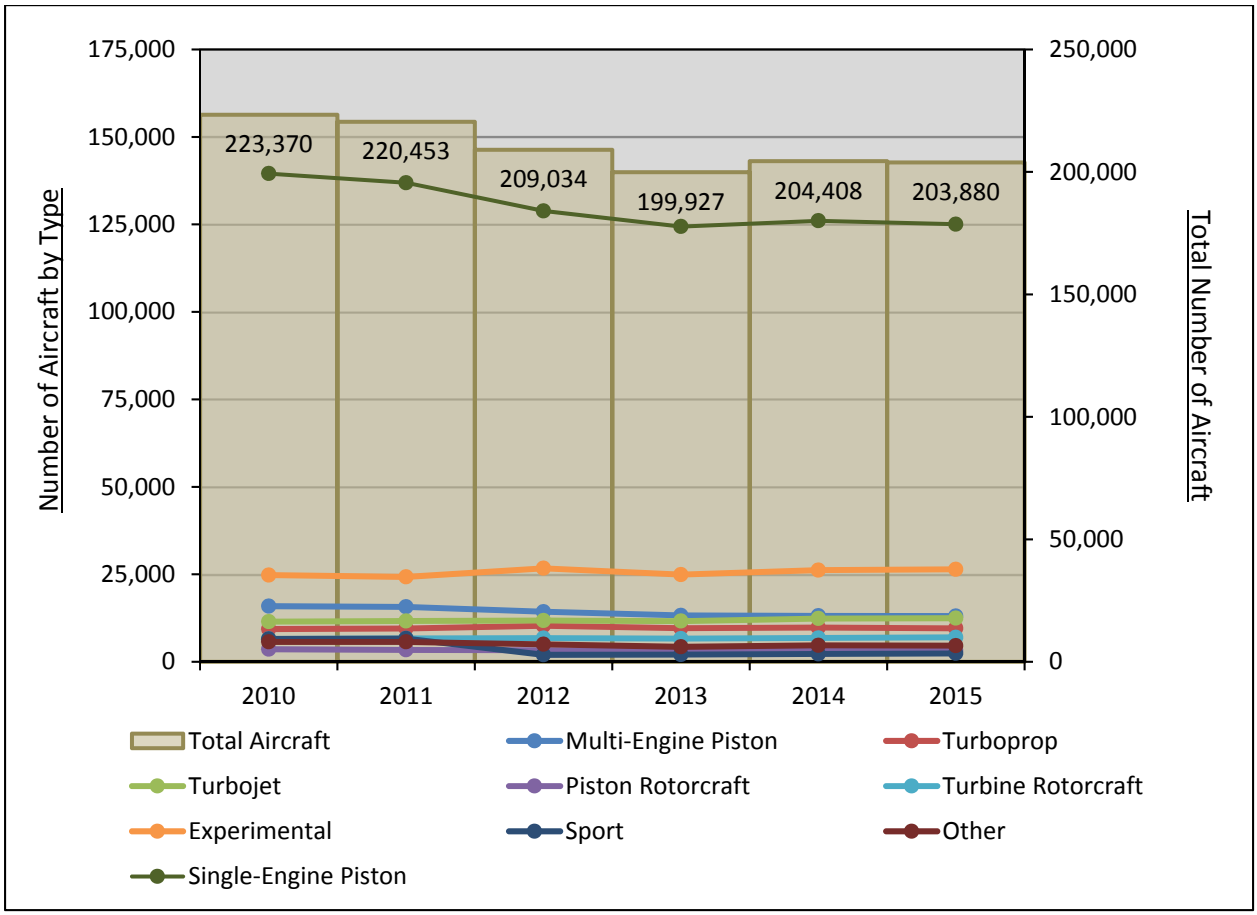
In terms of absolute numbers, the homebuilt market contributed the largest increase by adding more than 1,600 aircraft since 2010, which is a 7 percent increase. All turbine-powered aircraft exhibited growth since 2010, with turbojets leading the way with 9 percent growth, followed by turbine rotorcraft at 7 percent growth. Turboprops increased by a modest 2 percent during the period. This growth in turbine aircraft activity is additional evidence of the increasing use of business aircraft, which rely heavily on turbine aircraft.

One adjustment that is obvious in Figure 4-2 is a change in the classification of experimental light sport aircraft. Prior to 2012, these aircraft were grouped under the sport category. Starting in 2012, they were switched to the experimental category, as reflected in the jump that experimental aircraft experienced in 2012 and the drop that sport aircraft show in 2012.

There are a number of factors behind the decline in active aircraft. As discussed previously, the number of new aircraft produced is significantly below levels seen prior to the last recession, so the injection of new aircraft to the GA fleet is relatively low and has contributed to the decline in aircraft activity.

These trends are reflected in based aircraft in Kentucky. From 2005 to 2015, based aircraft at Kentucky's airports have dropped from 1,976 to 1,693, an average annual rate of decline of 1.7 percent.[1]

Figure 4-2
U.S. Active Aircraft, 2010 to 2015



Note: Classification of Experimental Light Sport Aircraft changed from Sport Aircraft to Experimental in 2012.
Source: FAA Aerospace Forecast FY 2016-2036.

Pilot Population

The pilot population is a prime driver of GA activity. Without pilots, planes cannot fly and demand for associated aviation services, found at many GA airports, suffers. Pilot certificates fall into one of eight classifications by the FAA:

- **Student Pilot** – Pilots in training. Student pilots may fly aircraft solo when properly authorized by a flight instructor. Unlike other pilot certificates, student pilot certificates expire 60 months after they are issued for those under 40 and 24 months after they are issued for those over 40.
- **Recreational Pilot** – Certified to fly aircraft with up to 180 horsepower and four seats, but may only carry one passenger.
- **Sport Pilot** – Certified to fly light sport aircraft. Limited to two seats and day-time flying only.
- **Private Pilot** – Certified to fly aircraft, as long as it is not for compensation or hire.

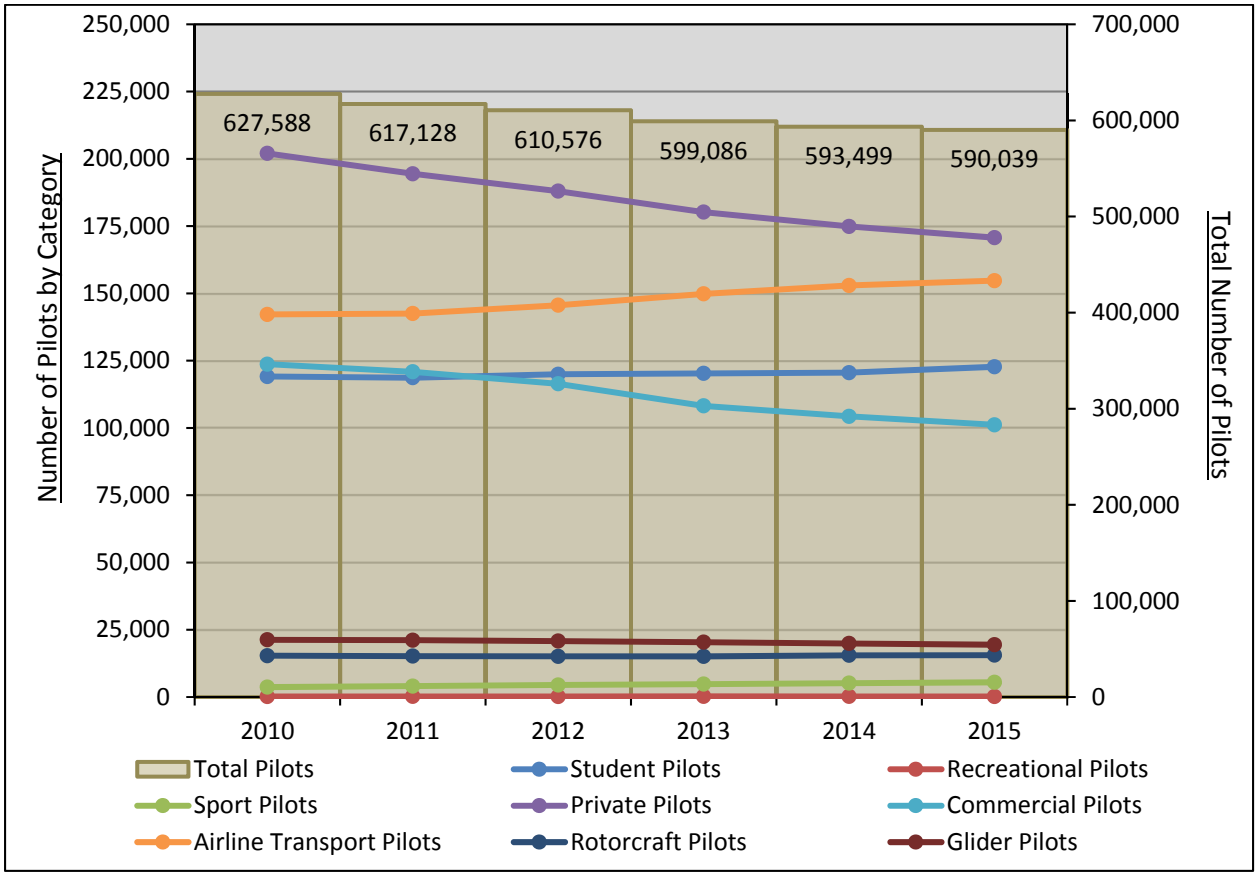
[1] Based aircraft reported by the FAA's Terminal Area Forecast for years 2005 and 2015.

- **Commercial Pilot** – Certified to fly for compensation or hire. Required to have 250 hours of flight time.
- **Airline Transport Pilot** – Certification required to fly as pilot in command or first officer for a scheduled airline. Required to have 1,500 hours of flight time.
- **Rotorcraft Pilot** – Pilots certified to fly helicopters and gyrocopters. This category includes those people that are certified to fly only rotorcraft. Pilots that are certified to fly both fixed wing and rotorcraft are included in the appropriate previously mentioned categories.
- **Glider Pilot** – Pilots certified to fly gliders and sailplanes. This category includes those people that are certified to fly only gliders. Pilots that are certified to fly aircraft in addition to gliders are included in the appropriate previously mentioned categories.

Figure 4-3 shows that the total number of pilots in the U.S. has fallen by nearly 38,000 since 2010, despite the obvious growth in airline transport pilots during that period. The loss of private and commercial pilots are the primary factors contributing to the decline in the overall pilot population.

The drop in commercial pilots, along with the increase in airline transport pilots, is partly explained by Congressional action that increased the minimum qualifications required for first officers. The Airline Safety and Federal Aviation Administration Extension Act of 2010 stipulated that after August 2013, only airline transport pilots could serve as flight crew members for scheduled airline flights (part 121). Prior to this legislation, first officers only needed to possess a commercial pilot certificate.

Figure 4-3
U.S. Pilot Trends, 2010 to 2015



Source: FAA Aerospace Forecast FY 2016-2036.

The relative growth in sport pilots, rising nearly 50 percent since 2010, has little impact on the overall pilot population because of the total number of sport pilots is not significant when compared to the number of private and commercial pilots. The same is true for rotorcraft pilots, which increased by slightly more than 1 percent during the period. Likewise, the small number of recreational and glider pilots meant that their declines of 10 percent and 9 percent, respectively, had little impact on the overall pilot numbers. One bright spot since 2010 is the rise in student pilot numbers, which increased by 3 percent since 2010. Since student pilots are stepping stones to higher pilot ratings, growth in student pilots offers the promise of future growth in other pilot ratings.

An obvious factor in the downward trend of pilots is the cost associated with becoming a pilot. Both in relative and absolute terms, the cost of flight training has increased over the years. In absolute terms, the cost of flight training has risen along with the price of training aircraft, fuel, insurance, and other expenses of flying. In relative terms, the cost of flying has risen as less expensive alternatives have become more readily available, as noted in a study by Harry R. Clements of the Wichita State University Department of Economics.

This study showed that GA activity decreases as commercial airline travel has become less expensive and become more accessible. Since the deregulation of the airline industry in 1978, the study showed that a 10 percent increase in airline travel drove down GA travel by 3 percent, indicating that one is being substituted for the other. The study also showed that increasing airspace regulation has resulted in higher GA training costs, which serve to discourage entry into the GA industry.

Finally, the study found that GA activity decreases when other competing forms of entertainment (that tend to be less expensive) increase, such as skydiving. Clements speculated that motorcycling, scuba diving, mountain climbing, and auto racing offer alternatives to flying and have stimulated the decline in the private pilot population.

Taken together, all of these factors serve as barriers to entry to GA, and are contributing factors to the decline in the private pilot population.

Pilot population trends within Kentucky mirror many of those seen at the national level. One exception is Kentucky's growth in student pilots, supported in part by the aviation program at Eastern Kentucky University, which is described in more detail in Chapter 5: Unique Aspects of Aviation in Kentucky. This growth in student pilots has helped mitigate the decline of the total pilot population in Kentucky.

Future of Avgas

Aviation gasoline, or avgas, is the primary aviation fuel used by piston-powered aircraft. It is notable for being the only remaining transportation fuel still containing lead, which is used to protect against engine detonation, also known as knocking. It is generally acknowledged that avgas will not be available in the future, for a number of reasons. For starters, the only western manufacturer of the lead additive is Innospec, a U.S. specialty chemical company that could choose to cease production for liability, financial, or other reasons. Another factor is pressure from environmentalists, who want to eliminate the use of leaded fuel. They are lobbying the U.S. Environmental Protection Agency (EPA) to eliminate the use of lead in avgas through regulation.

In light of these factors, the general aviation industry is collaborating with the FAA to develop a replacement for avgas. However, the technical and regulatory requirements, as well as the process of approval, have proven to be time consuming, with experts in 2012 estimating that a replacement fuel would not be available commercially until 2023.

Efforts to find a replacement for avgas involve extensive research by fuel companies and collaboration between aviation stakeholders – such as aircraft manufacturers, fuel refiners, and aviation associations – and the FAA and EPA. A key component of this collaboration takes the form of the Piston Aviation Fuels Initiative (PAFI), an industry-government initiative started in 2013. PAFI is working toward developing a viable unleaded aviation fuel by 2018. At the end of March 2016, the PAFI process selected two fuels out of 17 submitted in the first phase of testing. Shell and Swift Fuels each submitted one of the two selected fuels, which will go on to a second phase of testing expected to last until 2018.

Even though the GA industry is moving toward a lead-free fuel solution, the long timeline and uncertainty of the outcome act as additional barriers to entry for would-be aviators.

Summary

An analysis of GA parameters shows that recent trends have not been positive. New aircraft deliveries, the number of active aircraft, and the overall pilot population have suffered from the recession that began in late 2007 and have not recovered to pre-recession levels. The high cost of aviation has contributed to the decline in aviation activity. Uncertainty in regards to leaded aviation fuel and its possible replacement hinders the growth of the portion of GA that depends upon leaded fuel. While there are some segments of GA that have shown promise, such as the business use of GA aircraft and the niche markets of experimental aircraft, and the sport pilot sector, the overall trend in GA is likely to be negative for at least the short term, if not longer.

At the state level, Kentucky is likely to feel the impacts of these trends. However, Kentucky does have a number of positive attributes in terms of aviation. Recent initiatives have helped boost the student pilot population in Kentucky, thanks to aviation education efforts described in Chapter 5. Additionally, aerospace products manufactured in Kentucky have continued to be the number one export for several years, surpassing even automobiles and automotive parts. In 2016, Kentucky's aerospace businesses exported $10.8 billion worth of products.

Air Cargo Trends

Air cargo plays a vital role in global commerce, and Kentucky's airports play a major role in facilitating the flow of air cargo on global, national, and regional scales. Air cargo activity is supported at Kentucky's commercial service airports in the form of belly cargo carried on passenger airlines and express freight carried by integrated express carriers. In addition to these commercial service airports there are also several GA airports within Kentucky that support air cargo activity.

Statewide Trends

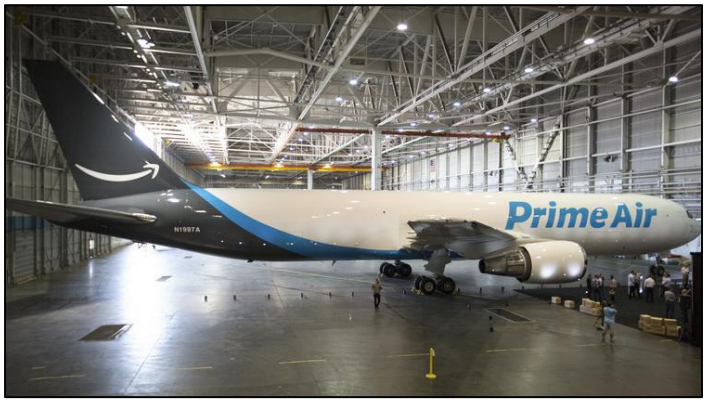
Kentucky is home to two major air cargo hubs operated by integrated express carriers DHL and UPS. DHL operates its North American hub at Cincinnati/Northern Kentucky International Airport (CVG), while UPS operates its 'Worldport' hub at Louisville International Airport (SDF). These hubs serve as sorting facilities that handle significant volumes of air cargo throughput, a small fraction of which originates in or is destined for Kentucky. Kentucky benefits not only from the direct economic activity that the hubs provide, but also from the growth in the warehousing and distribution industry that has been spurred by the presence of these hubs.

Since the launch of UPS' Next Day Air Service in 1982, UPS's Worldport has undergone numerous expansions to become the 5.2 million square foot processing facility that it is today. It is the largest fully automated package handling facility in the world, capable of sorting up to 416,000 packages an hour. The operation currently turns over approximately 130 aircraft daily, processing an average of 1.6 million packages per day with a record of nearly 5 million packages on its peak day of 2013. The facility has 70 aircraft docks and 155 miles of conveyors that transport parcels from around the world.[2] The presence of UPS drives Louisville International Airport's place among the world's top air cargo airports, which in 2015 ranks third in North America and in the top-ten globally. The airport handled nearly 2.6 million tons in 2015, representing a growth of 3 percent over 2014 and 19 percent over 2008.[3]

In 2009, DHL adjusted its business model, ceasing its U.S. domestic delivery service to focus solely on international shipments, and subsequently relocated its hub from Wilmington, Ohio, to Cincinnati/Northern Kentucky International Airport. DHL's new North American hub at CVG serves as an international gateway for shipping between North America and global markets. It is one of three global "Super Hubs" from which DHL Express serves 220 countries. Since DHL's arrival, total cargo tonnage at Cincinnati/Northern Kentucky International has increased from 40,000 tons in 2008 to over 800,000 tons in 2015, representing an increase of 1,910 percent. From 2014 to 2015, CVG's cargo tonnage grew by 12 percent, ranking 10th in North America.[4] Since 2009, DHL has invested $105 million in its hub and

[2] http://www.pressroom.ups.com/Fact+Sheets/UPS+Worldport+Facts
[3] http://www.aci-na.org/content/airport-traffic-reports
[4] http://www.aci-na.org/content/airport-traffic-reports

plans to invest an additional $46 million to continue increasing operational capacity to meet demand, which is largely driven by growth in e-commerce.[5],[6]



CVG's air cargo tonnage is poised to continue growing as Amazon announced in early 2017 its plans to build a centralized hub at CVG for its newly formed cargo airline, Prime Air. Amazon's $1.5 billion investment will result in a 3 million square foot facility expected to accommodate express e-commerce traffic from more than 200 daily takeoffs and landings by the Prime Air fleet. Service is expected to commence in the spring of 2017, and the new facility will employ more than 2,000 people when completed.[7]

Historic air cargo tonnage for Kentucky's commercial service airports is presented in **Table 4-1**.

[5] http://www.cvgairport.com/about/news/facts
[6] http://www.cincinnati.com/story/news/2014/11/20/dhl-express-expansion-boone-county-hebron-cvg/70007328/
[7] http://aircargoworld.com/amazon-to-move-prime-air-cargo-hub-to-cincinnati/

Table 4-1
Historic Air Cargo Tonnage at Kentucky Airports

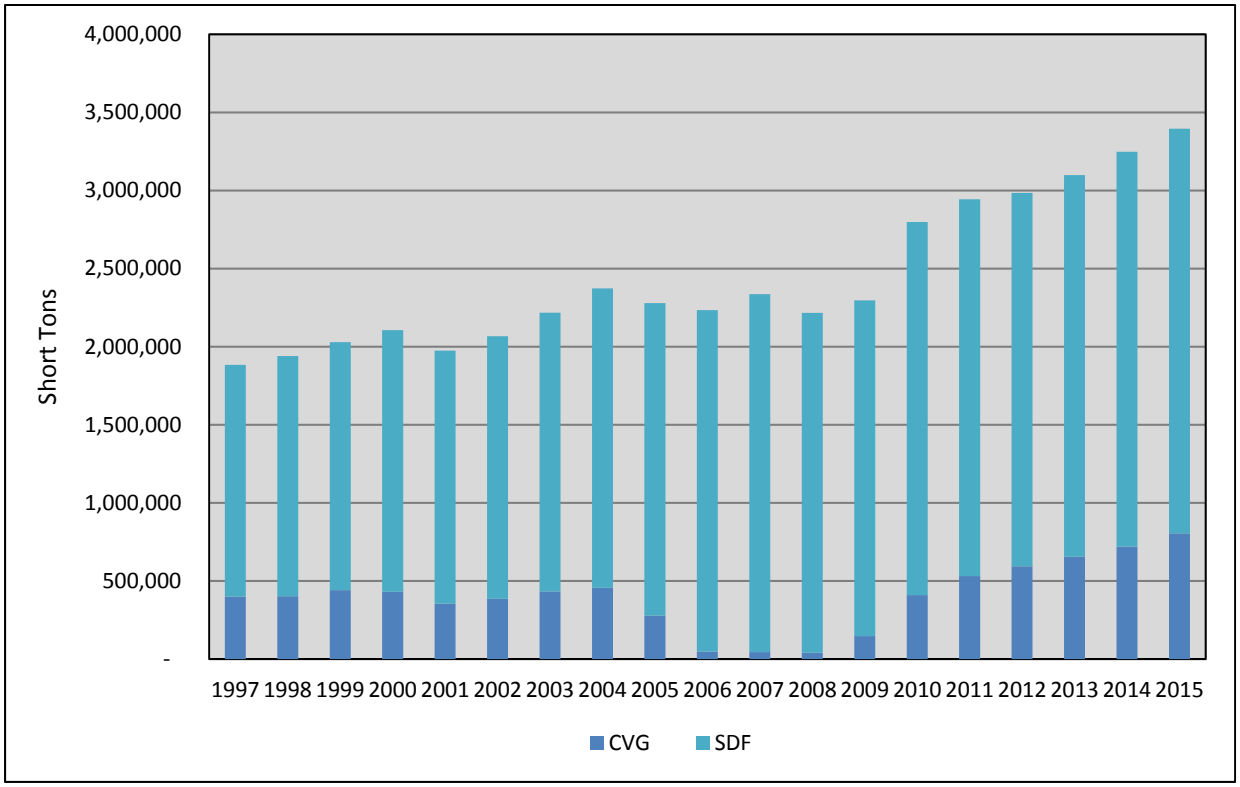
Year	CVG	LEX	PAH	SDF	TOTAL
1997	399,731	3,287	119	1,483,371	1,886,508
1998	401,646	3,031	303	1,537,721	1,942,702
1999	440,780	2,401	200	1,587,762	2,031,142
2000	430,805	2,381	303	1,674,991	2,108,480
2001	354,852	1,560	86	1,619,114	1,975,612
2002	385,824	962	69	1,680,120	2,066,975
2003	432,872	370	34	1,783,908	2,217,184
2004	455,590	188	35	1,917,459	2,373,273
2005	277,343	284	20	2,000,864	2,278,511
2006	47,718	250	8	2,185,916	2,233,892
2007	43,752	210	36	2,291,644	2,335,642
2008	40,014	186	11	2,176,264	2,216,476
2009	146,745	136	6	2,148,984	2,295,872
2010	409,284	82	0	2,388,327	2,797,693
2011	530,949	86	-	2,412,319	2,943,354
2012	593,786	107	-	2,390,211	2,984,104
2013	655,345	121	-	2,442,806	3,098,273
2014	719,440	138	-	2,527,851	3,247,430
2015*	804,088	**	-	2,591,155	3,395,243
AAGR					
2010-2015	14%	-100%	-100%	2%	4%
2005-2015	11%	-100%	-100%	3%	4%
1997-2015	4%	-100%	-100%	3%	3%

*2015 data directly from airport records; ACI-NA data not yet published.
**LEX air cargo statistics not available as of Q1 2016.
Source: Airports Council International-North America, Airport Records.

As shown in Table 4-1, Cincinnati/Northern Kentucky International has experienced the most dramatic growth in recent years, with an average annual growth of 14 percent since 2010 and 11 percent since 2005. Tonnage at Louisville International has increased steadily with an average annual growth rate of 3 percent since 1997. Year-over-year, tonnage at Louisville International has experienced growth in 15 of 17 years, with the exception of 2008, 2009, and 2012. Blue Grass Airport maintains a steady volume of passenger airline belly cargo each year, but is down from its overall peak tonnage of about 3,200 tons in 1997. Due to the proximity of Blue Grass Airport to nearby hubs in Northern Kentucky and Louisville, the majority of air cargo is trucked to and from the area. Barkley Regional Airport has not experienced air cargo tonnage since 2009 for the same reasons as Blue Grass Airport, plus it is within close proximity to FedEx's Memphis hub.

Statewide, total air cargo tonnage is driven by the two air cargo hub operations at CVG and SDF. In 2015, SDF represented roughly 76 percent of the total statewide air cargo tonnage, while CVG made up the remaining 24 percent. As shown in **Figure 4-4**, the strong statewide growth experienced from 2010 to present can be attributed to the establishment of DHL's new North American Hub at CVG.

Figure 4-4
Historic Air Cargo Tonnage 1997-2015, CVG & SDF

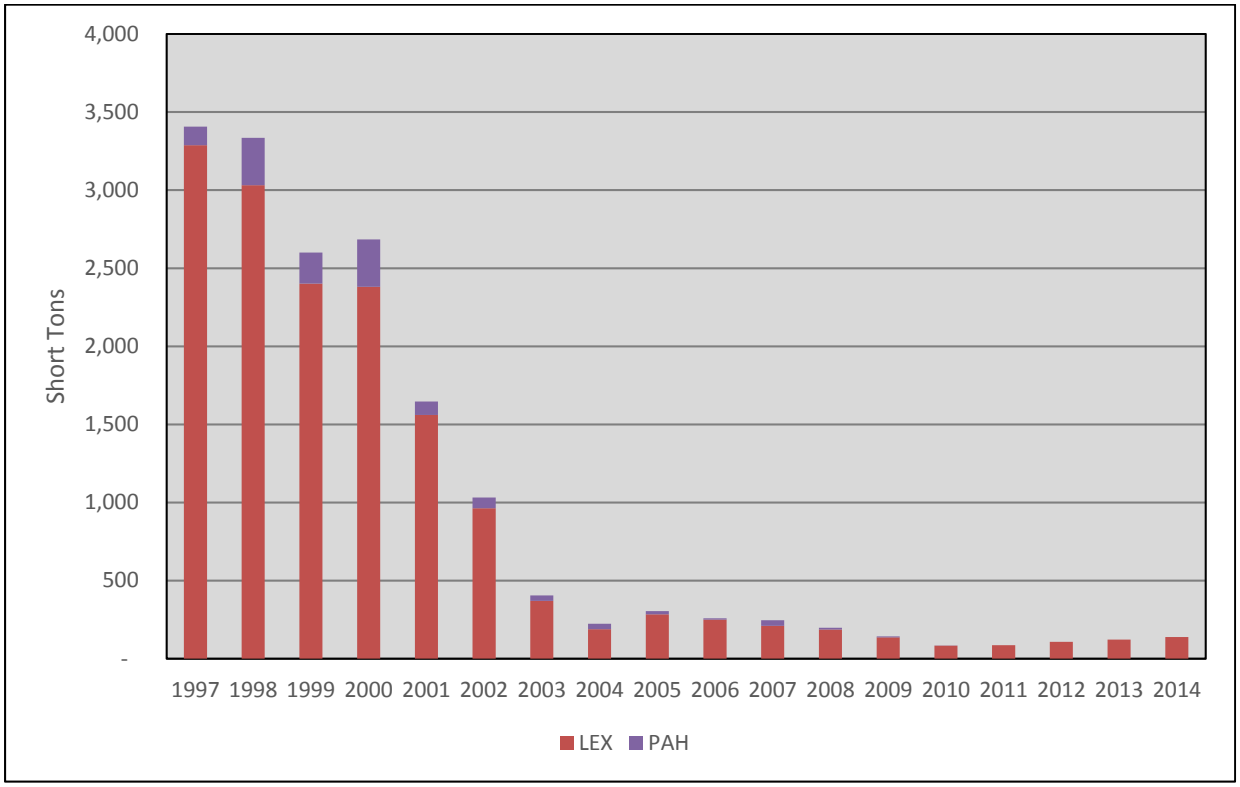


Note: 2015 data directly from airport records; ACI-NA data not yet published.
Source: Airports Council International-North America, Airport Records.

Prior to the establishment of its Wilmington hub, which was operated from 2003 to 2009, DHL previously operated out of CVG. DHL's departure from and return to CVG is evident in tonnage data shown for these years in Figure 4-4. CVG's decline in tonnage also corresponds to Delta Air Lines 2005 bankruptcy and subsequent flight cuts. Delta's 2008 merger with Northwest Airlines also resulted in further reduction in flights, contributing to a decline in passenger belly cargo at the airport – although it is still a relatively small fraction of overall tonnage.

Not including Kentucky's two air cargo hub airports, the state's two remaining commercial service airports with measureable quantities of air cargo tonnage are Blue Grass Airport and Barkley Regional Airport. As shown in **Figure 4-5**, these airports have seen strong declines in air cargo tonnage since 1997.

Figure 4-5
Historic Air Cargo Tonnage 1997-2014, LEX & PAH



Source: Airports Council International-North America, Airport Records.
2015 data not available as of Q1 2016.

Kentucky is an attractive location for air cargo hubs due to its generally temperate weather and short travel times. From UPS' Louisville hub, approximately 75 percent of the U.S. population is reachable within a two-hour flight, and a four-hour flight allows for access to 95 percent of the U.S. population. CVG is approximately 80 miles from SDF so similar figures apply. In turn, the surrounding areas of CVG and SDF have become prime spots for a multitude of companies to set up their own distribution facilities thanks to the presence of UPS and DHL and their extensive global reach. Businesses benefit from being in such close proximity to Kentucky's air cargo hubs by allowing later pickup times, shorter total delivery time, and reduced shipping costs. More than 140 companies have located to Kentucky to be near UPS' Worldport, including many notable e-commerce businesses.[8] A similar trend is occurring in the vicinity of CVG.

Major brands' distribution centers located in Kentucky include Amazon, American Greetings, Browne-Forman, Cengage Learning, Chegg, Dorman Products, Fruit of the Loom, Gap/Old Navy, Geek Squad, Gilt Groupe, Gordon Food Services, Levi Strauss, Nasty Gal, Sun Products, Toyota North American Parts Center, Tractor Supply, Walmart, and Zappos.[9] [10] A unique example is Clear Water Fine Foods, which operates the world's largest inland lobster tank in Louisville, to where Nova Scotia lobsters are shipped and kept in saltwater tanks at 39 degrees until they are sent via UPS to

[8] http://www.businessclimate.com/kentucky-economic-development/ups-dhl-put-kentucky-distribution-map
[9] http://midamericafreight.org/wp-content/uploads/Kelly_TransportationsRoleInKentuckysEconomicDevelopment.pdf
[10] http://www.businessclimate.com/kentucky-economic-development/kentuckys-strong-transportation-system-energizes-business-climate

restaurants across the country. Gilt Groupe is a fashion and home décor retailer that operates a "flash sale" business model, shipping between 20,000 and 30,000 units per day from their high tech facility in Louisville. BestBuy opened its Geek Squad City just south of SDF, which operates as a centralized repair and refurbishment center for tech-products. Prior to its opening in 2006, repairs were made at various locations throughout the country.[11] These firms, among many others, have logistics needs that are well accommodated by a combination of Kentucky airports and logistics infrastructure.

Given Kentucky's prominence in the horse racing and breeding industries, it is no surprise that Kentucky airports frequently support equine charter transport flights. According to the 2012 Kentucky Equine Survey, Blue Grass Airport and Louisville International Airport are both ranked in the top five U.S. airports involved in horse transportation. Air cargo carriers such as Kalitta Air set up special "airstables" on modified Boeing 727 aircraft. Horses are generally flown internationally but are also flown domestically over long distances. Larger airports such as New York (JFK), Miami (MIA), and Los Angeles (LAX), which have U.S. Customs/quarantine facilities, must be used when a horse is first imported into the U.S. The aforementioned airports plus Houston (IAH), Chicago (ORD), and Dallas (DFW) are most commonly used for exporting horses after departing Kentucky. In addition to Kalitta Air, other airlines that provide livestock shipping include El Al, CAL, Lufthansa, KLM, Cargolux, and FedEx.[12] A more detailed discussion of Kentucky airports' support of the equine industry is provided in *Chapter 5: Unique Aspects of Aviation in Kentucky.*

GA Cargo

In addition to the commercial service airports that support air cargo, there are also several general aviation airports in Kentucky that support air cargo activity. GA airports are frequently used by regional air cargo operators and feeder airlines as they provide several advantages such as convenience and flexibility. Air cargo is typically lightweight, time-sensitive, and high-value. Serving the air cargo needs of small market areas is often better accommodated by small aircraft operating at a general aviation airport that provides quick access to that market. This is often more economical than trucking to markets that are relatively isolated from the larger distribution network or those where the cargo demand does not warrant a full-size truck (LTL shipments). Operating at GA airports is particularly economical when there are multiple small markets that can be served by one aircraft operating a multi-segment route. Kentucky has several such small markets and its geography makes the state well suited for general aviation air cargo.

According to BTS T-100 data two of Kentucky's GA airports – Bowling Green-Warren County Regional and Elizabethtown Regional – reported small volumes of air cargo tonnage in 2014. These air cargo operations can range from scheduled shipments of medical supplies/samples to ad hoc shipments of automotive supplies. Bowling Green is home to General Motors' Corvette assembly plant, which often require emergency shipments of specialty parts or tooling.

The inventory effort of the system plan asked airports to report basic information on the frequency of air cargo operations. The results of the inventory found that of Kentucky's 53 public-use general aviation airports, 27, or 51 percent, reported having some level of air cargo activity. Three GA airports reported weekly air cargo operations: Addington Field in Elizabethtown, Bowman Field in Louisville, and Mount Sterling-Montgomery County. Fourteen GA airports reported monthly air

[11] http://www.businessclimate.com/kentucky-economic-development/distribution-assets-draw-top-firms-kentucky

[12] http://equinechronicleonline.com/modern-pegasus-horses-flying-internationally/

cargo activity, and 10 GA airports reported experiencing air cargo operations on a seasonal basis. All airports reporting air cargo activity on a daily basis are classified as commercial service airports.

Industry Trends

At the national level, due to both internal and external factors, the air cargo industry has experienced significant volatility that has resulted in rapid maturation of the industry. High fuel costs and a recessed economic climate caused an industry shift to trucking where unit cost savings became higher priority than shipment time. As customer bases and market shares contracted, air cargo carriers adapted by consolidating, shifting business models, or ceasing operations. Kitty Hawk Air Cargo ceased operating in 2008; BAX Global was acquired by DB Schenker in 2005 and ceased domestic air cargo activities in 2011; UPS acquired Menlo Worldwide (formerly Emery Worldwide) in 2004 and closed the Dayton hub in 2006; DHL acquired Airborne Express in 2003 and closed the Wilmington hub in 2009 after DHL withdrew from domestic delivery.

As a result of these changes, outside of smaller regional contract or charter operators, the current landscape of the domestic air cargo industry has effectively become a duopoly with FedEx and UPS as the last major players left standing. However, e-commerce giant Amazon is poised to shake up the industry landscape as it announced in January 2016 that it would lease 20 Boeing 767 widebody aircraft from Air Transport Services Group (ATSG) and operate out of the former DHL hub at Wilmington Air Park (ILN) in Ohio.[13]

Amazon has been operating a "trial express network" out of Wilmington since mid-2015 on key routes to Allentown, Pennsylvania; Dallas/Fort Worth, Texas; Oakland and Ontario, California; and Tampa, Florida. Each of these airports are within close proximity to Amazon distribution centers. Amazon is also operating a small European network with routes from Wroclaw, Poland, to Luton or Doncaster in the U.K., and Kassel, Germany. The advantage for Amazon is that the company knows their own air traffic volumes and knows the amount of cargo that needs to be transported between its 100-plus distribution centers across the country.[14] Rather than give its cargo to a third party where it would pay a premium and compete for limited space with other cargo shippers, Amazon saves money by chartering a plane itself. It is yet to be seen what impact Amazon's entry will have on the industry – whether it be an increase in tonnage or simply a tonnage shift away from more established carriers, Kentucky's air cargo hubs are likely to be impacted in some manner.

Apart from the Amazon development, the most significant area of growth for the air freight industry is on international segments between major markets. The more mature U.S. domestic market has been relatively flat over the past decade, with the rapid growth of 1980s and 1990s a distant memory. However, as the economy continues to strengthen and trade grows, so too will the demand for air cargo. The Boeing World Air Cargo Forecast 2014-2015 projects growth of 2.1 percent from 2013 to 2033 for intra-North American air cargo. Regional trade forecasts between North America-Asia, North America-Europe, and North America-Latin America are all projected to be over five percent over the same time period.

Summary

Air cargo activity is supported by both commercial service and general aviation airports in Kentucky. Louisville International, home to UPS' 'Worldport' hub, has been the busiest air cargo airport in the state since its establishment in the 1980s. Cincinnati/Northern Kentucky

[13] http://www.wsj.com/articles/cargo-airline-expands-flights-believed-to-be-for-amazon-1455125482

[14] http://motherboard.vice.com/read/a-secretive-air-cargo-operation-is-running-in-ohio-and-signs-point-to-amazon

International is currently undergoing a resurgence in air cargo growth as a result of DHL establishing its North American hub at the airport in 2009. In addition to integrated express cargo, SDF and CVG also support passenger belly cargo, which make up significantly smaller percentages of their total tonnages. Blue Grass and Barkley Regional Airports also have a history of supporting air cargo activity in the form of passenger belly cargo. General aviation airports such as Bowling Green-Warren County Regional and Elizabethtown Regional also play a role in facilitating air cargo operations by regional cargo carriers and feeder airlines.

Multimodal Issues

A safe and reliable transportation system is vital to Kentucky's future economic growth, national competitiveness, and overall quality of life. Kentucky's central location and accessibility to major multimodal transportation routes makes Kentucky a uniquely attractive environment for business, industry, and tourism. Multimodal transportation involves the movement of people and goods from an origin to a destination using more than one mode of transportation. Multimodal transportation typically includes a mixture of movement by highway, air, rail, waterway, public transit, bicycling, or walking. Multimodal transportation provides a pathway for meeting the increased demand on our transportation network by facilitating least-cost transport options that are safe, secure, and sustainable.[15]

To provide a safe and reliable transportation system for the next 20 years, state and regional transportation planning must be coordinated and comprehensive. The *2014 Long-Range Statewide Transportation Plan (LRSTP)* was developed by the Kentucky Transportation Cabinet (KYTC) to meet the vision of Kentucky's transportation system over the next 20 years while taking into consideration Kentucky's unique geographic and demographic challenges. The vision for the state's transportation system was defined as "a well-maintained, multimodal transportation system that delivers safe and reliable trips which improve Kentucky's quality of life."

Drawing primarily upon KYTC's *2014 Long-Range Statewide Transportation Plan (LRSTP)* and the *2016 Kentucky Freight Plan*, this section discusses the various multimodal issues in Kentucky that have the potential to impact aviation for both passengers and freight.

Multimodal Passenger

Commercial service airports often have multimodal linkages used by both passengers and airport workers, and, in Kentucky, these multimodal linkages consist of automobile access and bus service. General aviation airports do not typically have major multimodal linkages, with the obvious exception of automobile access. While there is no rail connectivity to Kentucky airports, there is a level of ferry use when accessing Kentucky airports. The focus of this section is on passenger-related multimodal activities.

Bus Service

In practice, multimodal transportation links have little influence on general aviation airports. As seen through the inventory effort of this study, multimodal connectivity is primarily related to commercial service airports. None of the commercial service airports in Kentucky are connected by passenger rail, while four of the state's five commercial service airports are served by bus. The Transit Authority of Northern Kentucky (TANK) provides bus service from downtown Cincinnati to the passenger terminal and DHL hub facilities at CVG, while the Transit Authority of River City (TARC) provides bus service to passenger terminal and UPS hub facilities at Louisville International. The Transit Authority of Lexington (LexTran) offers bus service to Blue Grass

[15] http://www.ktc.uky.edu/research/multmodal-transportation/

Airport from the downtown Transit Center. Barkley Regional and Owensboro-Daviess County Regional offer on-demand shuttle service. The inventory effort also determined that two of the 54 general aviation airports in the state system have bus connectivity: Bowman Field in Louisville and London-Corbin-Magee Field. A greater number of airports have on-demand taxi and shuttle services available to users.

Passenger Rail

While there is currently no direct rail access to any Kentucky airport, there is existing rail service in the state and dormant rail concepts that have the potential to impact airports.

Intercity passenger rail travel is provided by Amtrak, to Ashland, South Portsmouth/South Shore, Maysville, and Fulton, all along Kentucky's northern border.

Light rail or light rail transit is typically an urban form of public transport with a "light" passenger capacity that operates primarily along exclusive rights of way. The Transit Authority of River City (TARC) in Louisville, which runs the largest transit system in Kentucky, has explored the concept of light rail in the past. However, TARC halted their light rail study, *Transportation Tomorrow*, in 2004 due to funding and ridership hurdles. Proposals for a rail line between downtown Cincinnati and Cincinnati/Northern Kentucky International have been discussed in the past, but there is no project currently in development.

Ferry Operations

Another notable form of multimodal connectivity to Kentucky airports comes from ferries. Kentucky uses a ferry boat system to accommodate river crossings where construction of a bridge is not a feasible or desirable alternative. There are 10 ferry boats operating within or along the state's borders, seven of which provide river crossings at no charge. Ferry boats are considered "moving bridges" by the KYTC, and provide crossings over the Ohio, Mississippi, Green, Kentucky, and Cumberland Rivers. Funding is provided by the KYTC to facilitate operation of seven of the ferry boats. The federal government provides funding and operation of the two ferry boats located in Mammoth Cave National Park. The ferry boats meet an important need as part of the Kentucky transportation system and although they transport relatively low volumes of traffic, Kentucky's ferries are likely to indirectly serve the needs of some airport-bound traffic.

One example is the privately-operated Anderson Ferry, which crosses the Ohio River north of Cincinnati/Northern Kentucky International 10 miles west of downtown Cincinnati. Since it is the only automobile crossing between the Interstate 71/75 bridge downtown and the Interstate 275 bridge on the Indiana border, the ferry is popular among residents of Cincinnati's western suburbs for catching flights and getting to work.[16] Although limited, it is likely that Kentucky's nine other ferries provide service to airport users. Kentucky's ferries are listed in **Table 4-2**.

[16] http://www.andersonferry.org/anderson_ferry_information.htm

Table 4-2
Ferryboats in Kentucky

Ferry	Crosses	From	To	Sponsor
Anderson Ferry	Ohio River	Boone Co., KY	Hamilton Co., OH	Privately Operated
Augusta Ferry	Ohio River	Bracken Co., KY	Brown Co., OH	State Funded
Cave in Rock Ferry	Ohio River	Crittenden Co., KY	Hardin Co., IL	State Funded
Dorena-Hickman Ferry	Mississippi River	Fulton Co., KY	Mississippi Co., MO	State Funded
Green River Ferry	Green River	Edmonson Co., KY	Edmonson Co., KY	Federally Funded
Houchin Ferry	Green River	Edmonson Co., KY	Edmonson Co., KY	Federally Funded
Reeds Ferry	Green River	Butler Co., KY	Butler Co., KY	State Funded
Rochester Ferry	Green River	Butler Co., KY	Ohio Co., KY	State Funded
Turkey Neck Bend Ferry	Cumberland River	Monroe Co., KY	Monroe Co., KY	State Funded
Valley View Ferry	Kentucky River	Fayette and Jessamine Co., KY	Madison Co., KY	State Funded

Source: KYTC

Multimodal Freight

The movement of goods and freight throughout Kentucky is vital for each citizen in the Commonwealth, from the aerospace parts machinist to the mineworker to the pharmacist. Each has a need to transport raw materials, manufactured parts, and finished goods; and then products to be sold or purchased. The recently completed *Kentucky Freight Plan* (KFP), which is a supplement to the 2014 LRSTP, outlines the multimodal issues in Kentucky relevant to freight. This section discusses multimodal issues with relevance to aviation.

Multimodal Freight System

Kentucky's multimodal freight system enables the state to capitalize on its geographically strategic location. Kentucky is located within 600 miles of over 60 percent of the nation's population, personal income and manufacturing. Its central location facilitates the distribution of freight to over 30 states. Kentucky's freight network consists of extensive highway, rail, maritime, and aviation infrastructure.

Highway

The state is served by 10 interstates and 10 state parkways, including more than 500 miles of the federally designated Highway Primary Freight Network. This includes two of the nation's busiest north-south interstate corridors (Interstates 75 and 65), connecting industries across North America from Canada to Mexico. Kentucky also contains major portions of Interstate 64, which is a major east-west corridor stretching from Norfolk, VA to St. Louis, MO.[17]

Kentucky's highway network is the primary mode for freight accessing the majority of airports in the state, with trucks serving as the only other mode for transporting air cargo, either to or from the airport.

Rail

Kentucky's approximately 3,200 miles of railroad track carry a myriad of freight and provide connectivity to all points in the U.S. Class I track makes up approximately 2,300 miles of Kentucky's rail system and represent the most heavily travelled rail lines by revenue. Kentucky is traversed by CSXT's Chicago to Nashville, TN and Detroit, MI to Atlanta, GA mainlines, by Norfolk Southern's Cincinnati, OH to Atlanta, GA and New Orleans, LA mainlines, and by Canadian National's Chicago, IL to New Orleans, LA mainline. The Class I railroads are complemented by a network of regional and

[17] http://www.thinkkentucky.com/kyedc/pdfs/kytrannw.pdf.

short line railroads that provide in-state connectivity. The Paducah & Louisville Railway is one example, providing east-west service in Kentucky, connecting with six other carriers at three locations within the state.

Water

Kentucky is bordered on three sides by navigable rivers. The Ohio River forms the 660-mile northern border, which is the longest of the three border rivers. The Mississippi River forms the western border, and the eastern side of the state is bordered by the Big Sandy River and Tug Fork. With over 1,980 miles of commercially navigable waterways and 12 public port authorities, Kentucky also provides efficient year-round waterborne commerce. The Ohio River, a major tributary of the Mississippi River System, provides connectivity as far as Pittsburgh, PA, Minneapolis, MN, and Tulsa, OK. Western Kentucky sits at the confluence of the Ohio and Mississippi Rivers, marking the nominal transition between the Upper and Lower Mississippi River. The entire inland waterway system provides a waterway link to Canada via the Great Lakes, and to Mexican and South American markets via the deepwater ports of New Orleans, LA and Mobile, AL. Kentucky also connects the Ohio River to numerous southern cities such as Nashville, TN via the Cumberland River, Knoxville, TN and Chattanooga, TN via the Tennessee River, and Mobile, AL via the Tennessee-Tombigbee Waterway.[18]

This inland waterway network provides for efficient year-round freight transport of bulk materials, agricultural products, chemicals, minerals, metals, wood, manufactured goods, and containerized freight. The state's well-developed terminals and riverports have strong connectivity to rail. However, similar to rail, waterborne commerce has no intermodal connectivity with air transportation.

Air

There are six commercial airports in Kentucky, including two major shipping hubs that are home to UPS Worldport (Louisville) and DHL Express (Covington). In 2014, the Louisville International Airport was ranked third in the U.S. for annual air freight tonnage shipments.[19] There are 28 general aviation airports with runway lengths greater than 5,000 feet, allowing them to handle larger cargo planes. This transportation network, further highlighted in the following sections, makes it practical to move freight locally, regionally, and to all points of the globe.

In addition, Kentucky is an attractive location for air cargo hubs due to its generally temperate weather and short travel times. From UPS Louisville hub, approximately 75 percent of the U.S. population is reachable within a two-hour flight, and a four-hour flight allows for access to 95 percent of the U.S. population. A more detailed discussion of air cargo can be found in a previous section of this chapter.

Intermodal

The major Kentucky infrastructure development in the past 10 years has been the upswing in volume and investment in railroad container intermodal facilities. Kentucky has four intermodal facilities that can transfer containers and/or trailers of cargo from rail to truck. Norfolk Southern operates three facilities, two in Louisville and one in Georgetown, and CSX opened a facility in Louisville in 2012.[20] Rail carriers, with the assistance of some public subsidies, have invested heavily in creating terminals bridging the modal capabilities of roadways, rail, and marine cargo.

[18] http://www.thinkkentucky.com/kyedc/pdfs/kytrannw.pdf
[19] Kentucky Cabinet for Economic Development, Kentucky Economic Development Guide, 2014.
[20] Kentucky Transportation Cabinet, 2015 Kentucky Statewide Rail Plan, 2015.

The location of Kentucky's intermodal facilities is advantageous because of the Kentucky market, the good condition of Kentucky's road system, and the proximity to the national market. While intermodal growth over the past 20 years was primarily driven by international trade (specifically imports), development of new intermodal facilities and railroad operating and marketing practices has increased the viability of all-domestic intermodal moves.

Critical Connections and the First/Last Mile

Freight movements by truck in Kentucky rely heavily on the Interstate Highway System. Because trucks perform the initial pickup and delivery for most goods and commodities moved by air, rail, and water, the connector routes between the freight transportation modes are a critical link to facilitate the smoother movement of freight. Often these connectors or "last mile" segments are under local jurisdiction.

As freight volumes grow, the ability of the multimodal freight system to be resilient and responsive to the freight community's needs will be increasingly important to Kentucky's economic future. It is important to maintain the connectivity points with other modes of transportation. The connection points are where most efficiency is gained or lost during freight travel. In Kentucky, these connection points are airports, rail, truck distribution centers, pipelines and port facilities. The roads leading up to major connectivity points are designated National Highway System (NHS) Intermodal Connectors by Federal Highway Administration (FHWA) and KYTC.

Intermodal Connectors are often maintained by different entities and fall into the cracks in the planning and programming process. Investment in connectors is often in competition with other high-profile projects for the ever decreasing transportation funding. Intermodal connectors often suffer geometric issues, pavement lifecycle, and other challenges that create inefficiencies and reliability issues for freight users. **Table 4-3** lists Kentucky's Intermodal Connectors.

As shown in Table 4-3, there are only three NHS Intermodal Connectors that are directly related to airports (highlighted in blue). Although several other connectors could have the potential to impact aviation further downstream, it is unlikely due to the nature of commodities transported via these connectors. Air freight is typically lightweight, high-value, and time-sensitive, with very little connectivity to rail or maritime modes.

Table 4-3
Freight NHS Intermodal Connectors

Facility	Type	Connector Description
Bells Lane Petroleum/Chemical Pipeline	Truck/Pipeline Terminal	KY 2056 from I-264 W to the Louisville-Kentucky River Floodwall
Bells Lane Petroleum/Chemical Port	Port Terminal	KY 2056 - Louisville-Kentucky Floodwall to I-264
Campground Rd Petroleum Pipeline	Truck/Pipeline Terminal	Campground Rd (Cane Run to Ralph), Kramers Ln (Cane Run to Campground), Ralph Ave (Cane Run to Campground Rd)
Campground Rd Petroleum Port	Port Terminal	Same as above
Cincinnati/N KY International Airport	Airport	KY 212 from I-275 S to the Airport Roadway System
Clark Elkhorn Coal Tipple	Truck/Rail Facility	KY 1441 (US 460 to Clark Elkhorn Tipple #1 Ent), KY 1789 (US 460 to KY 1441)
Golden Oak Mining CO.	Truck/Rail Facility	KY 7 (KY 15 to KY 931), KY 931 (KY 7 to Facility)
Ivel Coal Tipple	Truck/Rail Facility	County Rd 1020 - US 23 to Facility
Blue Grass Airport	Airport	FS 8550 - US 60 to Facility
Louisville International Airport	Airport	Grade Ln (I-264 to UPS Feedor Truck Entrance), FS 8879 (I-264 to Facility)
Louisville/Ashland Oil/Chevron Dist. Center	Truck/Pipeline Terminal	KY 1681 - KY 4 Interchange to Facility
McCoy Elkhorn Coal Corp	Truck/Rail Facility	KY 194 - US 119 to Facility
Norfolk Southern Intermodal - Georgetown	Truck/Rail Facility	KY 620 - Facility to I-75 Interchange
Norfolk Southern Intermodal - Louisville	Truck/Rail Facility	Newburg Rd (I-264 to Bishop), Bishop Ln (Newburg to Jennings), Jennings Ln (Bishop to Facility)
Owensboro Riverport	Port Terminal	KY 331 (US 60 to Harbor Rd), Harbor Rd (KY 331 to Facility)
Praise Dock Coal Tipple	Truck/Rail Facility	KY 80 from US 460 to Facility
Truck to Barge Coal Dock Cluster, Boyd County	Port Terminal	KY 757 from US 23 near Lockwood to 2.3 Miles North

Source: Federal Highway Administration, National Highway System: Intermodal Connectors, June 18, 2012.

Industry Spotlight – Aerospace Manufacturing

Kentucky's aerospace industry has become the state's leading manufacturing export by value, exporting one quarter ($7.8 billion) of Kentucky's $27.5 billion total exports, according to 2014 Census Bureau figures. This sector grew by 37.5 percent between 2013 and 2014 alone. A major contributor to this growth are Kentucky's numerous suppliers for Cincinnati-based GE Aviation, which is seeing significant growth in demand for newer, more fuel efficient aircraft engines.[21] Without its extensive freight transportation network, Kentucky's aerospace industry would not be in the strong position it is today.

Having taken notice, the Kentucky Commission of Military Affairs (KCMA), in collaboration with the Kentucky Cabinet for Economic Development (CED) and KYTC, are currently conducting an *Aerospace, Aviation and Defense Industry Study* that will measure the economic impact, potential growth areas, education and workforce development issues, and develop recommendations for sustained growth within this part of the Kentucky economy. The results of the study will enable

[21] http://www.lanereport.com/48224/2015/05/kentuckys-exports-are-flying-high-with-aerospace/

Kentucky companies to understand and participate in the aerospace, aviation, and defense industry, while providing leaders, and policy-makers with an effective, updated information source to inform the legislative process and help continue to grow this sector of the economy. This study is expected to be completed by the end of 2017.

Summary

Other modes of transportation that could potentially impact aviation demand are bus, light rail, high-speed passenger rail, and multimodal freight connections with airports. With the exception of the highway and road network impacting passenger and cargo access, developments in other multimodal concepts currently have limited direct impact to much of the aviation system. Trucking serves as the primary, if not only mode to interline with air cargo. Despite Kentucky's extensive aviation, rail, and trucking components, interlining between aviation and rail is not economically viable due to the disparity in weight and value characteristics of the goods shipped by the two modes. Although the impact is minimal, several of Kentucky's airports, including CVG, have multimodal connectivity with ferry service across its major bodies of water. Having an understanding of the multimodal issues that impact aviation across Kentucky is essential for strategically improving the state's transportation system and provides opportunities to foster growth in key industries – such as aerospace manufacturing.

Technology Trends

Advances in technology have helped aviation evolve over its history, making flying safer, faster, and more efficient. For example, the invention of the jet engine enabled aircraft to fly faster, farther, and more reliably than piston-powered aircraft, opening new commercial opportunities for aviation. Technological changes are expected to alter aviation, improving the way people and goods are moved. Two innovations that are likely to impact aviation in Kentucky are the development of a new air traffic control technology known as NextGen, and unmanned aerial vehicles.

NextGen

The Next Generation Air Transportation System (NextGen) is a long-term plan by the FAA to transform the way the U.S. air transportation system operates through improvements in aircraft tracking systems, communication systems, and weather monitoring and forecasting systems. Very broadly, NextGen aims to shift air navigation from a ground-based system to a satellite-based system. The FAA expects the NextGen system to deliver increased operational efficiencies leading to shorter flight routes, less fuel consumption, reduced congestion and delay, fewer environmental impacts, and greater safety for aircraft.

NextGen is a complex system comprised of multiple components. This next section summarizes the major components of NextGen and their current implementation status.

Automatic Dependent Surveillance-Broadcast

Automatic Dependent Surveillance-Broadcast (ADS-B) is a key component of NextGen and has two systems – ADS-B Out and ADS-B In. Using a combination of ground stations, aircraft avionics, and the satellite global positioning system (GPS), ADS-B Out provides air traffic controllers with an aircraft's position, altitude, airspeed, and other information critical to ensuring aircraft separation. Because it relies on satellites instead of ground-based radars, ADS-B Out improves the coverage and situational awareness of air traffic controllers, including tracking of aircraft while taxiing at airports with adequate surveillance equipment, making ground movements safer for all aircraft.

ADS-B In allows properly equipped aircraft to receive weather and aircraft position information (for collision avoidance) while in flight. This will benefit both general aviation and commercial airlines with enhanced safety by giving pilots an improved ability to avoid hazardous weather and augment their responsibility to see and avoid other aircraft.

The FAA has established a deadline of January 1, 2020 for all aircraft operating in controlled airspace to be equipped with ADS-B Out avionics (the FAA does not require aircraft to be equipped with ADS-B In). The cost to equip and install ADS-B Out is several thousand dollars per aircraft, which is fairly insignificant for the airlines, but can be a substantial burden on private aircraft owners. Furthermore, the biggest advantage for general aviation aircraft is from ADS-B In, which imposes additional equipment and costs on the aircraft owner.

Collaborative Air Traffic Management Technologies

The Collaborative Air Traffic Management Technologies (CATMT) focuses on improving the FAA's Traffic Flow Management System, which is a wide ranging system that delivers air traffic data to users with the intention of improving overall awareness of the national air transportation system. Users include airlines, military, air traffic control, and the traveling public. The data available is extensive, and includes weather and its impacts on the national airspace system, flight schedules, and air traffic control actions that influence the national airspace system.

Data Communications

The Data Communications (Data Comm) portion of NextGen enables controllers and pilots to communicate with digitally written messages instead of over the radio. This allows complex messages, such as flight plan routings, to be transmitted quickly and with reduced risk of communication error to and from the aircraft cockpit.

The FAA began Data Comm in 2013 by delivering departure clearances (the initial routing an aircraft is expected to take) to flight crews operating at Memphis International and Newark Liberty International. The trials in Memphis and Newark have shown that use of the system can result in faster taxi outs, reduced delays, and reduced pilot and controller workload. As of March 2016, 18 air traffic control towers were equipped with Data Comm technology, including Louisville International, where UPS assisted the FAA with expanding Data Comm beyond Newark.

The FAA plans to expand its Data Comm services from air traffic control towers to all 20 air route traffic control centers (the facilities, commonly referred to as centers, that provide air traffic control services during most of the enroute portion of a flight) by 2021.

National Airspace System Voice System

The National Airspace System Voice System (NVS) will replace the current switch-based voice communication system used by air traffic control with a router-based system that provides a nationwide networking, monitoring and communication sharing capabilities. NVS is expected to enable direct communication between air traffic controllers and air crews, including operators of unmanned aerial vehicles.

Current communication technology limits the air traffic control facilities that an aircraft crew can reach based on geography. The NVS envisions an interconnected air traffic control communication system that can allow aircraft crews to reach any air traffic control facility networked into the NVS. This is important for purposes of shifting workload between facilities, or in the event that an air

traffic control facility is out of service and its communications need to be switched to another facility. The NVS is undergoing testing, which is planned for completion in 2019. Operational NVS is expected in the first FAA facilities in 2019 with full deployment of the system planned for 2026.

NextGen Weather

The weather component of the NextGen system consists of several improvements to the collection and dissemination of weather information. The NextGen Weather Processor will identify weather hazards in the terminal and enroute environments. The Aviation Weather Display consolidates current weather displays and provides consistent weather information for terminal and enroute users. The Common Support Services modernizes information management services for weather, and provides tailored weather products through System Wide Information Management (see below). Improved weather information is expected to reduce weather delays and enhance safety.

System Wide Information Management

The System Wide Information Management (SWIM) infrastructure is aimed at allowing more efficient data sharing among aviation users. It accomplishes this by establishing data format standards, translating data from different data systems into standard formats, and consolidating multiple data connections into a single access point. One example of how SWIM results in operational efficiencies is that the system allows collaboration between airline dispatchers and traffic managers by providing both user groups access to current weather and flight planning information. Using SWIM-enabled data, these two groups are able to cooperatively reroute traffic and take advantage of the most current information on weather, air traffic control traffic management initiatives, runway configurations, and airport deicing operations. The FAA completed the first portion of the SWIM initiative in 2015 and anticipates the second portion will be complete in 2016.

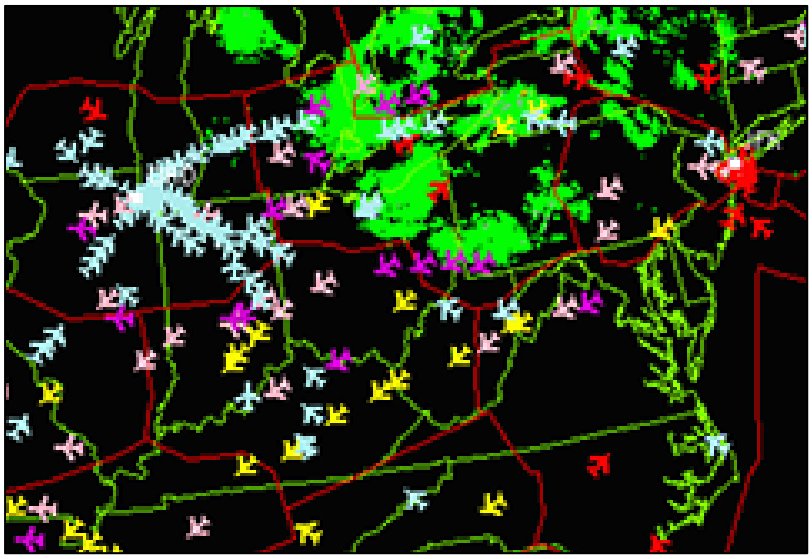
Enroute Automation Modernization

Enroute Automation Modernization (ERAM) consists of improvements to equipment at air route traffic control centers that will better automate a number of air traffic control functions, extend surveillance range, and increase the tracking capacity for each center from its current limit of 1,100 aircraft to 1,900. As of March 2015, ERAM was operational at all 20 of the continental centers. Additional enhancements are planned through 2017.

Terminal Automation Modernization and Replacement

Terminal Automation Modernization and Replacement (TAMR) is an equipment upgrade program similar to ERAM, but for air traffic control towers and terminal radar approach control facilities. These facilities receive improved radar processing and display systems under the program. The

FAA is implementing TAMR across three phases, the first two of which are completed. TAMR is scheduled for completion by 2020.



The NextGen system has the potential to greatly improve both commercial and GA. For example, thanks to NextGen modifications in arrival procedures at Louisville, UPS saves more than 7,700 gallons of fuel every night.[22] This is accomplished through the use of continuous descent arrivals, which reduce fuel burn and noise. The use of ADS-B In and Out promises to increase situational awareness for all aviators, thereby enhancing safety.

However, the Government Accountability Office has criticized the $40 billion program for being behind schedule and more than $4 billion over budget.[23] Furthermore, the high cost of equipping aircraft in comparison to the benefits received (especially for GA) may restrict the benefits to a smaller pool of participants than originally anticipated. Finally, concerns have been raised over the unencrypted nature of the signals sent out by aircraft to support NextGen technologies. The National Business Aviation Association has stated that under the NextGen system, each properly equipped aircraft broadcasts its aircraft type, position, airspeed, and unique identification in real time in the clear. Since these signals are not encrypted, anyone with the right kind of receiver can collect the data. In fact, flight tracking web sites such as flightradar24.com, make use of these kinds of receivers operated by volunteers that feed that data to the web site.

Unmanned Aerial Systems

The growth in unmanned aerial vehicles (UAV) has been spurred by improvements in engine technology, battery life, and miniaturization of components, all of which have driven down the costs of these easy-to-operate vehicles. As a result, recreational and especially business use of UAVs has proliferated. The following industries are just a sample of the businesses that expect to capitalize on UAV growth.

- **Agriculture** – UAV operations can provide farmers with information on how their crops are performing and provide the ability to apply pesticides, fertilizer, and seed to specific areas.
- **Energy** – Currently, pipeline and powerline inspections are carried out by manned aircraft. UAV operations have the potential to conduct these inspections for reduced costs.
- **Retailing** – Companies such as Amazon and Walmart are exploring how UAVs can be used to deliver products ordered online.
- **Film Industry** – The movie and TV industry expect to make use of UAVs as aerial filming platforms.

[22] *NextGen Update: 2014* (2014). FAA, August 2014.
[23] Air Traffic Control Modernization: Management Challenges Associated with Program Costs and Schedules Could Hinder NextGen Implementation (2012). Government Accountability Office, GAO-12-223, February 16, 2012.

- **Insurance** – UAV operations can provide the insurance industry with information more quickly and efficiently than current methods. For example, UAVs can be used to inspect roofs to evaluate a homeowner's policy, or survey damage from a tornado to speed claims.
- **Real Estate** – UAV use is expected be a boon for the real estate industry, giving the ability to view hard to reach areas of properties and provide views that are inaccessible to those on the ground.
- **Law Enforcement** – Police departments are interested in using UAVs to aid in tracking suspects and monitoring for illegal activity.
- **Search and Rescue** – UAV operations are ideal for when search and rescue is undertaken in remote areas where access is limited.

Safely integrating UAV operations into the national airspace system remains a challenge. Congress directed the FAA to develop rules for UAV operations by September 2015. The FAA published regulations for the commercial operation of UAVs that weigh up to 55 pounds in June 2016. The FAA continues to develop rules for other UAVs operations. The FAA also implemented in December 2015 a UAV registration process for all UAVs weighing more than 0.55 pounds. This registration regulation was vacated in May 2017 by the courts because it violated the FAA Modernization and Reform Act of 2012. The FAA is in the process of reviewing recommended rules for smaller UAVs, called micro-UAVs, that would be less restrictive than the rules for heavier UAVs.

With the FAA still in the process of developing UAV rules, the Kentucky Department of Aviation (KDA) has served as a clearing house for UAV issues and activities in the state. With its focus on economic development, KDA has reached out to private businesses engaged in UAV operations in an effort to promote the commercial use of UAVs while simultaneously encouraging their safe integration with other airspace users, and helping resolve issues that occur.

Engineering and computer science students are also in demand by the UAV industry and at least 50 universities in the U.S. have centers, academic programs, or clubs for drone engineering or flying. The University of Kentucky has an Unmanned Systems Research Consortium (USRC) that seeks to advance technologies associated with UAVs. Dr. Suzanne Smith is the director of the Kentucky Space Grant Consortium at the University of Kentucky and leads research efforts that includes sensor development and aircraft design. She has noted that there are quite a few companies in Kentucky that have applied to the FAA for permission to operate UAVs. She said that several factors contribute to this trend, including the large number of military bases in Kentucky that supply a technically skilled work force, and two major package delivery firms that are pushing to use UAVs. Notable areas of use that she indicated include atmospheric research, agricultural surveying, and bridge inspections, but she expects that there are many future uses of UAVs that are as yet not identified.

Wide Area Augmentation System

Aviation anticipated significant improvements to navigation with the development of the global positioning system (GPS). While the system provided excellent enroute positional awareness, it was initially found to lack sufficient accuracy for use in all but the least demanding instrument approach procedures, and could not be used to provide any sort of glideslope guidance. That changed with the development of the Wide Area Augmentation System (WAAS), a system that improves the horizontal and vertical accuracy of GPS to the point where WAAS-guided approaches now match the accuracy of precision instrument approaches, and can offer vertical guidance to as low as 200 feet above the airport surface in as little as 0.5 miles of visibility.

In Kentucky, 30 airports rely on WAAS-enabled approaches to provide them with the best approach minimums available. Tens of thousands of general aviation aircraft are already equipped with GPS and many thousands also have WAAS because it is an attractive upgrade. In addition, some commercial operators have also equipped scheduled service aircraft to fly WAAS-guided approaches. It is expected that the FAA will come to rely more and more on WAAS approaches because they can be implemented without the need for additional ground-based equipment.

Summary

Technology is a key driver in the advancement of aviation. Several examples of this have been highlighted in this report. NextGen is reshaping the way air traffic control and aviators work together to make more efficient use of limited airspace. UPS has already assisted the FAA with demonstrating some of the benefits anticipated by the aviation industry once the NextGen system is fully deployed. General aviation expects to reap safety dividends on the in-cockpit weather and better collision avoidance technology that NextGen offers.

Demand for commercial UAV services appears to be growing despite uncertainty around how the FAA plans to integrate UAV operations safely into the national airspace system. The use of UAVs is expected to impact airspace and airport operational standards.

Wide spread use of WAAS-supported instrument approaches has enhanced accessibility for numerous Kentucky airports, increasing the safety and versatility of those facilities.

Finally, it should be mentioned that governmental policies have the potential to impact general aviation activity, either positively or negatively. Some examples include the personal property tax on aircraft, environmental compliance requirements, and the limit for air carriers on jet fuel sales tax, which deprives the state of needed aviation revenue while encouraging commercial airline activity.