EMERGING SECTOR SERIES:

Aviation and Aerospace

GROWTH AND OBSTACLES IN THE AVIATION AND AEROSPACE SECTORS IN ALASKA

Presented To The Alaska Division Of Economic Development

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I. Executive Summary

> "Alaska is an aviation incubator. We have been the leading aviation incubator in the [United] States for [the past] 50 to 60 years."
> – Skip Nelson, CEO and Founder of ADS-B Technologies

Alaska's first manned flight took place in 1913. In the century since then, air transportation has become a critical link for communities, a cultural milestone, and an economic driver in the 49th State. With Alaska's vast size, lack of road systems, and distance from other population centers, air travel is a necessity. For this reason, the state has a highly developed aviation sector that is unusually large by several measures relative to its population. Aviation is both a major industry in the state and an entrepreneurial pursuit for Alaska innovators.

Emerging Sector Series: Aviation and Aerospace Opportunities is the third report in a series completed by the University of Alaska Center for Economic Development (CED) in partnership with the State of Alaska Department of Commerce, Community, and Economic Development's Division of Economic Development. The report attempts to capture the current state of the aviation and aerospace sectors in the Alaska and identify opportunities for growth. In the process, CED interviewed dozens of businesses and subject matter experts and reviewed data and secondary literature from a variety of sources.

As segments of the economy with strong roots in Alaska, both aviation and aerospace emerge from this study as areas of deep economic specialization for the state. With a major air cargo hub, two rocket launch sites, abundant airfields and airspace, and an entrenched aviation culture, Alaska offers real assets to aviation businesses.

General findings about the aviation and aerospace landscape in Alaska include:

- **Alaska's in-state market for aviation products and services is outsized.** Alaska has more pilots and registered aircraft per capita than any other state. The state is home to more registered aircraft than 45 other states. This leads to increased demand for aviation services and products.
- **With more airspace than any other state, and over 750 airports, Alaska is an attractive place to test new aviation technologies.** The state is also home to two space launch sites.
- **The state has a history of innovation related to air transportation.** Many civilian uses of unmanned aircraft were first tested in Alaska, as was the new global standard for navigation and air traffic management technology.
- **Alaska's global position offers strategic value.** Located less than 10 flight hours from nearly all of the industrialized world, Anchorage is one of the world's busiest cargo hubs.
- **Alaska benefits from military infrastructure.** Alaska can attribute substantial aviation and aerospace competencies to the US Army and Air Force bases and infrastructure like the Long Range Discrimination Radar (LRDR). As a customer base, Alaska's large military presence attracts aerospace firms.

As industry sectors, aviation and aerospace cover a broad range of business activity and opportunities that can be leveraged as part of broader economic development strategies. These include:

- **Aviation is a major economic driver in Alaska.** One Federal Aviation Administration (FAA) study estimates that aviation contributes nearly 40,000 jobs with indirect/induced effects in Alaska, rivaling some of the state's largest industries. Alaska has the highest concentration of aviation employment of any state, indicating a high degree of economic specialization in the sector.
- **Ted Stevens Anchorage International Airport, the world's fifth busiest cargo airport, offers opportunities to attract companies.** The Alaska AeroNexus Alliance is currently marketing airport sites to firms that may benefit from proximity to a major cargo hub.
- **Training and education programs.** The University of Alaska system is a leader in aviation education and attracts a large share of students from out of state. The global demand for pilots is high and growing.
- **A small number of specialized firms in Alaska design and build aircraft components and sell them globally**. These companies specialize in small bush aircraft, which are flown in remote locations around the world.
- **Alaska is a major test site for unmanned aircraft**, thanks to the Alaska Center for Unmanned Aircraft Systems Integration (ACUASI) at the University of Alaska Fairbanks.
- **Commercial space launches are expected to increase in the coming years**, presenting opportunities for the state with its two rocket launch sites.

Based on a review of and analysis of current trends, CED has identified four focus areas to capture the economic opportunities for aviation in Alaska. These are:

- **Launch and sustain economic development attraction efforts like the AeroNexus Alliance that promotes investment at Ted Stevens Anchorage International Airport.** Attraction of new firms requires marketing and ideally leverages incentive programs, which Alaska generally does not utilize.
- **Become a leading center for training.** Through the University of Alaska and other training programs, Alaska has an opportunity to promote itself as a global training hub for piloting and other aviation specialties. The state's uncongested, uncontrolled airspace could be a major asset.
- **Create mechanisms to support research and development,** such as research and development (R&D) tax credits and assistance for firms seeking Small Business Innovation Research (SBIR) grants through the Small Business Administration.
- **Develop aviation-focused entrepreneurship and innovation.** The support systems of the state's entrepreneurship ecosystem include startup capital, mentors, events, and networking. Building an entrepreneurial focus area around aviation—similar to the one emerging in renewable energy—could help to spawn high growth companies. This should be led by entrepreneurs themselves with support from economic developers, government, investors, and others.

Alaska's Economic Advantages in Aviation

Airspace

With 2.4 million square miles of airspace, FAA's Alaska Region is nearly 80% the size of the entire land area of the Lower 48 states. The abundance of Class G (uncontrolled) airspace makes Alaska an ideal testing location for new technologies like unmanned aircraft.

Source: FAA

Global Position

The shortest air route between major cities in East Asia and North America is usually directly over Alaska. Anchorage is less than 10 hours from most of the industrialized world.

Source: Alaska International Airport System

Manufacturing and Export

Several firms in Alaska specialize in manufacturing aircraft components for in-state as well as national and international markets. Alaskan firms are market leaders in some niches like aircraft skis.

Source: CED interviews

Aviation Workforce

Alaska has the highest concentration of aviation employment, and more pilots per capita than any other state.

Source: BLS, FAA

Pioneering New Technologies

The state has a long history of developing and testing aviation technologies, with ADS-B and unmanned aircraft being two recent examples.

Source: CED interviews

Figure 1: Alaska's Economic Advantages in Aviation

II. Introduction

On a summer day in 1913, a group of spectators gathered in Fairbanks to witness an unusual sight. Aviators James and Lilly Martin had shipped a Martin Tractor Aeroplane from Seattle and were now staging a demonstration of this novel flying machine, hoping to sell it. The aircraft--clumsy looking to modern eyes with its biplane design, translucent fabric skin, and thin support struts --sputtered to speeds of 45 miles per hour at an altitude of 200 feet. Despite attracting the attention of onlookers, no one bought it.[1] Nonetheless, July 3, 1913 marked an important milestone in Alaska history. A decade after the Wright Flyer first left the ground in North Carolina, Alaska had witnessed its first flight.

Despite the apparent lack of buyer interest, the Martins must have seen a sales opportunity in a northern territory of vast distances and virtually no roads. However, Alaska's golden age of aviation would not truly begin until the 1920s. The story of the decades that followed would be dotted with names like Noel Wien (Alaska's first commercial aviator), Ben Eielson (first to fly mail), and Joe Crosson (first to land on Denali's glaciers).[2] These and other pioneers pushed the limits of their aircraft and built lifelines for the territory's far-flung communities. The military saw strategic value in Alaska as well and built bases, airfields, and radar stations.

Alaska is home to more licensed pilots and registered aircraft per capita than any other. Photo courtesy of the Alaska Division of Economic Development.

Today, Alaskans understand intuitively that aviation matters. In the century since the Martins' inaugural flight, aircraft remain essential to the movement of people and goods. One in every five Alaskans lives in a borough or census area with no highway connection.[3] By one estimate, 86 percent of the state's municipalities fall into this category.[4] Many communities could scarcely exist or participate in the modern economy without commercial aviation.

This dependence on air travel has spurred intense interest and specialization in aviation. The state is home to more licensed pilots and registered aircraft per capita than any other. Anchorage International Airport is the second busiest cargo airport in the U.S., and fifth in the world.[5] There are over 750 airports in Alaska, with 242 owned by the State of Alaska. Two of the nation's 19 space rocket launch sites are located in Alaska.[6] These and other superlatives help to characterize Alaska's deep relationship with aviation.

Figure 2: State-owned airports in Alaska. Only the boroughs and census areas in grey have road access. Those in green areas have limited or no highway connections at all. Source: DOT&PF.

Aviation has a major economic footprint in Alaska. As an industry, aviation includes air carriers (cargo and passenger), airport operations, component manufacturing, and research and development. The Federal Aviation Administration (FAA) estimated that civil aviation created 39,000 jobs in Alaska in 2014, counting indirect and induced effects.[7] This amounts to more than one job in ten having some connection to air transportation. Aviation's role as a driver of employment in its own right is similar in magnitude to that of the seafood industry.[8] All told, Alaska has a higher concentration of air transportation employment (as a share of the total workforce) than any other state.[9]

Alaska's aviation economy and the assets that buttress it help to make air transportation a natural outlet for innovation and entrepreneurial energies. Scarcely more than decade after the Martins' Fairbanks barnstorming, Alaska bush pilots experimented with home-built skis and floats.[10] In more recent years, Alaskans demonstrated some of the first uses of unmanned aircraft for non-military uses. Beginning in the late 1990s, pilots in the state helped the FAA develop Automatic Dependent Surveillance-Broadcast (ADS-B) for navigation and air traffic management. The technology is now the global standard. Today, aerospace innovators in Alaska are experimenting with airships, liquid-fueled rockets, and unmanned cargo delivery.

Yet as Alaska is a center for aviation innovation, the sector also faces notable headwinds. Efforts to grow the economic footprint of the Anchorage International Airport's air cargo hub face difficulties in attracting large firms. Nationwide competition is strong in the unmanned aircraft space, where state government and the University of Alaska have invested considerable energies. Aviation businesses cite obstacles in the cost of operations, difficulty attracting skilled workers, and complex regulatory processes. Tackling these challenges and encouraging growth will require a dedicated focus. This report is a part of that process.

The Focus of This Report

Aviation and aerospace touch so many aspects of the state economy, from tourism to defense, that they can be difficult to define from an economic perspective. This study attempts to focus on aspects of civil aviation and aerospace with the potential to bring new dollars into the state economy as either business revenues or new investment. The interests and focus areas of entrepreneurs currently launching aviation businesses also factored into the discussion. Opinions will differ on which aspects should be included under these broad parameters, but the CED and Division of Economic Development teams, in consultation with subject matter experts, determined the following areas of focus:

- Air cargo and logistics, especially as relates to the Ted Stevens Anchorage International Airport
- Training and education offerings in aviation with recognition outside of Alaska
- Manufacturing of aircraft components
- Use and commercialization of unmanned aircraft
- Other emerging technologies in aviation
- Commercial space launches and associated activity

As an additional note, this report references the important role of the military in aviation and aerospace in general, and Alaska in particular. Civil aviation benefits from the military as a source of technology and developer of the workforce (since many aviators and business owners have military backgrounds). However, the project team decided not to make the military a primary area of focus. CED felt that defense-centered economic development in Alaska could not be adequately addressed as a component of an aviation and aerospace study of this scope.

Alaska Punches Above its Weight In Aviation

Licensed Pilots

There are 10 pilots for every 1,000 residents in Alaska, compared to national average of less than two per 1,000 residents in the US as a whole.

Airports

With 758 airports, Alaska has more landing facilities than all but three states--Texas, Florida, and California. TSAIA is the world's fifth busiest cargo airport.

Aircraft

Only five states are home to more registered aircraft than Alaska. Even large, populous states like New York, Pennsylvania, and Illinois host fewer aircraft than Alaska.

Aviation Employment

Aviation employs a larger share of Alaska's workforce than that of any other state, as determined by a location quotient analysis.

Enplanements

Alaska has one of the highest numbers of passenger trips per capita of any state, with 6.8 enplanements per resident compared to a national average of 2.5.

Figure 3: Alaska Punches Above its Weight in Aviation

III. Air Cargo and Logistics

If you fly non-stop between East Asia and almost any major city in North America--say, between Beijing and Los Angeles--you might be surprised to find yourself flying over Alaska and the Bering Sea. To look at a flat map of the Earth, it may not be obvious that the most direct routes between Asia and North America require entering Alaska airspace. This odd fact is a major reason for Ted Stevens Anchorage International Airport's (TSAIA) global importance as an air cargo hub.

Located halfway between Tokyo and New York, Anchorage is less than ten hours by air to 95 percent of the world's industrialized population.[11] Cargo arriving in Anchorage can be moved to or from Asia, Europe, or the Lower 48 with ease. As of 2017, Anchorage ranked fifth in the world for air cargo volume, and second in the US behind Memphis. Anchorage's desirable location makes the city a hub of Asia-North America air cargo transfers; refueling in Alaska allows flights to carry more cargo and less fuel, increasing revenue.

Top Global Airports for Air Cargo, 2017

Rank	Airport	Metric Tons
1	Hong Kong	5,037,970
2	Memphis, TN	4,336,753
3	Shanghai, China	3,824,280
4	Incheon, South Korea	2,921,692
5	Anchorage, AK	2,718,209
6	Dubai, United Arab Emirates	2,651,272
7	Louisville, KY	2,602,696
8	Tokyo, Japan	2,336,427
9	Taipei, Taiwan	2,269,584
10	Frankfurt, Germany	2,194,056

Figure 4: World's top 10 airports ranked by freight loaded and unloaded in 2017. Source: Airports Council International.

Anchorage Air Cargo Volume

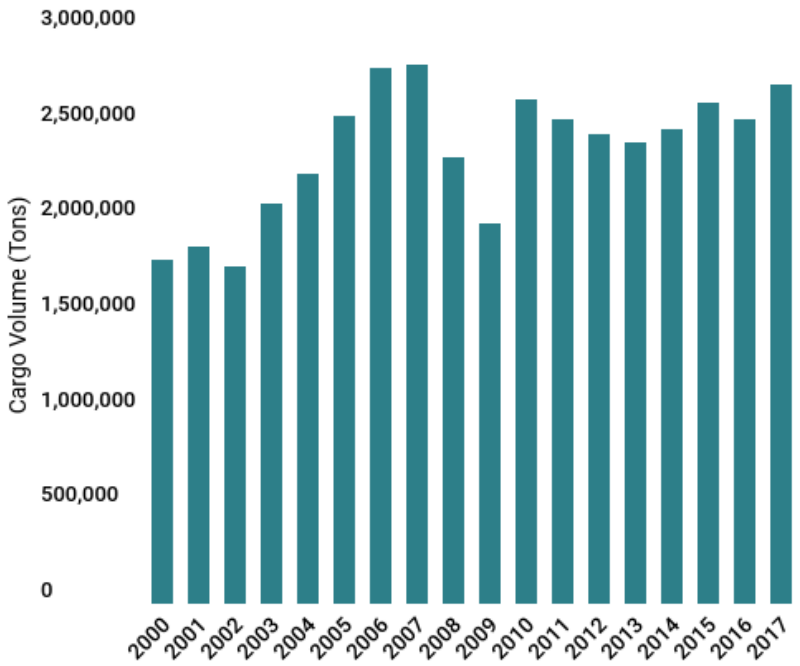


Figure 5: Annual cargo volume for TSAIA. Source: Airports Council International.

As a 2014 report about TSAIA notes: "[An] intermediary stop in Anchorage, as opposed to flying from Shanghai to Oakland, actually increases total flight distance by around 144 miles. But this allows the aircraft to carry an additional 45,000 kg of cargo instead of extra fuel which increases revenue for the trip."[12]

Top Origins and Destinations for Cargo to/from TSAIA

Top International Cities	Top US Cities
Seoul	Chicago
Taipei	New York
Shanghai	Los Angeles
Hong Kong	Dallas/Ft. Worth

Figure 6: TSAIA's top cargo origin and destination cities ranked by cargo volume. Source: GLDPartners, AEDC.

As a result, a large logistical support industry is based at TSAIA, including a FedEx regional hub. Nearly 1,000 people are directly employed in private sector air freight transportation in Anchorage.[13] But the true economic impact of TSAIA is much larger than this would suggest. A 2012 study by Anchorage Economic Development Corporation (AEDC) and the McDowell Group found that the airport was responsible for creating nearly 16,000 jobs, accounting for public sector administration, support services, and indirect/induced jobs in other sectors. Roughly $1 billion in annual payroll resulted from these jobs.[14]

The Alaska AeroNexus Alliance is an active effort to attract private investment to TSAIA on its strength as a cargo hub. Led by TSAIA (a state government entity), AEDC, and the Municipality of Anchorage, AeroNexus seeks to market the airport to industrial firms needing quick access to air freight logistics. Taking the lead on marketing efforts under AeroNexus, AEDC's Will Kyzer says that products moving through Anchorage span numerous industry categories. Seafood, cut flowers, pharmaceuticals, and automotive parts are just a few examples. If some component of the value chain could be performed in Anchorage, the result could be an economic opportunity. Kyzer points to a 2014 (updated in 2015 and 2016) report entitled *AIAS Air Cargo Related Economic Development: Opportunity Assessment*.[15]

The report identified three major target industries to attract to TSAIA:

- Third party logistics firms
- Global manufacturing businesses with supply chains spanning Asia and North America. Examples include aerospace, apparel, automotive, electronics, pharmaceuticals, and toys.
- Specialty logistics providers [16]

Kyzer is especially interested in the opportunity surrounding pharmaceuticals. When drugs are shipped from the US to China, for instance, a certain percentage may reach their expiration date or fail quality control standards. These must be sent back to their manufacturer in what is referred to as reverse logistics. The drugs themselves contain sensitive intellectual property and often must be handled or disposed of on US soil under the protection of US law. An Anchorage-based operation could sort, repackage, or incinerate them.[17]

The *Opportunity Assessment* created a scenario in which a pharmaceutical reverse logistics center was located at TSAIA. In the scenario, products arrived from Shanghai, Beijing, and Tokyo and went on to

Will Kyzer stands on an Alaska Airlines converted 737-700 freighter, the first model to be converted from passenger to cargo. Photo Credit: AEDC

Chicago and Newark. The assessment found TSAIA to have the highest qualitative and quantitative scores, beating the nearest competitors.[18]

Airplane components were the subject of another scenario. TSAIA placed third amongst competitors in terms of strategic location for a North America spare parts logistics distribution center. Factors in the decision-making process included cost, time in transit, reliability, and business environment and infrastructure. TSAIA scored low for business environment and infrastructure, but scored high in time in transit and reliability.[19]

Another attraction opportunity relates to the aircraft themselves rather than their contents. Maintenance, repair, and overhaul (MRO) companies perform critical work to keep aircraft operating safely with minimal down time. An established MRO provider based at TSAIA would be positioned to capture some of this demand, with the heavy traffic from Asian cargo aircraft. The Asian MRO market for engines is poised to grow by 10% annually for the next five years. According to a study by the Boston Consulting Group on behalf of TSAIA, the airport has access to a large "captive" fleet of Boeing aircraft with 59% of the Asia-North America air cargo market. The consultancy points to the global position, aviation culture, and state government financing through the Alaska Industrial Development and Export Authority (AIDEA). At the same time, the report notes the state's high corporate taxes, labor costs, and remoteness from the US as weaknesses to overcome. The study estimates that an engine MRO operation could create roughly 300 high-skilled, high-paying jobs in the state.[20]

Kyzer and former TSAIA manager John Parrot point out that there are obstacles to expanded economic

Anchorage International Airport is the second busiest cargo airport in the U.S., and fifth in the world.
Photo Credit: Chris Arend Photography

development at the airport. In some cases, competing airports such as Seattle-Tacoma, Calgary, and Vancouver have developed real estate sites for commercial tenants, where TSAIA has few "move-in" ready sites on airport property. The cost of business is generally high in Alaska due to the price of real estate, labor, freight, and energy, which can deter firms. The state also has little ability to offer attraction incentives such as tax abatements.

TSAIA is unique among the world's other top cargo hubs in that it is relatively isolated from both manufacturing and large markets. "We're nine hours from everywhere but three hours from nowhere," laughs Parrot. Shanghai and Taipei are located near major centers for global manufacturing. Memphis and Louisville provide ready access to intermodal facilities and US population centers. By contrast, Anchorage is a technical stop in which jets refuel and sort cargo for their next destination. The Alaska economy benefits, but the impact could be larger if more companies clustered in or near the airport to add further value.

Air Cargo Hub

Ted Stevens Anchorage International Airport Cargo Hub

Advantages

- Global position
- Developed runway infrastructure
- High cargo throughput
- US legal and intellectual property protections
- Favorable tax environment: no income or sales tax
- Free trade zone
- Cargo transfer rights

Barriers

- Limited site availability: buildings and shovel-ready sites
- High business costs: labor, energy, construction
- Small workforce with limited skill sets
- Few state or local incentives to attract investment
- Competition from more cost-competitive locations
- Limited flexibility as a state-owned asset (i.e. procurement and personnel processes)
- Absence of large-scale manufacturing or other value chain segments

Opportunities

- Attracting firms in logistics, MRO, and manufacturing
- New business models for entrepreneurs
- Growing MRO demand

IV. Training

As a U.S. Air Force squadron commander at Yokota Air Base near Tokyo, Randy "Church" Kee bemoaned the congestion of Japanese airspace. In addition to the heavy air traffic from one of the world's largest cities, high atmospheric winds made it difficult for his pilots to stay current with their training. The solution was to move the squadron to more suitable airspace twice each year to a place where airspace is open and readily available: Alaska. The state was also convenient to access from Japan. Kee, now a retired Major General leading UAA's Arctic Domain Awareness Center, said those trips were essential to keeping his aviators proficient.

In both Alaska and the U.S. as a whole, pilots are in high demand. Boeing estimates that 1.5 million additional pilots, cabin crew, and technicians will need to be trained by 2035.[21] The University of Alaska Anchorage (UAA) and Fairbanks (UAF) highly contribute to the state's aviation education. UAA offers a professional pilot training program certificated by the FAA. Ralph Gibbs, Director of Aviation Technology Division, notes, "UAA is a 141 flight school [referring to an FAA regulation], embedded in a university program-[making it] more rigorous and structured." By contrast, regulation Part 61 schools require less from students. UAF does not offer flight instruction, but does offer an Associate of Applied Science (AAS) degree in professional piloting, which helps prepare students for required FAA written exams for piloting certificate ratings. Additionally, over 40 flight training schools are located in Alaska, although not all are active.[22] Since the FAA increased the mandatory number of instruction hours under Part 141, pilots have become even more scarce.

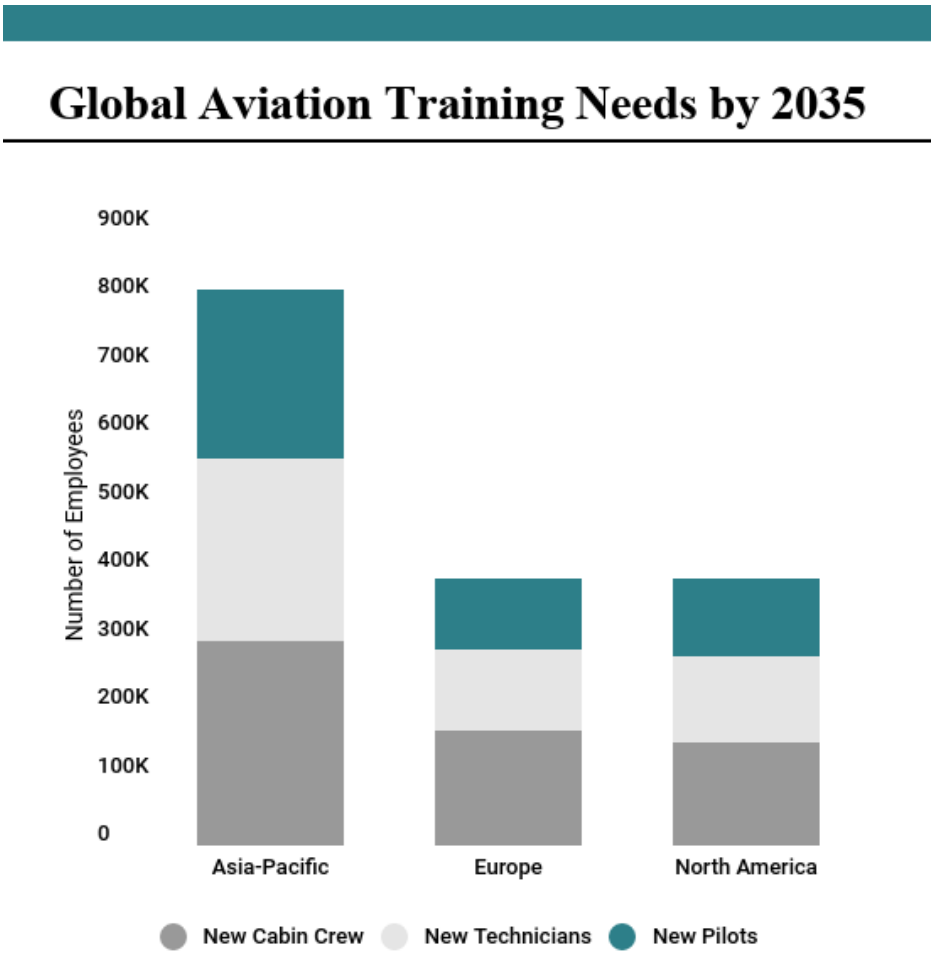


Figure 7: Projected demand for pilots, technicians, and cabin crew by region. Source: Boeing Corporation.

Alaska's Aviation Training Assets

Organization	Program	Degree Type
	Hands on Training	
Hands on Training Talkeetna Build A Plane - Talkeetna, Alaska	An IRS-approved 501 (c) (3) non-profit organization working in formal partnership with the Federal Aviation Administration and many other organizations to promote aviation and aerospace education.	
Hooper Bay Build A Plane - Hooper Bay, Alaska	Chevak High School's aviation program that started in 2009.	
	Flight Training	
40 private flight training schools with business licenses in Alaska		
	University Education	
University of Alaska Anchorage (UAA)	Air Traffic Control Aviation Administration Aviation Maintenance Professional Piloting Aviation Administration/Management Airframe Power Plant	Associate of Applied Science Degree Bachelor of Science Degree Aviation Technology Minor Certification
University of Alaska Fairbanks (UAF)	Aviation Maintenance Air Frame Power Plant Professional Piloting *The aviation technology program is one of only a few in the United States where students can earn an airframe and power plant mechanics license in one year. College of Engineering offers Aerospace Engineering Minor	Associate of Applied Science Certification
	K-12 Education Opportunities	
AvStem	Introduction to aviation courses.	
Galena Interior Learning Academy (GILA)	Private pilot's license courses.	

Figure 8: Alaska's aviation training assets.

On top of the shortage of pilots, flight instructors are particularly hard to come by. When the US economy hit a recession in 2008, people traveled less the following year and major airlines hired just 30 pilots. From 2009 to 2017, that number skyrocketed to 5,000.[23] When pilots were not working for the airlines, they were often working as flight instructors. However, as the demand for pilots increased, they went on to work for airline companies, creating the shortage. The major commercial airlines pay up around $200,000 annually, while flight training entities usually pay significantly less.

To enhance student recruitment at the national level, Gibbs is building partnerships with community colleges with aviation programs around the country. These schools offer associate's degrees but not bachelor's, so students needing the higher degree can naturally feed into UAA's programs.

Gibbs stresses that UAA's aviation division is not simply a set of training programs for in-state students seeking in-state aviation jobs. It is a leading program on the national stage, attracting a sizable share of its student body from out of state, and even from outside the US. It is one of the few programs in the US to award bachelor's degrees for professional piloting and aviation administration, even as airlines increasingly prefer this higher level of education. John Beissmann, who graduated from the program with a BS in Aviation Administration in 2017, moved to Alaska specifically for the education at UAA. "I came up here for it," he says. "They always say 'if you can fly in Alaska, you can fly anywhere' just because of the conditions." Beissmann took a hiatus from his job at Delta Airlines in Chicago to earn his degree, which positioned him for a major promotion within the company when he returned in 2018.

Like Gibbs, Kee sees an opportunity for Alaska to stand out as a global training hub for piloting and other aspects of aviation. He notes that some East Asian airlines--from the countries with the greatest projected demand--train in the Lower 48, to avoid the congestion of major cities just like he did as a squadron commander. Why not Alaska?

Training and Education

Aviation Training and Courses

Advantages

- Unencumbered airspace for training
- Global position is accessible
- University of Alaska aviation programs
- Numerous private training entities

Barriers

- Limited instructional capacity
- Limited awareness of Alaska as training location
- Shortage of qualified flight instructors

Opportunities

- High demand for pilots and aviation workers
- Attraction of training entities to Alaska
- Opportunity to cement leadership role as aviation training hub

V. Manufacturing

Jason Kepler has a messy office. He points to a model of a single-engine airplane on his desk amid stacks of papers and mechanical bits and pieces. The aircraft is a Chinese design similar to various types of bush planes flown in Alaska. Kepler is designing several flight-critical components for the engine, and building prototypes in the metal shop adjacent to his office.

An MIT-trained aerospace engineer, Kepler is the lead engineer for Aero Twin, located at Merrill Field in Anchorage. Designing parts for a Chinese company may be a novel project for Aero Twin, but designing and making aircraft components for sale globally is not. Aero Twin specializes in the Cessna Caravan, commonly flown by small air carriers throughout Alaskaand the developing world. They have designed and built landing gear deflectors, rudder locks, exhaust deflectors, baggage compartments, and a long list of other components. The company holds the supplemental type certificate (STC) for many of them, giving it an exclusive right to produce it under FAA regulations. Most of Aero Twin's sales come from outside the US; Australia, Africa, Southeast Asia, and Canada are major markets.

Alaska is not known as a manufacturing hub. Most of the state's manufacturing employment is in seafood processing; even counting this sector, Alaska has the lowest concentration of manufacturing jobs of any state other than Hawaii.[24] This makes Alaska's aircraft parts makers all the more remarkable for their ability to design and build high value products and export them globally. A key strength for Aero Twin and similar companies is the presence of a large market in the state. Manufacturers interviewed as part of this study said that proximity to a large customer base--with roughly 9,000 registered aircraft--was a major advantage to operating in Alaska. This customer base provided a foundation from which to build economies of scale sufficient to expand sales outside of the state.

The iconic Alaskan Bushwheels brand illustrates the importance of that in-state market. Started in Alaska, the company moved to Oregon in 2000 when a new owner purchased it, hoping to take advantage of a less expensive business climate. In an unusual move, Birchwood-based Airframes Alaska bought the business and

The shop floor at the Birchwood-based Airframes Alaska, now home to the iconic Alaskan Bushwheels brand. Photo Credit: CED

relocated operations back to the state in 2014. Manufacturing their product in Alaska is a point of pride for the company, but the business case was also important. While 10 percent of the company's revenue is international and 30 percent is from the Lower 48, the bulk of company sales are to Alaska pilots. Being close to those customers and minimizing shipping costs was important.[25] With 40 employees, Airframes Alaska is almost certainly the state's largest aviation manufacturing business. In 2015, Inc. 5000 listed it as the fastest growing private company in Alaska, and 37th on a list of the top US manufacturing companies.[26]

At the opposite end of the Anchorage Bowl, a company called Airglas specializes in landing skis, cargo storage pods, fuel tanks, and other components made from fiberglass and carbon fiber. Founded prior to statehood by World War II aviator Wes Landes, Airglas boasts customers in over 40 countries, with overseas militaries being an especially important segment. The Japanese Defense Forces recently purchased skis for their Apache helicopters from Airglas, for instance. The company dominates a niche market space, and operations manager Jim Hammer does not believe the firm has any direct competitors across most of their product lines. Prior to building up an international customer base, the company started out serving Alaska bush pilots who needed to land on snow with something more reliable than home-built skis.

Products designed and built in Alaska include:

- Cabin seats
- Cargo pods
- Engine baffles
- Exhaust deflectors
- External load cargo racks
- Forward looking infrared radiometer (FLIR) canister mounts
- Fuel tanks
- Fuel valves
- Fuselages
- Hot rod mufflers
- Instrument panels
- Landing skis
- Nose forks (for landing gear)
- Passenger door steps
- Short take-off and landing (STOL) kits
- Tundra tires
- UAV recovery system
- Wheels and brakes
- Wing struts

Airglas landing skis. Photo Credit: Ciara Zervantian

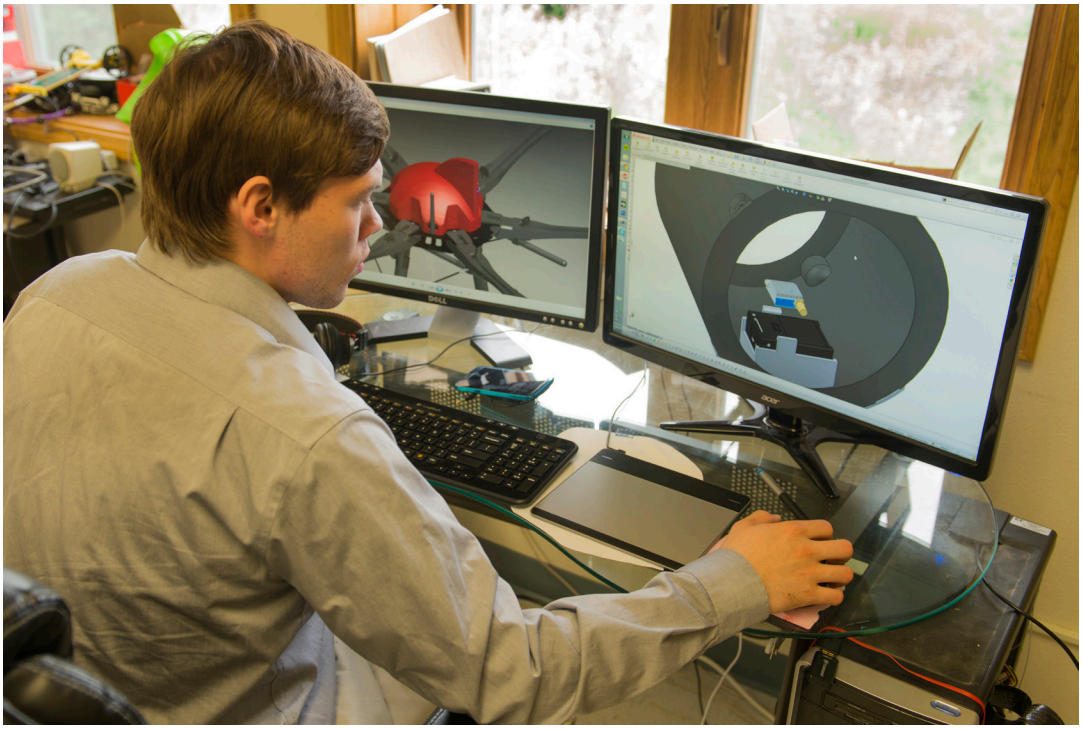
Alaska Bushwheels. Photo Credit: CED

Each of the manufacturers interviewed boast the ability to perform R&D to develop and test new products. Highly trained individuals like Kepler focus on expanding the available product lines by designing components and shepherding them through the lengthy STC process mandated by the FAA. In many cases, growth depends on an expanding array of product offerings since the market for parts for any one bush aircraft type (like a Cessna Caravan) is limited. However, several of these companies noted the great difficulty and expense in designing and certifying new products. As Kepler explained, the company may invest considerable personnel costs in a new product that will not produce revenue for several years, and may not prove viable at all. Capital available to sustain this type of R&D investment is scarce for such small companies. The federal SBIR program may be one option to secure R&D funding in some cases.

Additive Manufacturing

In recent years, additive manufacturing equipment has become more affordable and available, creating ample opportunities in a variety of industries. The top aviation industry leaders are using 3D printing, otherwise known as additive manufacturing, to produce airplane parts. An example of this is Airbus's new A350 XWB aircraft that uses more than 1,000 3D printed components - a record number in an aircraft.

Levi Bassler, owner of Imagine it Alaska, sees a future for 3D printing for aircraft parts in Alaska. Bassler is open to working with people who want parts for aircrafts, such as cabin walls, that don't need approval from FAA because they are not flight critical nor a material specific part. Additive manufacturing or 3D printing creates a 3D object from electronic data then builds a product layer by



A technician at UAF's ACUASI reviews a 3D rendering of UAV components.
Photo Credit: Greg Martin

layer from the bottom up. 3D printing allows for the manufacturing of highly complex shapes, on demand as needed.

One of the major aerospace firms experimenting with additive manufacturing is GE Aviation, a company that has 8.5 percent of the aircraft, engine and parts manufacturing market share in the US.[27] With the development of 3D-printed engine fuel nozzles, GE Aviation was able to reduce fuel consumption as well as emissions. Engineers struggled to cast the nozzle tip because the tips' interior geometry was too complex. GE used 3D printing to make the nozzle tip from nickel alloy and replaced 20 traditionally-made parts with a single piece that weighed 25 percent less than the ordinary nozzle and was more than five times as durable.

Several component manufacturers interviewed as part of this study indicated a degree of interest in 3D printing as a likely trend in the future. At the same time, they noted the difficulty of security FAA approval and the high capital cost of the equipment. The FAA approval process for supplemental type certificates, which are required for flight-critical components, specifies the process by which the product is made as well as strength characteristics. Still most were aware of the technology and interested in finding ways to utilize it, such as it for creating prototypes rather than for functional components.

Paul Herrick, UAA aviation maintenance technology professor, says his students are interested in additive manufacturing. He recently oversaw a student research project on the subject. Although he sees great potential in the use of the technology globally, he is also skeptical about widespread use in small aircraft in Alaska. In the world of aviation maintenance, he says, "we will sacrifice innovation for reliability." Many of the aircraft his former students maintain were designed in the 1930s, built using technologies that have scarcely changed in 80 years.

Aircraft Parts Manufacturing

Aircraft Parts Designed and Made in Alaska

Advantages

- Concentration of aircraft in Alaska
- High specialization in small aircraft
- Export orientations of firms
- R&D capabilities

Barriers

- Limited growth in number of small aircraft
- High cost of R&D
- Complex regulatory process

Opportunities

- Expansion of product lines
- Investment in R&D
- Growth potential in developing markets (i.e. China)

VI. Emerging Technologies

Automatic Dependent Surveillance-Broadcast

On January 1, 2001, Skip Nelson was piloting a commercial aircraft from Anchorage to Bethel in what seemed like ordinary circumstances. At a certain point during the flight, an air traffic controller reported to him via radio that he was outside of radar surveillance range, and provided him a new piece of information: something called an ADS-B vector. Automatic dependent surveillance-broadcast (ADS-B) determines the precise location of an aircraft in real-time and shares the information with ground stations and other aircraft. Although the flight was otherwise routine and uneventful, Nelson recognized the historical significance of the exchange. It marked a milestone in a global revolution in the management and navigation of air traffic.

Prior to the Capstone program one pilot was killed every 9 days on average in Alaska. A pilot's life expectancy was just 20 years. After the Capstone program was implemented the initial number of accidents in Alaska decreased by up to 50 percent.

Skies around the world are becoming increasingly crowded. This poses several challenges such as flight delays, increased costs, and negative environmental impacts. The FAA and its global counterparts have long recognized a need for more efficient air traffic management to reduce flight times, fuel consumption, and safety hazards.

Nelson's Bethel flight in 2001 marked the first use of ADS-B for flight control, occurring as the nascent technology was being tested. Under an FAA program called Capstone, Alaska pilots like Nelson helped develop and test the technology and prove its effectiveness. This is not the first, or last time that Alaskan played an important role in aviation research and development.

The Capstone program started in Alaska in 1999 as an effort to reduce the highly disproportionate number of fatal aircraft accidents in Alaska. Before this program, in Alaska one pilot was killed every 9 days on average. A pilot's life expectancy was just 20 years. The initial number of accidents in Alaska decreased by up to 50 percent due to the Capstone program with its use of ADS-B—a huge accomplishment.[28]

Since the Capstone program, ADS-B has been replacing radar systems that were used for well over half a century to manage air traffic. FAA has since mandated ADS-B in most private and commercial aircraft that fly in controlled airspace, beginning in 2020; other national governments have followed suit.

Although the technology was tested and improved in Alaska, many low-flyers have not installed ADS-B equipment because traffic information services are unavailable in many areas of Alaska due to limited number of ground-based stations. According to FAA, Alaska needs 12 to 14 more ADS-B ground stations.[29] Some general aviation pilots also do not want to install the equipment because of the cost. According to Nelson, radar stations cost $10-20 million and require heavy use of electricity and human operators. On the other hand, an ADS-B antenna is eight inches in diameter and has a single radio on ground costing around $250,000.

Capstone Program in Alaska 1999-2006

A United States government-funded aviation safety program for the state of Alaska, primarily focusing on rural areas of the state.

1999

The Federal Aviation Administration (FAA), the Alaska Pilot's Association, commercial operators, the University of Alaska, MITRE Corporation, some avionics manufacturers and individual pilots work together on Capstone Program.

2006

The FAA integrates the Alaskan Capstone project into the national Automatic Dependent Surveillance – Broadcast (ADS–B) program.

2007

The program reduces the accident rate in the eastern part of Alaska by around 40%.

2020

Beginning January 1, 2020, an airplane flying in controlled airspace must be equipped with ADS-B Out. ADS-B Out refers to an aircraft broadcasting its position and other information. ADS-B In refers to an aircraft receiving the broadcasts and messages from the ground network such as TIS-B and FIS-B.

Figure 9: Capstone Program in Alaska

Today, Nelson owns and operates a private firm called ADS-B Technologies, with a dozen employees. ADS-B Technologies is a rare instance of a technology-based firm operating from Alaska and serving a global market. The company has been certifying ADS-B products and introducing the technology to the continents of Asia, Africa, and South America. "Developing countries can skip radar and go to ADS-B," Nelson said. He is particularly proud of his work in helping such countries create modern air traffic control frameworks.

The company also does limited manufacturing of components, owns and licenses intellectual property, and consults for aerospace giants like Lockheed Martin. Nelson believes a major opportunity exists in cybersecurity, since ADS-B generates large quantities of data that malicious actors can intercept and misuse. People are tracking celebrities, there are concerns about terrorism, and competitors can gain advantages and potentially affect stock prices by tracking aircraft locations. His firm is creating a product that Nelson claims will handle issues that come with cybersecurity by preventing location signals from being seen.

The development and testing of ADS-B provides an example of Alaska's comparative advantages in aviation being leveraged to create a new technology-based product with export potential. As with unmanned aircraft, Alaska's geographical advantages and aviation expertise made it an ideal place to test and prove new technologies.

Skip Nelson, one of the developers of the Capstone program, stands in his office at ADS-B Technologies. Photo Credit: Ciara Zervantain

Navigation Systems

Required Navigation Performance (RNP) ensures an aircraft stays within a specific containment area and avoids known objects, allowing for landing and takeoff in areas with poor visibility or known hazards. In 1996, Alaska Airlines was the first airline in the world to use RNP while landing in Juneau in foggy conditions. Since then, airlines have used RNP to minimize congestion at major airports in the US.

Weather Cameras

Aviation weather cameras throughout Alaska continuously update conditions, allowing pilots to look at visual evidence of weather conditions before they fly. These weather camera images can be found online and help reduce weather-related aviation accidents and flight interruptions. In June 2007, the first 80 sites were installed. Now there are nearly 900 cameras at 228 sites across Alaska. Weather cameras across the state have contributed to the reduction in number of aircraft accidents.[30] The need to update the cameras as new technology becomes available, as well as process and store the data, present opportunities for entrepreneurs.

Dirigibles (Airships)

Based in Anchorage and Kenai, PRL Logistics hopes to change how heavy cargo is delivered to rural communities around Alaska. In partnership with Straightline Aviation, PRL Logistics plans to bring the world's first heavy-lift hybrid airships to Alaska in 2019. Airship operations will be based at PRL Logistics Operations Center in Kenai and supported by other PRL locations throughout the state.[31]

Some may associate airships with the fiery Hindenburg disaster of 1937. However, new airships designed by Lockheed Martin do not contain hydrogen as the Hindenburg did. These airships get 80 percent of their lift from the buoyancy of helium gas and 20 percent from aerodynamic lift along with four thrusters. The LMH-1 is capable of carrying 22 tons of freight and up to 18 passengers plus crew. According to Lockheed Martin, the LMH-1 burns less than one tenth the fuel of a helicopter per ton as they require less energy to remain in flight.[32] For a state that depends on air cargo for essential supplies, airships could open up new options for economical delivery.

Emerging Technologies

Technologies Changing the Aviation Industry

Advantages

- Abundance of uncongested, airspace for testing
- Diverse geography and topography
- Strong aviation culture
- History of aviation innovation
- High density of pilots

Barriers

- Limited availability of technical skills (i.e. software development)
- Limited awareness of Alaska as a testing location
- High operating costs

Opportunities

- Expansion of R&D activity
- New business models for entrepreneurs
- University-industry partnerships

VII. Unmanned Aerial Vehicles

Founded by brothers Nick and Ben Kellie, K2 Dronotics has a unique twist on commercial use of unmanned aerial vehicles (UAV). Rather than operating UAVs as a service, they provide customers with hands-on training and let them fly the UAVs themselves. Their passion for flying UAVs sprang from watching their father, a bush pilot, fly around Western Alaska. Ben, an engineer, called Nick who was working for an oil and gas company, and told him he thought UAVs had great potential in Alaska. Being avid entrepreneurs, they saw an opening and wanted to jump into a growing market.

K2 Dronotics' work involves aerial data collection across the state. Their UAVs are safely and efficiently surveying hard-to-reach areas, at significantly less cost than manned aircrafts. UAVs are able handle some tasks that satellite imagery cannot. They can fly closer to the ground and under the weather, providing a higher level of detail and accuracy. Unlike satellites, UAVs do not have to wait for an orbit path.

After testing different business strategies, the Kellie brothers are now trying to empower customers get their own UAV certification and fly the aircraft themselves. If a customer is remote, they will ship the drone to them and the customer will return the equipment after the job is completed. "We will ask the customer what they are trying to accomplish and help them buy the right drone and with the initial payloads," says Ben Kellie.

K2 Dronotics is not alone in seeing a market opportunity. The use of UAVs is rapidly expanding to commercial, scientific, recreational, agricultural, and other applications. Unmanned aircraft have existed for several decades and evolved through military use. The market for commercial UAVs will eventually pass the military market in size. The global commercial UAV market is projected to reach over $2 billion by 2022, according to a report by Hexa Research.[33]

A UAV pilot readies the Ptarmigan for takeoff. UAVs are often used for jobs considered "dull, dirty, or dangerous." Photo courtesy of the Alaska Division of Economic Development

The economic benefits to Alaska will be considerable if UAVs are safely integrated into in the National Airspace System—the nation's airspace subject to FAA policies are regulations. From 2015 to 2025, the total economic impact of UAV integration in Alaska could result in $112 million in spending and create 141 jobs, according to a study from the Association for Unmanned Vehicle Systems International. The study estimates that UAV integration in the United States will result in $82.1 billion in economic impact and create 103,776 jobs by 2025. Nationally, the most promising commercial and civil markets include precision agriculture and public safety. In Alaska, UAVs high potential commercial uses include public land management, environmental monitors, and remote infrastructure surveillance.

To realize the commercial potential of UAVs, the FAA is developing a regulatory framework to allow for safe integration into the National Airspace System. The 2025 economic impact projection for Alaska is likely to be more accurate if no restrictive legislation or regulations are enacted that would restrain expansion of the technology.[34] Even with the economic benefits that come with this, numerous issues remain. Questions to address include:

- How will UAVs interact with air traffic control?
- Will pilots operating under visual flight rules be able to spot a drone in their airspace?
- What happens if a UAV loses the connection with its remote operator?

Alaska has played a leading role in the integration of unmanned aircraft through the Alaska Center for Unmanned Aircraft System (ACUASI) at the University of Alaska Fairbanks (UAF). When Alaska was selected in 2013 as one of the six official FAA test sites in the United States as part of the Pan-Pacific UAS Test Range Complex, ACUASI took on a crucial role in helping integrate UAVs into in the National Airspace System by researching a wide variety of applications for the technology (see examples below). While a regulatory framework for UAVs is not yet fully formed, ACUASI is permitted to utilize the technology for research purposes. These missions will be used to inform FAA regulations, as well as test the viability of certain UAV applications.

As a recent example of ACUASI's work, UAF was one of ten organizations out of 150 applicants nationwide to be selected for a pilot program to use UAVs to deliver health care supplies. K2 Dronotics' Ben Kellie will be part of a project that plans to test medical device deliveries between the communities of Hope and Indian by flying over Turnagain Arm. Eventually, delivering medical supplies to remote Alaska villages could be a reality.[35] Ben notes, "The real technology is developing the systems that allow that to happen, such as communications and navigation."

Technicians at UAF's ACUASI . Photo Credit: Greg Martin

Recent UAV Efforts at UAF

Mapping

Geographic mapping of inaccessible terrain and locations:

- Mapping river ice before and during breakup along Yukon River.
- Monitoring gas flare stacks at oil and gas infrastructure for need to replace.
- Monitoring critical infrastructure at Trans-Alaska Pipeline beyond visual line of sight.

Surveying

Mapping Arctic land and conducting flyovers to survey marine wildlife:

- Mapping Aialik Glacier in Kenai National Fjords Park.
- Flying over ice fields to capture ice ridge data and surface structure.
- Conducting ice seal surveys on spotted and ribbon seals as well as walrus studies.

Hazard Management

Hazard assessment as well as search and rescue operations:

- Assisting Alaska State Troopers find a missing autistic boy carrying a rifle.
- Supporting wildlife personnel to map forest fires.
- Use for chemical herder application and insitu burning ignition.

UAV Traffic Management

Unmanned Aircraft Vehicle Traffic Management:

- Integrating communication pathways to allow simultaneous aircraft tracking.
- Developing workflow and missions to fly four systems in air at the same time.
- Multiple aircraft tracking with sense and avoid as well as ADS-B.

Leading UAV Integration

Leading UAV integration in Alaska, USA, and the Arctic:

- Lead for one of seven FAA test sites in USA, Pan-Pacific Test Range Complex (PPUTRC).
- Core member of the Center for Excellence for Unmanned Aircraft Systems (ASSURE).
- Lead applicant for one of the 10 chosen Dept. of Transportation UAS Integration Pilot Programs.

Figure 10: Recent UAV Efforts at UAF

A UAV Economic Development Strategy for Alaska
In 2015, the Center for Economic Development and State of Alaska Division of Economic Development released a report outlining a strategy to further develop UAVs as an industry sector. The report outlined four strategic planks:

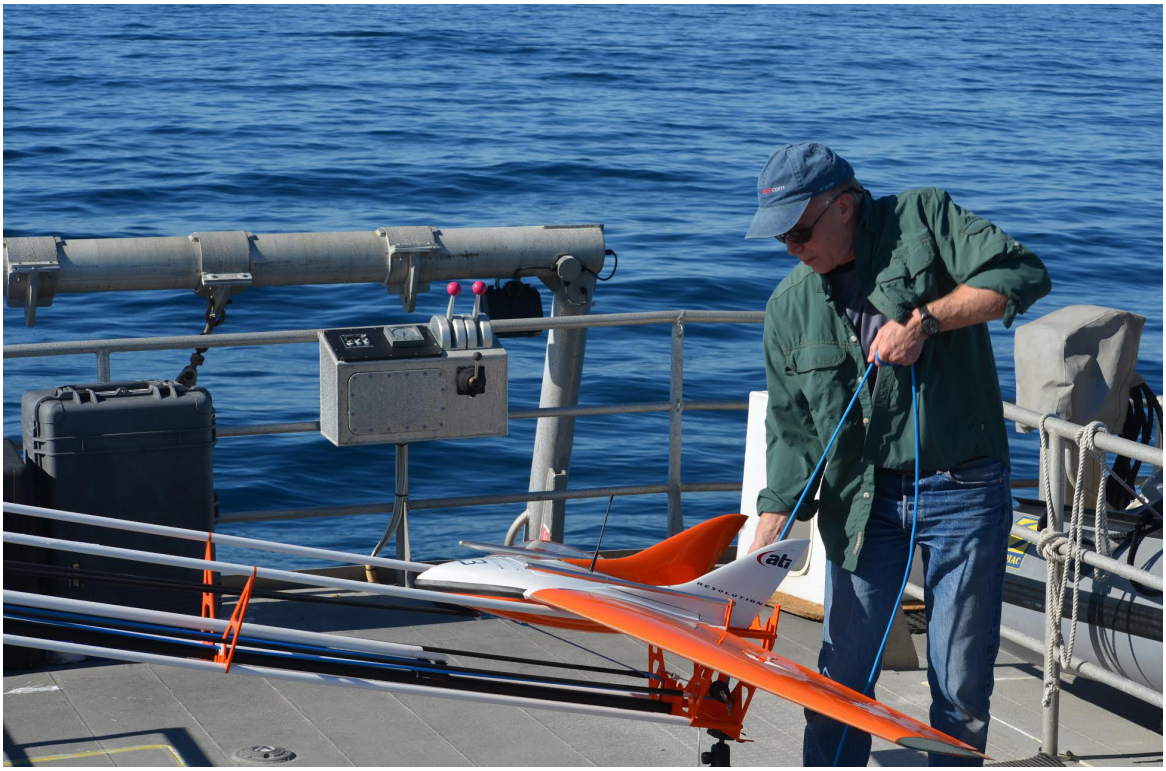
- Create a strong business climate for UAV businesses by incentivizing large anchor firms to establish Alaska operations. This could be accomplished through marketing efforts and the use of incentive programs.
- Fostering innovation and entrepreneurship through targeted R&D efforts, the development of a university research park, and increasing the available of risk capital.
- Cultivating a talented workforce through University of Alaska aviation programs, STEM education at all levels, and industry-university partnerships.
- Improve strategic partnerships and collaboration by creating a leadership structure and coordination mechanisms for the sector. [36]

Figure 11: UAV-Centered Economic Development Strategy for Alaska

Unmanned Entrepreneurs

While watching a James Bond movie many years ago, it dawned on Alan Erickson how a parachute system could be useful for drones. Erickson became an enthusiastic UAV user when they became available, only to have the frustrating experience of losing expensive equipment during flights. He realized a recovery system for drones was missing from the market. With this in mind, he started Anchorage-based Indemnis, and put a team together to develop a deployment system called Nexus, which in the case of a failure lessens the impact on hardware from a fall from the sky. Indemnis does not sell their product yet, but have several beta users signed up. According to the co-founder of Indemnis, Amber McDonald, "FAA regulation will enable this market to expand." Indemnis is working hard to solve problems that come with safely integrating drones in the National Airspace System by finding ways to make flying drones over people safer.

A bush pilot, Tim Veenstra knew his experience doing aerial survey work for fisheries in Alaska waters gave him an advantage to take on the challenge and opportunity of developing a system that could track high sea debris. In the early 2000s, he caught wind of a new research opportunity sponsored by NASA and the State of Alaska to develop systems to track ghost nets -- lost fishing gear that kill fish year after year as they drift through the ocean. Veestra's Wasilla-based company, Airborne Technologies, Inc. (ATI), took advantage of a government grant that helped further his research and kept his business growing. NASA accepted Airborne Technology's proposal to use satellite-communicating buoys to track the convergence of ocean currents to monitor the path the nets were likely to take and use sensor-equipped aircraft to find debris fields. The effort would minimize manual cleanup and be cost effective.

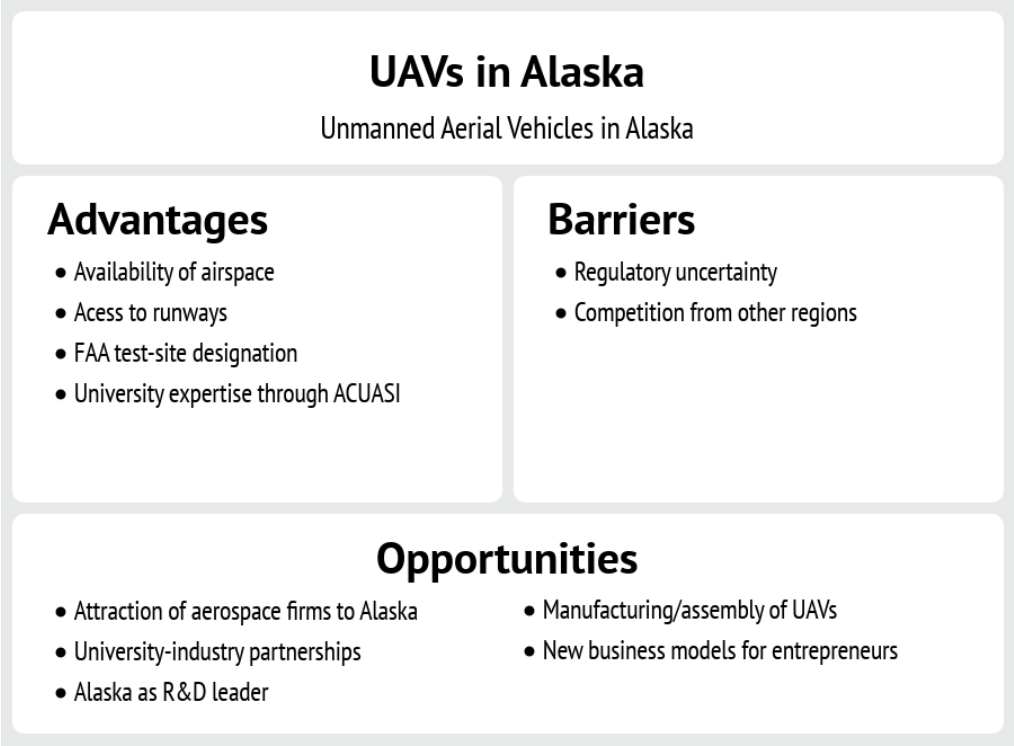


Tim Veenstra getting ready to launch a UAV(Resolution) onboard a NOAA vessel.
Photo Credit: Airborne Technologies

After his research with NASA was completed, he formed Ocean Trek Research as a spinoff company. Under a Small Business Innovation Research (SBIR) grant from NOAA, ATI developed an unmanned aircraft system and software package to track ocean debris. Veenstra's efforts show what innovation can look like in Alaskan context.

While some UAV companies are home-grown, others are drawn to Alaska from out of state. California startup Sabrewing is aiming to use their 60-foot wingspan UAV to carry cargo to rural communities such as Bethel. Its Wyvern aircraft has a similar payload to the Cessna 208 Caravan. The aircraft's ability to fly in poor weather conditions makes this especially attractive in rural Alaska. With advanced systems on board, the UAV will be able to fly safely in airspace without needing a pilot in the cockpit. No passengers will be allowed on board; the primary goal is to carry cargo to remote parts of Alaska.

Sabrewing hopes its UAV manufacturing will eventually take place in Alaska. Making the UAVs in-state solves logistical challenges and could ultimately reduce expenses because FAA regulations require approval to fly over population centers, which prevents the company from easily flying the UAVs from California to Alaska.[37]



VIII. Aerospace

When people think of industries with a presence in Alaska, the space industry may not come to mind. Yet, Alaska hosts two of the county's 19 orbital or suborbital launch sites. Craig Campbell, the President and CEO of Alaska Aerospace Corporation (AAC) feels upbeat about the economic development opportunities presented by growing private interest in space.

AAC is a state-owned corporation operating Pacific Spaceport Complex - Alaska (formerly known as the Kodiak Launch Complex), a satellite launch facility at Narrow Cape on Kodiak Island. Pacific Spaceport Complex - Alaska (PSCA) is the nation's only high latitude full service spaceport. The facility is an ideal place for satellite launches into polar, sun synchronous, and highly elliptical orbits because of this northerly latitude. The facility was the nation's first commercial spaceport not on a federal range and operations there are not controlled by the government. This sets PSCA apart from other launch sites in which military-related launches take precedence over commercial ones.

Rockets (also referred to as launch vehicles) transport payloads to space. Launch vehicles have several segments and are typically assembled at the launch site. Payloads are the carrying capacity of a launch vehicle, which typically hold satellites, scientific experiments, remote sensing equipment, and supplies for space stations. When a launch vehicle reaches space, the payload is the only segment that remains in orbit for a period of time. The remaining segments burn off as they enter back into the atmosphere and so does the payload at a later time once it is instructed to do so.

Craig Campbell, President and CEO of Alaska Aerospace Corporation. Photo Credit: CED

US Space Launch Sites

Launch Site	Operator	State or Territory	Type of Launch Site	Type of Launches Supported	Open to Commercial Operations?
California Spaceport	Harris Corporation	CA	Commercial	Orbital	Yes
Cape Canaveral Air Force Station	US Air Force	FL	Government	Orbital	Yes
Cecil Field Spaceport	Jacksonville Airport Authority	FL	Commercial	Suborbital	Yes
Edwards Air Force Base	US Air Force	CA	Government	Suborbital	No
Ellington Airport	Houston Airport System	TX	Commercial	Suborbital	Yes
Florida Spaceport	Space Florida	FL	Commercial	Orbital/ Suborbital	Yes
Kennedy Space Center	NASA	FL	Government	Orbital	Yes
Mid-Atlantic Regional Spaceport	Virginia Commercial Space Flight Authority	VA	Commercial	Orbital	Yes
Midland International Air and Space Port	Midland International Airport	TX	Commercial	Suborbital	Yes
Mojave Air and Space Port	East Kern Airport District	CA	Commercial	Suborbital	Yes
Oklahoma Spaceport	Oklahoma Space Industry Development Authority	OK	Commercial	Suborbital	Yes
Pacific Missile Range Facility	US Navy	HI	Government	Suborbital	No
Pacific Spaceport Complex Alaska	Alaska Aerospace Corporation	AK	Commercial	Orbital/ Suborbital	Yes
Poker Flat Research Range	University of Alaska Fairbanks Geophysical Authority	AK	Non-Profit	Suborbital	Yes
Ronald Reagan Ballistic Missile Defense Test Site	US Army	Marshall Islands	Government	Orbital/ Suborbital	No
Spaceport America	New Mexico Spaceport Authority	NM	Commercial	Suborbital	Yes
Vandenberg Air Force Base	US Air Force	CA	Government	Orbital/ Suborbital	Yes
Wallops Flight Facility	NASA	VA	Government	Orbital/ Suborbital	No
White Sands Missile Range	US Army	NM	Government	Suborbital	No

Figure 12: US Space Launch Sites

Campbell notes that the space industry is changing with the advent of liquid fueled rockets with smaller payloads. Compared to the traditional solid-fueled rockets, the new types rely on more frequent but cheaper launches. This means greater demand for launches and more opportunity for launch operators like AAC to generate revenue from them. Young companies like Space Exploration Technologies (SpaceX), Rocket Lab, and Vector specialize in these cheaper rockets. According to the FAA, investors poured $2.8 billion into 43 space-related startups in 2016, the most ever for the industry. In 2017, a record number of commercial launches took place, and forecasts predict continued growth.[38]

To capture a share of this growth, Campbell has led AAC to become a more nimble and business-minded organization. In 2014, state funding ended and the corporation transitioned to a self-supporting revenue model. To allow them to collaborate more closely with the private sector, the corporation established a subsidiary called Aurora Launch Services. They improved their facilities to provide liquid fuel capability to cater to this rising market segment. AAC hopes to eventually establish a second launch site in an equatorial part of the world, which would satisfy additional customers and bring revenue back to Alaska.

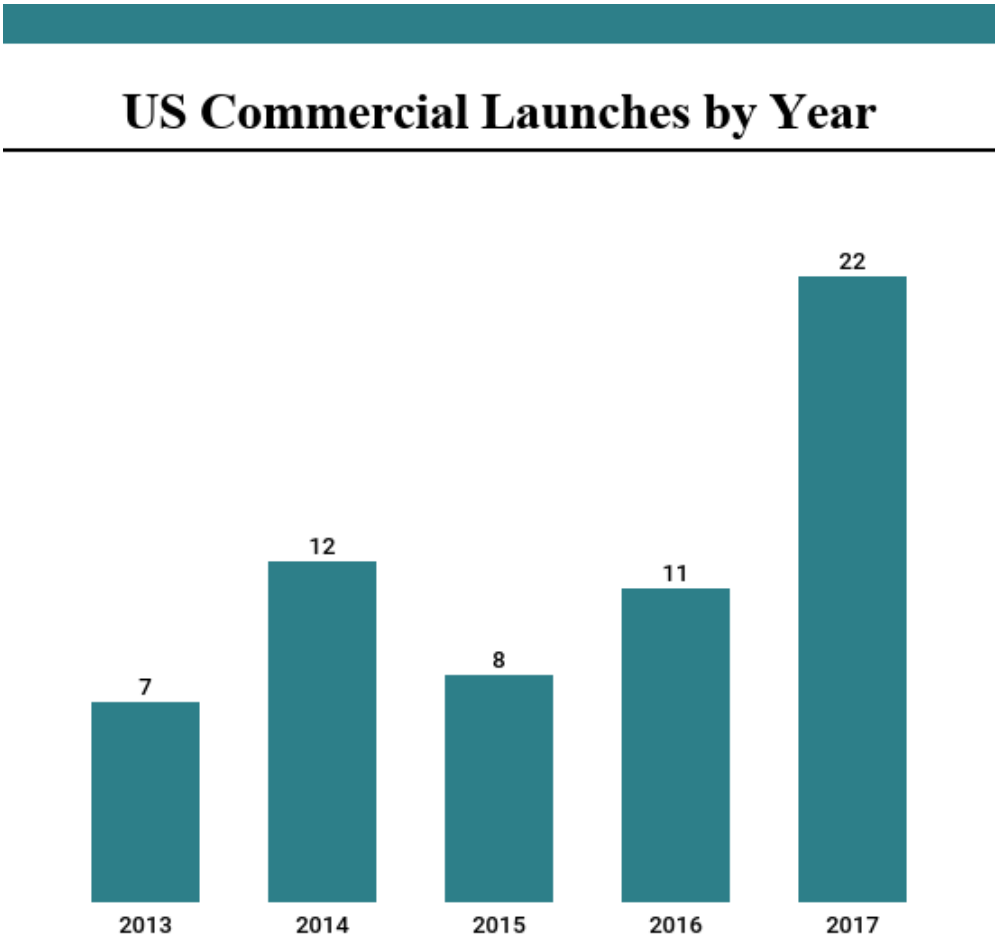


Figure 13: US Commercial Launches by Year

AAC's major competitor is Spaceport Systems International at Vandenberg Air Force Base in California. Vandenberg has a better access launch equipment and support services than PSCA; distance is a challenge for the Kodiak site due to shipping costs and logistics challenges. However, PSCA offers wide launch azimuths (launch directions) ranging from 110 to 220 degrees from which to launch. Vandenberg's launch azimuths only range from 168 to 220. Because Vandenberg is a large and busy military facility, delays in launch schedules are sometimes inevitable. PSCA markets itself as a more flexible site.

According to the FAA, investors poured $2.8 billion into 43 space-related startups in 2016, the most ever for the industry. In 2017, a record number of commercial launches took place, and forecasts predict continued growth.

Alaska's Aerospace Assets

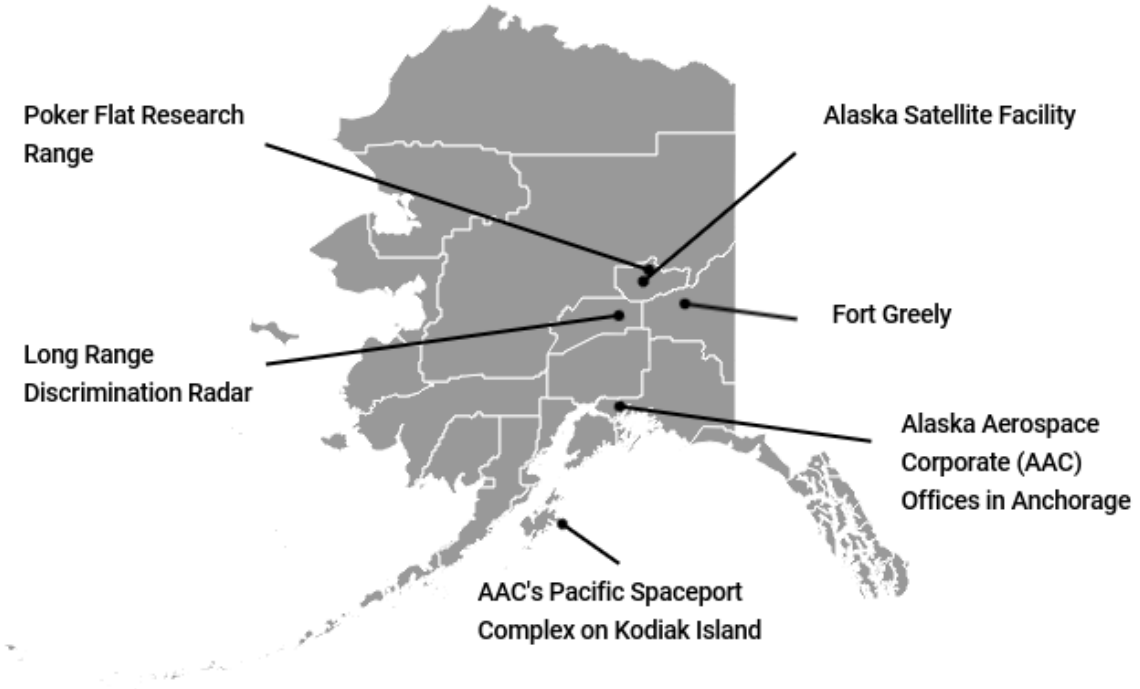


Figure 14: Alaska's Aerospace Assets

A 2011 report by McDowell Group found that AAC can create approximately 195 direct, indirect, and induced jobs and a total of $21 million in annual wages and benefits from small and medium-lift operations. A single launch puts nearly $3.5 million into the economy (counting indirect and induced effects) with employees spending time at local restaurants, buying gifts for family members, going on sightseeing tours, and taking guided fishing trips.[39] Beyond this, Campbell notes the opportunity to attract companies to Alaska that need ready access to space launch facilities. He also points out the high-skilled, high paying jobs associated with the space industry.

Aerospace

Commercial Space Launch

Advantages

- Two launch sites
- AAC role in business development and facilitating commerce
- Airspace availability
- Access to polar orbits

Barriers

- High operating costs
- Remote location
- Difficult logistics (transporting large launch vehicles)

Opportunities

- Growth in commercial market
- New launch vehicles with more frequent launches
- Launches generate ancillary economic activity

IX. Recommendations

Alaska's aviation and aerospace assets contribute to a large and vitally important industry for the state. As the state seeks to broaden its economy to reduce dependence on oil and gas, aviation and aerospace offer economic strengths to leverage. Overcoming Alaska's high operating costs and skilled labor shortage is not easy, however. The Center for Economic Development developed the following recommendations through review of the data presented in this report.

Launch and sustain economic development attraction efforts

The state's considerable assets in aviation and aerospace make it an attractive investment for out of state companies in several respects—airports, global location, market size, rocket sites, and others. However, it is also an expensive operating location with limited support infrastructure and industrial real estate. The state generally lacks incentive programs like tax abatements or other inducements that could mitigate some of the cost concerns. Dedicated marketing efforts are one aspect of attraction campaigns. State and local government incentive programs also have the potential to attract employers and help grow the economy.

The AeroNexus Alliance, which is marketing TSAIA to industrial firms, could be used as a model for aerospace companies seeking access to rocket launch sites, or those testing unmanned aircraft. Attraction efforts could incorporate lessons from the AeroNexus Alliance. AEDC and TSAIA have noted the barriers of limited real estate and cumbersome state personnel and procurement rules that have inhibited interest from industrial tenants. Wherever possible, these kinds of obstacles should be removed.

Defense contractors could also be the targets of economic development attraction efforts, drawn to Alaska by the state's large military presence among other assets. The Long Range Discrimination Radar (LRDR) project and F-35 squadron in Fairbanks provide for large outside investments in Alaska.

Talkeetna Air Taxi. Photo courtesy of the Alaska Division of Economic Development

Become a global training hub for aviation

The University of Alaska system offers nationally competitive degree programs in professional piloting, aviation maintenance technology, air traffic control, and aviation administration and attracts students from out of state to attend these programs. Alaska's global position and abundant airspace and airports combined with highly regarded training programs could be leveraged to make Alaska a global training hub. This would generate economic impacts through increased spending, and also give companies in the state greater access to top aviation talent. With high national demand for trained pilots, Alaska could assume a leadership role in the national and global training industry. New public investment in university aviation programs would allow for the ability to serve (and attract) more students. Corporate training programs, such as those serving airlines, could also be the target of attraction campaigns.

Create mechanisms to support research and development

All of the manufacturing firms interviewed in this study perform some level of R&D to expand their product lines. Each also pointed out that R&D is expensive and risky, since it may take years to monetize a new product and some R&D efforts end up being dead ends. The largest of these companies has only about 40 employees and many are even smaller, meaning that capital is scarce. Several expressed support for an R&D tax credit at the state level. This type of credit has been used in other states to incentivize R&D activity by reducing tax burdens for eligible activities. Expanded R&D capability could help these firms expand and gain market advantages over out-of-state competitors.

Small Business Innovation Research (SBIR) grants from federal agencies are another pathway to support aviation and aerospace R&D. Raising awareness about the SBIR program and providing technical assistance to businesses applying for the program could be viable ways to expand R&D.

Aerospace companies like Lockheed Martin, the successful bidder on the LRDR project, have established operations in Alaska. Encouraging aerospace R&D activity in Alaska could be one way to take advantage of these firms, who have considerable technological capabilities. The University of Alaska system could assist in performing industry-focused R&D as well.

Develop aviation-focused entrepreneurship and innovation

To build home-grown aviation businesses with high growth potential, the state's aviation community should strengthen its relationships within the entrepreneurial ecosystem, which consists of entrepreneurs, mentors, economic developers, angel investors, pitch events, business plan competitions, mentorship programs, and coworking spaces. The entrepreneurship community is a statewide network of public and private participants that seek to support the formation of high growth potential firms. Alaska's aviation stakeholders could encourage in-state entrepreneurs to launch businesses just as they may attract out-of-state firms.

The renewable energy sector provides an example of how the entrepreneurship and aviation communities could work together more closely. The state's first startup accelerator, Launch Alaska, has a dedicated focus on businesses that work in the food-water-transportation-energy nexus. It helps its cohort companies grow by providing capital as well as by providing access to subject matter experts and in-state customer segments. Complementary events like the VOLT49 renewable energy innovation sprint encourage the use of entrepreneurial tools to solve challenges. Aviation entrepreneurs could ultimately build their own support systems, possibly incorporating a business accelerator or incubator.

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