

WASHINGTON STATE'S PATH IN THE GLOBAL AEROSPACE RACE

AeroNex: Empowering Collaboration and Innovation in Aerospace

July 2023

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Introduction

Washington state has a rich history in aviation and aerospace, dating back to the early 20th Century. The state has been a leader in the industry since the establishment of the Boeing Company in 1916 and producing numerous commercial and military aircraft. Boeing's presence and dedicated supply chain have been a significant economic driver for the state and the country's aerospace ecosystem, employing 105,000 people at 1,540 companies in Washington, generating \$56.8 billion annually in sales,¹ and contributing 5% of the state's total Gross Regional Product (GRP). Combined, 3% of all jobs in the state are related to aviation and aerospace.

However, the COVID-19 pandemic significantly impacted the aviation and aerospace sectors. As the industry looks toward recovery, it faces challenges related to labor availability, materials, carbon emissions, and the need for innovation. Washington, in particular, is experiencing pressures from increasing domestic and international competition. Within the United States, Texas, the Midwest, and the Southeast regions are capturing an increasing market share of the aerospace market with business-friendly environments and lower costs to do business.

This report provides an outlook on the industry, highlighting key areas such as space exploration, uncrewed systems, and next-generation air mobility in Washington state. The state must invest substantially in driving innovation to maintain its leading edge, marketing the strengths of Washington's aerospace sector, and equipping the current and future workforce for the next generation of aircraft.

Proviso

The Aviation and Aerospace Advisory Committee (AAAC) was created by the Washington State Legislature in 2022 to advise the Departments of Commerce & Transportation on matters related to aviation and aerospace in the state. The committee's charge was to develop recommendations regarding operating and capital budget requests to support aviation and aerospace, in addition to formalizing strategies to enhance the safe and effective use of public-use airports and aerospace facilities (meaning aerospace manufacturers) in the state. Specific topics include:

- Employment of emerging aviation and aerospace technologies to include uncrewed, autonomous, and alternative propulsion systems
- New, changed, or proposed federal regulations
- Enhance national and international competitiveness
- State policy considerations
- Funding priorities and capital project needs
- Methods to reduce greenhouse gas emissions
- Workforce development needs and opportunities; and
- Multimodal requirements.

Process

Six subcommittees studied the following priority areas:

1. Airport Services, Infrastructure, and Testing
2. Commercial/Military Manufacturing
3. Space and Satellites
4. Uncrewed Aerial Systems (UAS)
5. Emerging Segments (electric, hydrogen, hybrid, Advanced Air Mobility - AAM)
6. Workforce and Education

The goal of the committees and taskforce was to formulate recommendations for legislators, with the initial results to be summarized and presented in December 2022 (see previous submission). The following report includes the second and final submission outlining the subcommittees' findings and recommendations.

Committee Structure: The Aviation and Aerospace Advisory Committee comprised more than fifty stakeholders representing legislators, ports and airports, aerospace supply chain companies, educators, labor representatives, military personnel, and other advocates. The committee established subcommittees to study and address the six priority areas.

Subcommittees consisted of members from all state regions who possess aviation, aerospace, workforce, advanced manufacturing, or related expertise. They provided valuable insights for advancing new aircraft technologies, airports, vertiports, aviation fuels, spacecraft, satellite systems, and other innovations to transform people's travel and contribute to a sustainable economy. Meetings were conducted over several months, allowing for in-depth discussions and the exploration of diverse perspectives. The outcome resulted in collaboratively distilled ideas and patterns from the subcommittee members' collective expertise and insights.

During the initial meetings, it became apparent that all sectors had common needs. That led to restructuring the subcommittees so stakeholders could delve deeper into designing solutions to address these shared themes. Groups consisted of the same individuals who participated in the subcommittee meetings, thus ensuring continuity and consistency in exploring identified themes. These work groups aimed to delve deeper into the themes, fostering collaboration and enabling the development of more refined strategies and initiatives.

The project team extracted and consolidated the results after concluding the subcommittee meetings. These themes represent the overarching areas of concern and focus, encapsulating the perspectives and recommendations put forth by the subcommittees and serving as the foundation of this report. The resulting four significant areas of focus include:

1. Airport Services and Infrastructure
2. Innovation Network
3. Sector Marketing
4. Workforce Development

Aviation & Aerospace Industry Overview

DEFINITIONS

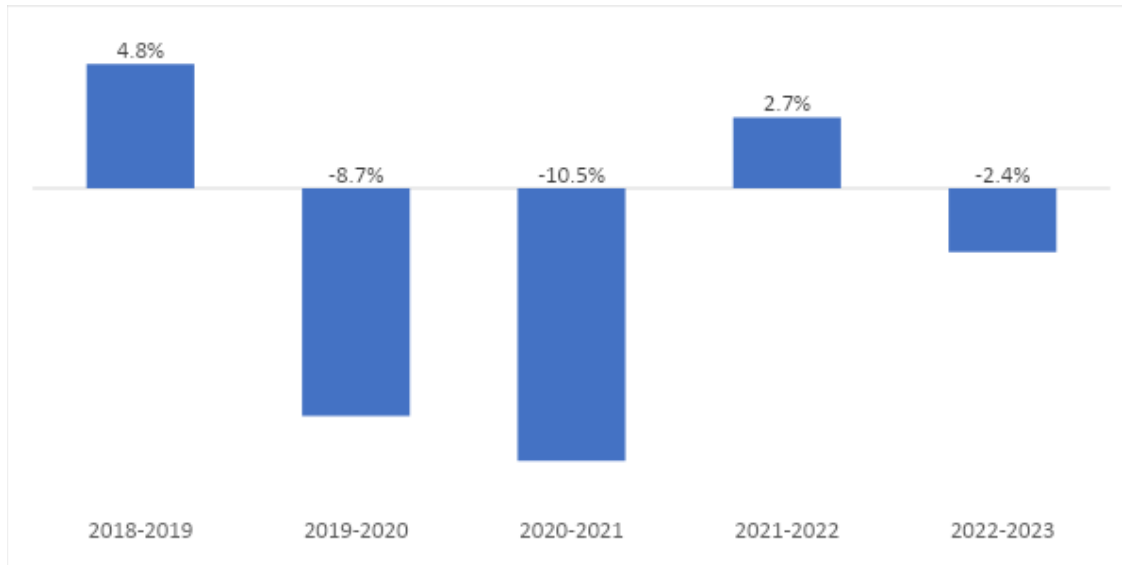
For purposes of this report, the aerospace cluster is defined by its entire industries, which are identified within the subsequent taxonomy:

334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
334519	Other Measuring and Controlling Device Manufacturing
336411	Aircraft Manufacturing
336412	Aircraft Engine and Engine Parts Manufacturing
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing
336414	Guided Missile and Space Vehicle Manufacturing
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
481111	Scheduled Passenger Air Transportation
481112	Scheduled Freight Air Transportation
481211	Nonscheduled Chartered Passenger Air Transportation
481212	Nonscheduled Chartered Freight Air Transportation
481219	Other Nonscheduled Air Transportation
488111	Air Traffic Control
488119	Other Airport Operations
488190	Other Support Activities for Air Transportation
541715	R&D in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)
611512	Flight Training

INDUSTRY PERFORMANCE

The aerospace industry contributes roughly \$29.8 billion, or 5%, to the state’s GRP. The aerospace cluster sustains an approximate workforce of 105,000 individuals across 1,540 businesses subject to payroll in the State of Washington. Unfortunately, the adverse effects of the pandemic resulted in a reduction of approximately 17,350 jobs, reflecting a decline of 14.2% within this sector.

Figure 1. Job Performance in the Aerospace Cluster, State of Washington (2018-2023)



Over the past five years, the revenue generated from aircraft, engine, and parts manufacturing nationwide has exhibited a compounded annual growth rate of 3.7%, culminating in a total of \$323.1B. Notably, the year 2023 witnessed a commendable upturn of 7.8% in revenue, subsequently yielding a profit margin of 8.3%.

Post-Pandemic Recovery Kickstarted U.S. Manufacturers

- Air travel skyrocketed in the years following COVID-19, reestablishing demand for passenger airplanes and flooding airlines with much-needed cash.
- The heightened use of aircraft increased the wear and tear of current fleet inventories. This has driven increasing demand for replacement parts and maintenance-related materials.
- Airlines that found themselves with capital surplus began to cycle out older airplane models as they purchased newer, more fuel-efficient planes from aircraft manufacturers. New planes with new technology have driven production demand, increased the need for new knowledge and expertise, and increased revenue for aircraft manufacturers and companies throughout the supply chain.

U.S. Imports Drop, Exports Skyrocket

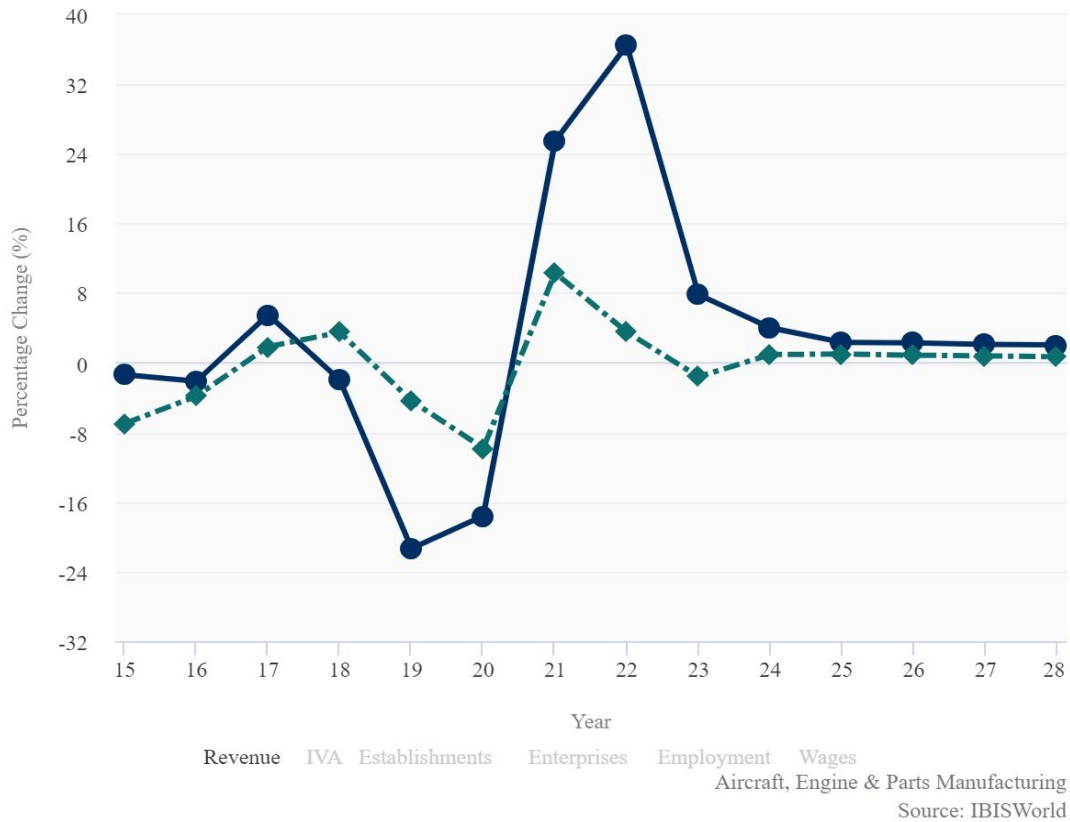
- COVID created supply chain issues for manufacturers that import many aircraft parts and raw materials required to assemble planes. This generated a domestic adaptation to the supply chain, causing them to buy more input goods closer to home.

- The U.S. is rated near the top for global airplane suppliers. Boeing’s presence in Washington places the state in a strong position for aircraft production.
- Other countries expanded air travel options over the past decade, boosting demand for industry products. With the U.S. (and Washington state) firmly placed as an aerospace manufacturing supply chain leader, the domestic industry has retained or improved its standing.
- Exports have risen as countries with expanding air capabilities increasingly rely on US-made aircraft, engines, and parts.

Defense Contractors Face Inconsistent Funding

- Federal funding for defense budgets initially increased but has tapered off in recent years.
- Defense contractors have increasingly tried to stabilize against government funding fluctuations by diversifying their services and investing in the commercial aviation sector.
- The defense budget will increase domestically and abroad as Russia's invasion of Ukraine continues and the United States arms its military allies.
- The geopolitical dynamics in the Pacific Rim (e.g., China and North Korea) will also likely increase military spending for the next few years.

Industry Performance 2015–2028



DEMAND

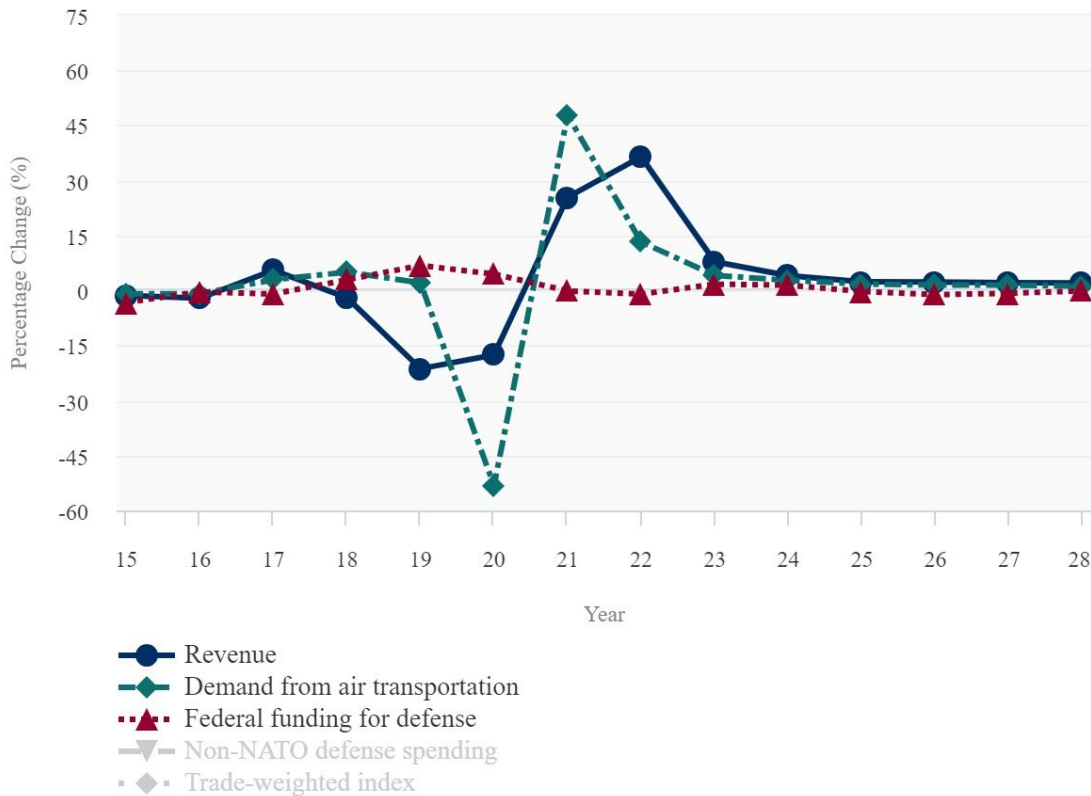
Air Transportation

As air travel increases, so will the demand for passenger airplanes. Air transportation companies can improve competitiveness with newer, more fuel-efficient aircraft models. This can, in turn, spur demand from upstream manufacturing. Demand from air transportation—both passenger and cargo—has risen and is expected to continue to grow in 2023, representing ongoing opportunities for growth.

Federal Defense Funding

The defense budget includes allocations for aircraft, parts, and related equipment. With an increase in defense spending by \$26B in 2023, additional opportunity exists to expand defense contracts.²

Key External Drivers 2015–2028

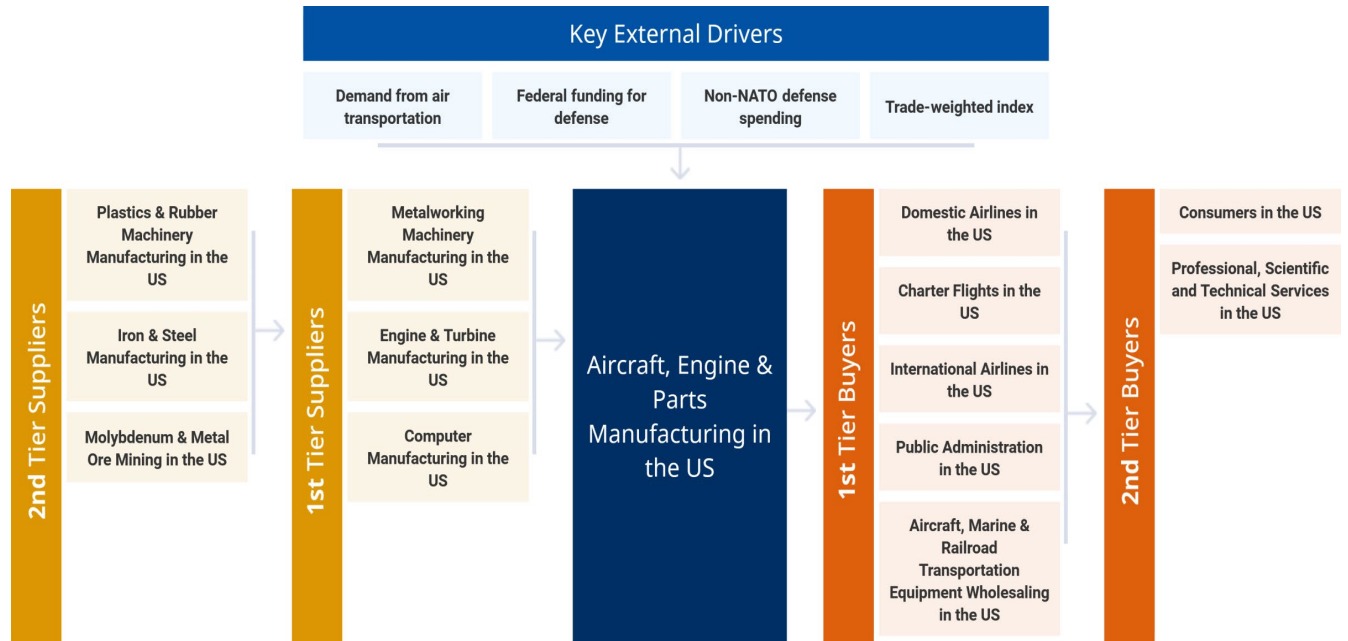


Aircraft, Engine & Parts Manufacturing
Source: IBISWorld

Aerospace Manufacturing Supply Chain

Washington’s aerospace supply chain extends far beyond Boeing. The state is home to numerous aerospace suppliers and subcontractors, providing various components, systems, and services that support aircraft production. These companies contribute to the broader aerospace manufacturing ecosystem and provide critical support to Boeing and other aerospace manufacturers.

Figure 2. Supply Chain for Aircraft, Engine & Parts Manufacturing



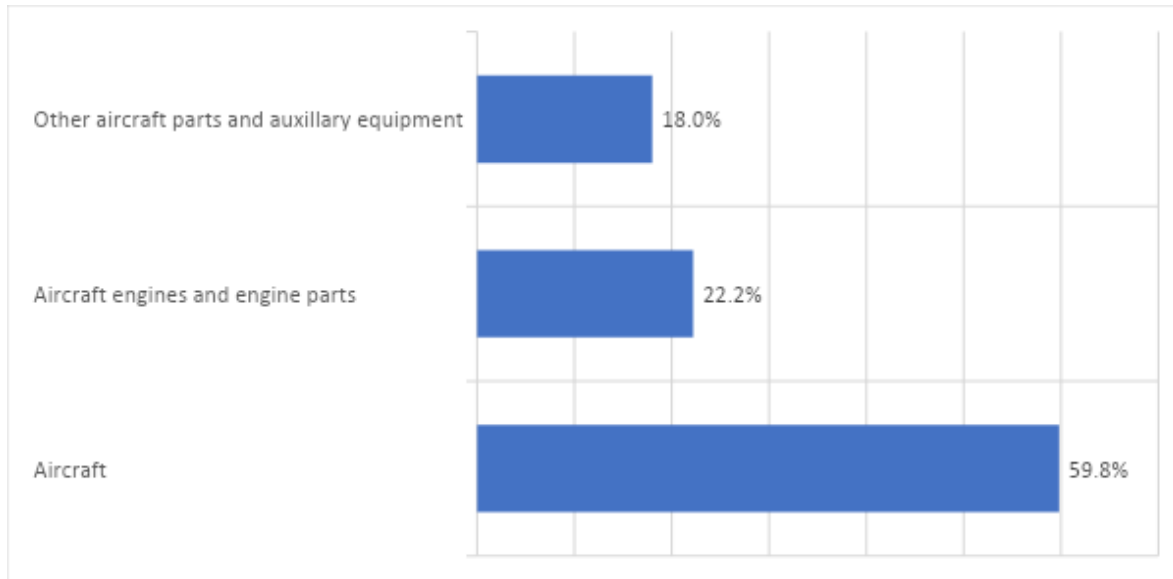
Aircraft manufacturing provides the most revenue for the cluster, representing nearly 60% of industry revenue in 2023—which broadly includes civilian and military aircraft, as well as modifications to completed aircraft. Additionally, uncrewed aerial vehicles (UAVs) have become increasingly important to military actions in recent years, and manufacturing has risen accordingly. UAV sectors in agriculture, wildfire control, and remote inspection of the power grid are rapidly growing as well.

Furthermore, aircraft engines and parts for aircraft engines account for 22% of revenue in 2023, including turbine, shaft, jet, and rocket engines. Fuel efficiency is the foremost aim of technological development in this segment, and R&D teams are focused on swapping lighter materials where possible. Research and production of sustainable aviation fuel (SAF) align with Washington's “green” reputation and present a commercial opportunity for product and technology development in this area.

Other aircraft parts and auxiliary equipment include civilian and military aircraft subassemblies and parts, aircraft mechanical power transmission equipment, propellers, helicopter rotors, research and development of parts (excluding engines), and landing gear. Sales in this segment are generally for replacement parts on existing aircraft, so increased flying time means a greater need for repairs and more money in the pockets of parts manufacturers. Some items, such as subassemblies, have become more advanced as composite material use has increased, while others, such as fasteners, are more standardized and have remained largely unchanged.

Other parts account for 18% of industry revenue in 2023.

Figure 3. Products and Services Segmentation



Source: IBIS World

Industry Outlook

Nationally, aircraft, engine, and parts manufacturing revenue are projected to grow at an annual growth rate of 2.6% to \$366.8B over the next five years, with profit reaching 7.8% in 2028.

Boeing - new technological rollouts will boost revenue

- Following setbacks involving two 737 MAX jet crashes, Boeing has recently received approval from the Federal Aviation Administration (FAA) to continue production of these jets; an array of improvements to the Maneuvering Characteristics Augmentation System (MCAS) should serve to prevent future tragedies.
- The new 737 MAX line of airplanes contains several efficiency-focused innovations that reduce emissions by increasing fuel efficiency, a benefit that is in high demand from airlines seeking to manage volatile fuel prices.
- These new higher-cost jets will begin to replace older models, boosting demand for new plane orders, parts, and other revenue in the supply chain.

Military exports to US allies will provide new revenue for defense contractors

- As tensions with Russia remain high, more and more NATO members will seek military equipment from US manufacturers.
- The United States subsidizes research and development in the defense segment of aircraft manufacturing in an effort to produce the most high-tech armaments on the planet, which has proven successful in the rollout of the F-35 Lightning II fighter jet.
- Uncrewed aerial vehicles have become indispensable to modern combat, and manufacturers will benefit from widespread demand to keep soldiers out of the line of fire by building more of these aircraft types.

- While exporting military products is a rigorous and thoroughly monitored process, US oversight boards generally allow the sale of aircraft, engines, and parts to countries aligned with US interests.
- A depreciating US dollar, measured by the trade-weighted index, will make US goods comparatively less expensive and further boost exports.

Air travel is expected to grow steadily

- Commercial air transit represents the largest portion of industry revenue, so steady demand for aircraft to carry passengers to and from their destinations is vital for manufacturers of aircraft and aircraft parts. Demand for air transportation has risen since the pandemic and is expected to continue to grow at an annual rate of 0.8% into 2028 (IBIS World).
- Domestic trips by US residents and international trips will both rise over the next five years, representing a continued interest in travel following the still-lingering pandemic lockdowns. China, in particular, has seen a surge in the growth of its middle class, which now has disposable income for travel. Although their state-owned aircraft manufacturer (COMAC) recently had its first commercial flight, it will still be several years before they can scale manufacturing to be a significant threat to Western manufacturers.
- Increased air transit places more stress on planes, which boosts demand for replacement parts.

Emerging Segments

- Electrical propulsion systems
- Electric Aircraft Charging Infrastructure
- Renewable fuels, hydrogen-electric, zero-emission, green tech
- Hydrogen Fuel Supply
- Sustainable aviation fuel (SAF)
- VTOL—Vertical takeoff and landing
- UAS—uncrewed aircraft systems (defense, commerce, fixed-wing)
- High-Altitude satellites and Platform-stations
- Artificial Intelligence (AI): is expected to grow from \$152.4 million in 2018 to \$2.2 billion by 2025 in the aviation market alone
- Sun-powered Aircraft
- New materials
- Zero-Fuel Aircraft
- Autonomous Flight Systems
- LIDAR technology from automated cars

Commercial Space

- The success of SpaceX, Blue Origin, and other private space ventures has opened the field for future commercial endeavors.
- Sierra Nevada has also managed a growing share of space vehicle manufacturing, securing a contract to supply the International Space Station. Even so, this contract will expire in 2024, creating opportunities for other companies to acquire major contracts.
- The space tourism market also holds promise, with Virgin Galactic and Blue Origin conducting manned tests. These companies are also planning their first commercial flights over the next few years.
- SpaceX broke the monopoly on national security payload launches once held by The United Launch Alliance (ULA), while Northrop Grumman and Blue Origin are innovating new rockets that could compete.

Competitive Landscape

The aerospace industry in Washington is known for its high competitiveness and significant influence. Over the years, the state has cultivated a strong aerospace ecosystem, but it is currently facing increasing competition. In 2020, Washington ranked third among the top 10 states for aerospace attractiveness, but by 2022, it had dropped to seventh place.

In the aerospace industry, operators face both internal competition from other industry players and external competition from operators in other industries. This increasing competitiveness is driven by the industry's somewhat standardized nature, where safety and efficiency enhancements are typically regulated and adopted universally. As a result, the industry displays adaptability in terms of its geographical reach. Moreover, due to the constant advancement of aircraft technology, skilled labor becomes indispensable, and the industry is in a perpetual state of research and development.

When deciding on a location, operators in the Aircraft, Engine, and Parts Manufacturing industry consider various factors. These factors encompass government incentives, the availability of skilled labor, and proximity to universities conducting fundamental research. Suppliers often establish facilities close to major original equipment manufacturers' factories to minimize transportation expenses, leading to the formation of manufacturing hubs. Defense contractors, on the other hand, frequently distribute their operations across multiple states to garner support from legislatures and government officials.

Leading States in 2023 for Aircraft, Engine, and Parts Manufacturing Companies: Share of the Total Industry in U.S.:

1. California – 11.1% | Growth rate (2018-2023): 2.3%
2. Texas – 10.0% | Growth rate (2018-2023): 8.0%
3. Washington – 7.0% | Growth rate (2018-2023): 9.9%
4. Florida – 6.8% | Growth rate (2018-2023): 0.1%
5. Ohio – 5.6% | Growth rate (2018-2023): 6.1%

Location Factors

When deciding on a location, aerospace manufacturers carefully consider various requirements and operational needs. While each manufacturer may have unique criteria based on their production processes, product portfolio, and target markets, there are common considerations that aerospace manufacturers generally share when selecting or maintaining a geographic location.

1. **Proximity to Key Markets:** Aerospace manufacturers prefer to be close to major markets such as airlines, defense agencies, and space agencies to reduce transportation costs and allow for better customer support and collaboration. Washington's I-5 corridor is well positioned to meet proximity needs; however, other factors such as workforce, land availability, and expansion capability may be challenges. On the east side of the state, Spokane hosts Kaiser's aluminum manufacturing plant and a growing aerospace manufacturing cluster, with overnight service to the Puget Sound.
2. **Skilled Workforce:** Access to an available skilled workforce is crucial as aerospace manufacturers seek a strong engineering and technical talent pool, including specialists in aerospace manufacturing, materials science, and avionics. Labor costs are another major consideration. Washington ranks high in its quality of education and availability of mechanical engineers. However, other states, such as those in the Southeastern U.S., maintain a competitive advantage with lower wages, flexible wage structures, considerably lower costs of living, and employer-friendly laws.
3. **Infrastructure:** Aerospace manufacturing requires specialized infrastructure, including airports, transportation networks, and logistics capabilities. The presence of suitable facilities and access to reliable transportation options are vital considerations. Delayed infrastructure maintenance and expansion to meet growing industry and commercial demands throughout Washington's aerospace facilities places the state at a disadvantage.
4. **Research and Development (R&D) Resources:** Aerospace companies often prioritize regions with established and highly invested research and development institutions, universities, and technical centers. These provide opportunities for collaboration, innovation, and access to cutting-edge technology. Washington maintains strong relationships with its research universities, especially the University of Washington and Washington State University. Larger aerospace manufacturers work closely with these institutions to optimize resources and opportunities. Additional effort is needed to facilitate and promote access to manufacturers throughout the state, especially at the small-to-medium business level, to adopt new technologies and practices.
5. **Regulatory Environment:** Compliance with aviation and aerospace regulations is critical. Manufacturers prefer locations with clear and supportive regulatory frameworks that promote safety, streamlined processes, and favorable policies for industry. Washington is known for having a clear and supportive regulatory framework for aerospace manufacturing. The challenge often lies in the potential for excessive regulation, which hinders the development and implementation of new technologies and practices within the industry. It is important to recognize that a complex and burdensome regulatory framework disproportionately impacts tier 2-3 suppliers. These

suppliers are typically small and medium-sized businesses with fewer resources compared to prime suppliers.

Though overlapping the topic of Workforce (see #2), Washington is often criticized for labor laws specific to employing minors or integrating children under 18 into the workplace in a manufacturing environment. While many challenges remain in the perception of what is allowable, the state can help aerospace manufacturers bridge the workforce gap through education and facilitation to hire younger employees. Helping employers work with schools, youth, Labor and Industries, and others to create a safe workplace while facilitating more onsite work experiences for youth can expedite workplace readiness for high school graduates.

6. Supply Chain Ecosystem: An efficient and robust supply chain is essential for aerospace manufacturers. Businesses rely upon a strong network of specialized manufacturers, component suppliers, and material providers. Proximity to suppliers helps reduce lead times and costs. Washington excels in its proximity to aerospace supply chain providers and delivery logistics solutions. Manufacturers located throughout the state are readily available to provide qualified solutions, and the delivery logistics network is built on the back of other large Washington employers such as Amazon.
7. Economic Incentives and Support: Government and local authorities often provide economic incentives to attract aerospace manufacturers. These may include tax incentives, grants, subsidies, and infrastructure support. The availability of such incentives can influence location decisions. Washington has a history of providing incentives at the state, regional, and local levels, and its continuation of such practices can ensure continued success in attracting new manufacturers to the state.

However, what is often overlooked when considering incentives are the indirect beneficiaries, such as tertiary manufacturers. Manufacturing companies have a substantial economic influence not only at the primary level but also at the secondary level. Since supply chains often align with manufacturers when they establish new facilities, the economic impact of the primary company is amplified through the addition of secondary companies and jobs.

Several states and locations use incentives to attract and retain manufacturers, such as those below:

- (a) Boeing (South Carolina, U.S.): In 2009, Boeing received approximately \$300M in economic incentives from the state of South Carolina to establish a manufacturing facility for its 787 Dreamliner aircraft.³ The incentives included tax breaks, infrastructure improvements, and workforce training support. This investment helped create thousands of jobs and boost the local economy.
- (b) Airbus (Mobile, AL, U.S.): Airbus received roughly \$10M in economic incentives from the state of Alabama to build an assembly plant for its A320 series aircraft in Mobile.⁴ The incentives

included tax abatements, infrastructure development, and grants. The facility has become a major aerospace manufacturing hub, generating jobs and attracting suppliers to the region.

- (c) Bombardier Aerospace (Mirabel, Quebec, Canada): Bombardier Aerospace partnered with the Canadian federal and provincial governments to establish its aerospace manufacturing facility in Mirabel.⁵ The incentives included financial support, tax credits, and research and development grants. The facility has contributed to the growth of the aerospace industry in Quebec and has become a center for aircraft production and innovation.
 - (d) Embraer (Melbourne, FL, U.S.): Embraer, a Brazilian aerospace manufacturer, received economic incentives from the State of Florida to establish its assembly and customer center in Melbourne.⁶ The incentives included tax benefits, infrastructure assistance, and workforce training programs. The facility has created jobs and has been instrumental in the expansion of Embraer's operations in the United States.
8. Security and Stability: Aerospace manufacturing involves sensitive technologies and classified information. Manufacturers prioritize regions with political stability, robust security measures, and protection of intellectual property rights. Washington maintains a respected reputation for enforcing intellectual property laws, including patents, trademarks, and copyrights. The state's thriving technology and innovation sectors rely heavily on protecting intellectual property, further underscoring the state's commitment to upholding these rights.
 9. Environment: Aerospace manufacturers are increasingly conscious of environmental sustainability. With the growing concern and awareness of workers for corporate social and environmental responsibility, companies recognize their commitment to the environment as a key factor to attract and retain top talent. Manufacturers often seek states with favorable environmental regulations, access to renewable energy sources, and a commitment to reducing carbon emissions.

Overall, selecting a location involves a comprehensive assessment of various factors, including market demand, cost considerations, competition, and the specific needs of each aerospace manufacturer. It is a strategic decision that requires careful analysis to optimize operational efficiency, customer satisfaction, and long-term success in the aerospace industry.

Best Practices

The aerospace industry is characterized by its continuous drive for innovation and collaboration, resulting in various initiatives that shape its future. Within this rapidly evolving sector, certain organizations have emerged as exemplars, showcasing best practices that serve as benchmarks for excellence. These industry leaders have successfully implemented strategies and processes that optimize efficiency, ensure regulatory compliance, and promote sustainable practices. By examining these best practices, we can glean valuable insights into the successful management and operation of aerospace companies.

1. Foster collaboration and coordination among stakeholders: Initiatives like the FlyOhio program in Ohio and the Quebec aerospace strategy demonstrate the importance of bringing together

various entities, including government agencies, research institutions, and industry partners, to strengthen and support the aerospace industry. This collaboration helps drive innovation, address regulatory challenges, and promote growth.

2. **Develop specialized aerospace ecosystems:** Locations such as Houston, Texas, and Colorado have successfully established aerospace ecosystems that encompass a range of assets, including spaceports, research institutions, military commands, and major aerospace companies. These ecosystems facilitate operational collaboration, knowledge sharing, and integration between aerospace sectors, leading to economic growth and job creation.
3. **Invest in research and development:** The presence of renowned research institutions, laboratories, and centers of excellence like the National Oceanic and Atmospheric Administration (NOAA), University Corporation for Atmospheric Research (UCAR), and Laboratory for Atmospheric & Space Physics (LASP) in Colorado, and the National Institute of Standards and Technology in Colorado, help drive technological advancements in aerospace. Investing in research and development enables the industry to stay at the forefront of innovation and maintain a competitive edge.
4. **Support the growth of small and medium-sized businesses (SMBs):** The Quebec aerospace strategy and the focus on assisting SMEs in their development highlight the importance of nurturing and supporting smaller companies in the aerospace sector. This can be achieved through financial frameworks, funding pools, and initiatives that promote innovation, provide resources, and encourage collaboration with more prominent industry players.
5. **Promote advanced air mobility and uncrewed aerial systems (UAS):** Efforts such as the proposed drone highway system in Ohio, drone delivery pilots in Detroit-Windsor, and the establishment of the American Center for Mobility in Michigan demonstrate a commitment to advancing air mobility and the integration of uncrewed aerial systems. These initiatives involve testing, research, and policy development to enable safe and efficient operations of drones and other uncrewed vehicles, paving the way for future logistics, transportation, and more applications. UAS test ranges and pilot training schools can help revitalize rural airports, as seen with the economic benefit at the Pendleton, Oregon airport with their UAS facility.
6. **Support startup ecosystems and innovation partnerships:** Michigan's Autotech Attraction and the Office of Future Mobility and Electrification exemplify creating an environment that attracts startups and supports emerging technologies in the aerospace sector. Funding platforms, grants, and collaborative programs with academia and private industry help foster innovation, drive economic growth, and position the state as a hub for mobility-related technologies and businesses.
7. **Promote a conducive business environment:** Wichita, Kansas, emphasizes its low startup costs, which benefits high-tech startups. Additionally, being a top city for remote work can attract aerospace professionals interested in working remotely while still connected to major national

aerospace hubs. Providing an attractive business environment, suitable infrastructure, and resources encourages industry growth and attracts top talent.

These best practices collectively contribute to the aerospace industry's growth, innovation, and sustainability, reinforcing its position as a pioneer in technology and exploration.

State Initiatives⁷

Florida, California, and Texas are important competitors in the aerospace industry. California, with approximately 850 aerospace companies, ranks second after Washington in terms of industry size. The presence of three NASA research centers and the Mojave Air and Space Port contributes to the growth and development of the sector. Texas is known for its strong aerospace and aviation industry, with several major aerospace companies operating in the state. Florida also has a significant aerospace sector, focusing on space exploration and related activities. The industry's geographic proximity to commercial space launch infrastructure is desirable to space companies.

It is worth noting that Georgia, the top-ranked state for aerospace attractiveness in 2020, boasts a thriving aerospace industry. The state's infrastructure is ranked number one, with an aerospace and defense workforce of 108,000 employed by over 800 aerospace companies.

Ohio, ranked second, has a favorable corporate tax structure, a healthy economy, and a strong industry presence. The state is also a major supplier to Boeing and Airbus, housing over 550 aerospace and aviation A&D organizations, including research centers and facilities like Battelle Air Force Research Laboratory and NASA Glenn Research Center.

California is a major center for the aerospace industry, housing numerous initiatives and organizations at the forefront of aerospace technology and exploration. Southern California has a rich aerospace history and continues to be a center for aerospace activities. Initiatives in this region encompass both commercial and defense aerospace sectors. The area is known for aerospace manufacturing, research institutions, and organizations working on space exploration, satellite systems, and advanced aircraft technologies.

Here are some key aerospace initiatives in California:

1. NASA's Jet Propulsion Laboratory (JPL): Located in Pasadena, JPL is a leading research and development center for robotic space exploration. JPL manages numerous missions, including the Mars rovers and deep space probes, and conducts cutting-edge research in areas such as astrophysics, Earth science, and planetary exploration.
2. SpaceX: Headquartered in Hawthorne, California, SpaceX is a private aerospace company founded by Elon Musk. Known for its groundbreaking achievements in reusable rocket technology, SpaceX has transformed the commercial space industry and plays a vital role in launching satellites, resupplying the International Space Station, and paving the way for future missions to Mars.
3. California Aerospace & Aviation Association (CAAA): The CAAA is an industry association dedicated to promoting California's aerospace and aviation sectors. It fosters collaboration,

advocates for industry interests, and supports workforce development and educational initiatives to sustain California's aerospace leadership.

4. Aerospace Corporation: Based in El Segundo, the Aerospace Corporation provides technical expertise and guidance to government agencies, including the Department of Defense and NASA. It supports the development, acquisition, and operation of space systems and contributes to national security and space exploration efforts.
5. Spaceports: Several spaceports are being developed in the state, including the Mojave Air and Space Port and the Vandenberg Space Force Base. These facilities support both commercial and government launches, testing of innovative aerospace technologies, and space tourism initiatives.
6. California Polytechnic State University (Cal Poly): Cal Poly has a renowned aerospace engineering program and is known for its CubeSat development program. Students at Cal Poly have the opportunity to design, build, and launch small satellites, gaining hands-on experience in aerospace technology and research.

These initiatives in California underscore the state's prominence in aerospace technology, research, and space exploration. California's concentration of cutting-edge companies, research institutions, and educational programs contribute to advancements in the industry and propel the state's aerospace sector forward.

Florida's Space Coast: Located on the eastern coast of Florida, the Space Coast is home to the Kennedy Space Center and Cape Canaveral Spaceport. Initiatives in this region focus on space exploration, launch systems, and commercial spaceflight. Companies like SpaceX and Blue Origin have significant operations in the area, contributing to the growth of the commercial space industry.

Here are some key aerospace initiatives driving advancements in space exploration, commercial aerospace, and research in Florida:

1. Kennedy Space Center (KSC): Located on Florida's east coast, KSC is NASA's primary launch site for human spaceflight. It supports a wide range of missions, including the historic Apollo moon landings and the space shuttle program. KSC continues to serve as a launch facility for NASA and commercial space companies like SpaceX.
2. Cape Canaveral Spaceport: Adjacent to Kennedy Space Center, Cape Canaveral Spaceport is a major launch complex that supports both government and commercial space launches. It enables various missions, including satellite deployments, interplanetary probes, and crewed missions to the International Space Station.
3. Commercial Space Industry: Florida is home to multiple commercial space companies, including SpaceX, Blue Origin, and OneWeb Satellites. These companies conduct research, development, and launch operations, driving innovation and contributing to the expanding commercial space industry.

4. Florida Space Coast Consortium: The Florida Space Coast Consortium is a collaborative effort among academic institutions, aerospace companies, and government agencies. It aims to promote research, education, and economic development in the aerospace industry, supporting the growth of the Space Coast region.
5. Space Florida: Space Florida is the state's aerospace economic development agency. It works to attract and support aerospace companies, encourage spaceport infrastructure development, and foster partnerships to promote Florida as a premier destination for aerospace activities.
6. Embry-Riddle Aeronautical University: With campuses in Daytona Beach and the Space Coast area, Embry-Riddle Aeronautical University offers comprehensive aerospace programs and research initiatives. The university's expertise contributes to workforce development, research advancements, and collaboration with industry partners.

These initiatives in Florida highlight the state's significant contributions to space exploration, commercial aerospace, and research. Florida's strong presence in the aerospace industry supports job creation, technological innovation, and educational opportunities, solidifying its position as a key player in the global aerospace landscape.

Texas has emerged as a key aerospace hub with initiatives spanning multiple cities with a range of initiatives and organizations driving advancements in space exploration, aviation, and defense. Houston, known for the Johnson Space Center, contributes to human spaceflight and research. Dallas-Fort Worth area hosts aerospace manufacturing, research, and development activities. Additionally, cities like San Antonio and Austin are home to aerospace companies and research institutions.

Here are some key aerospace initiatives in Texas:

1. NASA Johnson Space Center—For more than 50 years, NASA's Lyndon B. Johnson Space Center (JSC) in Houston has led the United States and the world on a continuing adventure of human exploration, discovery, and achievement.
2. Houston Spaceport—Houston Spaceport is an FAA-licensed, urban commercial spaceport offering unprecedented access to a thriving aerospace community.

These initiatives in Texas highlight the state's contributions to space exploration, aviation, and defense industries. Texas' strong presence in aerospace research, manufacturing, and launch capabilities positions it as a key contributor to the growth and advancement of the aerospace sector.

Ohio is ranked #2 in terms of attractive corporate tax structure, healthy economy, and strong industry presence. Ohio is also the largest U.S. state supplier to Boeing and Airbus. The state has an A&D ecosystem of more than 550 aerospace and aviation A&D organizations, including Battelle Air Force Research Laboratory, the Ohio Unmanned Aircraft Systems Center, and the NASA Glenn Research Center.

FlyOhio Initiative—FlyOhio seeks to make Ohio airspace among the first in the nation ready to fly beyond visual line of sight (BVLOS). FlyOhio is an initiative of the Ohio UAS Center, and stakeholders include JobsOhio, Dayton Development Coalition, Ohio Federal Research Network, and the City of Springfield. This initiative seeks to address the BVLOS issue by coordinating ongoing UAS research throughout Ohio while identifying and pursuing future research opportunities. The UAS Center works with public, private, and research partners on the technology needed to allow numerous drones, operated remotely, to fly safely over longer distances without fear that they will collide with other aircraft or ground-based objects or pose a threat to humans.

Colorado has a vibrant aerospace industry and is home to several notable initiatives and organizations. Here are some key aerospace initiatives in Colorado:

- Colorado Space Coalition (CSC): The CSC is a collaboration between industry, government, and academic entities aimed at promoting and expanding Colorado's aerospace industry. It focuses on fostering partnerships, attracting investment, and supporting workforce development to maintain Colorado's leadership in aerospace.
- United Launch Alliance (ULA): ULA, headquartered in Centennial, Colorado, is a joint venture between Boeing and Lockheed Martin. ULA provides reliable launch services for commercial and government customers, supporting national security and space exploration missions.
- Aerospace and Defense Industry Association of Colorado (ADIA): ADIA is an organization that brings together aerospace and defense industry stakeholders in Colorado. It advocates for the industry's interests, promotes collaboration, and supports the growth and competitiveness of aerospace and defense businesses in the state.
- Spaceport Colorado: Located at the Front Range Airport in Adams County, Spaceport Colorado is an initiative to establish a commercial spaceport. It aims to support the growing commercial space industry by providing infrastructure for horizontal and vertical launch activities.
- National Center for Atmospheric Research (NCAR): Based in Boulder, NCAR conducts research in atmospheric and related sciences. While not solely focused on aerospace, its work contributes to understanding and predicting weather patterns, climate change, and atmospheric phenomena relevant to aerospace operations.
- Colorado School of Mines: The Colorado School of Mines offers specialized programs in aerospace engineering, focusing on areas such as spacecraft design, propulsion systems, and satellite technology. The university's research and academic initiatives contribute to the development of aerospace talent and innovation in the state.

These initiatives in Colorado demonstrate the state's commitment to advancing aerospace technology, research, and education. They also highlight Colorado's role as a hub for aerospace manufacturing, space exploration, and fostering collaboration between industry, academia, and government entities.

The above-mentioned state-level initiatives aim to cultivate a conducive environment for innovation, investment, and collaboration within the aerospace industry. These states strive to position themselves as leading hubs for aerospace manufacturing, research, and development by offering targeted incentives, infrastructure development, workforce training programs, and research partnerships.

The following noteworthy initiatives undertaken by select cities highlight their impact on the growth and sustainability of the aerospace industry.

Wichita, Kansas, has a strong presence in the aerospace industry, particularly in aircraft manufacturing and aviation-related initiatives. Here are some key aerospace initiatives in Wichita:

1. **National Institute for Aviation Research (NIAR):** Based at Wichita State University, NIAR is a leading aerospace research institution. It provides advanced testing, research, and development services to the aviation industry, supporting innovations in materials, manufacturing processes, and aircraft design.
2. **Wichita State University's Aerospace Engineering Program:** Wichita State University offers a renowned aerospace engineering program, providing education and training for aspiring aerospace engineers. The program collaborates with industry partners and conducts research in various aerospace-related areas, contributing to advancements in the field.
3. **Aircraft Manufacturing:** Wichita is historically known as the "Air Capital of the World" due to its significant involvement in aircraft manufacturing. The city is home to major aircraft manufacturers, such as Textron Aviation (Cessna and Beechcraft) and Spirit AeroSystems, which produce a range of general aviation and commercial aircraft components.
4. **Wichita Area Technical College (WATC):** WATC offers aerospace manufacturing programs, providing technical training and workforce development to meet the aerospace industry's needs. These programs equip students with the skills required for careers in aircraft assembly, maintenance, and manufacturing.
5. **Kansas Aviation Museum:** The Kansas Aviation Museum preserves and showcases the region's rich aviation heritage. It offers exhibits, educational programs, and events that highlight the significant role Wichita has played in the development of aviation and aerospace.

These initiatives in Wichita reflect the city's long-standing association with the aerospace industry. The presence of research institutions, educational programs, and aircraft manufacturing companies demonstrates the commitment to aerospace innovation, workforce development, and preserving the aviation legacy in the region.

Huntsville, Alabama: Huntsville is known for its strong presence in space and defense industries. Initiatives in this region include the development of the U.S. Space and Rocket Center, research facilities, and aerospace engineering programs. The area is a hub for space exploration, missile defense, and advanced technology development.

Workforce

Prior studies have called for urgency in developing the workforce of tomorrow for Washington's aerospace manufacturers.⁴ Others predicted the current workforce shortage, recognizing the current impact and projected future crisis decades ago.⁸ Today, we find ourselves without more time to prepare for the talent shortage - because we are in it. It is time to take immediate action. As a result, this section has become more robust, given its significance and urgency to the airport and aerospace industry.

Any competitive industry relies on an abundant, qualified workforce to drive innovation and meet global market demands. Washington has consistently held a high industry ranking as a business location choice for international and domestic aerospace manufacturers.⁹ The state had been ranked #1 overall for the past several years,¹⁰ with labor and education ranked highest, followed by research and innovation. Today, the State of Washington has dropped to #7 in the rankings.

Aerospace leaders like Boeing and Blue Origin helped build Washington's strategic advantage as an employer of choice. However, concerns specific to infrastructure and overall costs (including housing and living expenses) continued to rise quickly.⁵ Focusing only on the overall #1 ranking makes it easy to see the state as "the most competitive business environment."¹¹ Overlooking workforce trends and postponing comprehensive resource alignment delayed the state's ability to adapt to changing conditions and adequately prepare for future workforce needs.

Today, post-pandemic production demand in commercial aerospace is at previously unseen levels. Travel has resumed, service demands have increased, and production demands are high, but the state's workforce infrastructure is fragile. For example, Boeing has surged in new orders of 737 MAX deliveries, but supply chain disruptions continue, and labor shortages in critical positions constrain full recovery.¹² Lower available workers in manufacturing, declining worker participation (turnover/retention), below-average job preparation among new employees, and decreased career interest in skilled trades (e.g., welding, machining) present unique challenges for the industry.³ Many aerospace manufacturers struggle to focus on the basics: meet production demands, maintain profitability, and stay in business.

Developing Washington's aerospace workforce must take a different approach. It requires action-oriented partnerships of leaders in the public sector, business, and education to meet these challenges:

- The workforce shortage will continue for many years. The current pipeline is inadequate to replace the retiring workforce.¹³ Steps to increase volume or compensate for the shortage with other strategies must be a priority.
- Employee skillsets will fall short of employer needs over time. Employers must prepare to address those shortfalls and offer career development to retain employees.
- Employers must offer career development to attract less qualified employees with the right aptitude for employment and begin the development process.
- Continuous internal and external recruitment to build the talent "pipeline" is critical. Providing employers with resources to help do it is essential.
- Employers must increase access to workers in remote locations, with limited technology, or from rural communities to enhance applicant pools and access to resources.

- Partnerships must enhance equitable resources for all groups through broadening access to technology. These efforts can improve access to support for women, BIPOC communities, and traditionally underserved populations to careers in manufacturing positions.

A VISION FOR THE FUTURE OF THE WORKFORCE

Understanding the goal of workforce management can help clarify the desired outcome. Tomorrow's workforce must align to help manufacturers meet new demands that continuously shift to meet the accelerated speed of customer needs. Increased production demands, stronger competition, fewer available workers, and the need to constantly improve talent will drive change. The ability to apply best practices can help aerospace manufacturers adapt quickly. The following are some of the most prominent pressures affecting aerospace workforce development over the next 5-10 years.

Industry 4.0: Upskilling for Technical Competency

Innovation in manufacturing is founded on Industry 4.0 ("IR4.0"), referring to the ongoing automation of traditional manufacturing and industrial practices using modern technology.¹⁴ Integrating smart technology, IoT (Internet of Things), improvements in industrial practices, big data, and advanced robotics are part of the movement.

Industry 4.0 creates critical pressure to adopt data-driven manufacturing.¹⁵ Enhanced automation impacts how people work with machines, data, technology, and each other as part of their core job requirements. Aerospace manufacturers often invest in technology but fail to update processes or upskill people to optimize efficiencies. Employers who fail to adapt to these demands will be unable to offer what is needed to attract talent or to compete in the market. Companies cannot meet business needs to move forward without ongoing upskilling to keep up with changing technology.

As the industry shifts to Industry 5.0 ("IR5.0"), it will re-integrate humans *with* technology to optimize reliability, efficiency, and results. Manufacturers will require more technology and automation from operations. A shift is expected in employee requirements and the need for massive upskilling for more technical know-how to operate automated processes.

Upskilling for Technology and People Skills

A survey of 803 global employers representing 11.3M workers across 27 industry clusters (including manufacturing) reported that technology remains a primary driver to transform business over the next five (5) years.¹⁶ Business growth relies on intelligent technology deployment and complementary upskilling to deploy the technical business functions. Similarly, people skills are also critical to effectively executing business operations. For example, communication skills are essential to helping organizations, teams, and individuals understand and align with the company's goals.

Rapid AI, robotics, and automation lead to more sophistication.¹⁷ These do not eliminate the need for production workers. It transforms the type of expertise needed to adapt to new requirements. As a result, the following are trends that demonstrate the need for ongoing reskilling:

- Digitalization will require both depth and breadth of technical proficiency among all employees.
- Robust digital platforms will surpass standard Enterprise Resource Planning (ERP) systems and require workers to use more sophisticated tools, methods, and technologies.

- Advancements in artificial intelligence (AI), cobots (collaborative robots), and cybersecurity will shift worker requirements, causing a rapid transformation in worker capabilities.
- Most businesses expect to accelerate automation involving reasoning, decision-making, data processing, and manual work.

The rate of change will accelerate. Demands to upskill employees will continue to grow.

The Factory of the Future

People will always be needed, even with increased automation. However, a shift will take place in the competencies required to meet business goals. As employers automate manual tasks, they will require new skills to perform evolving technologies. Technology will surely displace lower-skilled jobs *as they exist today*, but researchers predict strong growth in other jobs created by new technologies. This “churn” of simultaneous job reduction and growth provides employers with an opportunity to prepare current workers for the future as they are trained for new requirements.

Creating a vision for tomorrow can guide the industry’s efforts today. The Factory of the Future must be connected, collaborative, customer-centric, and people-oriented.¹⁸ Emulating the best practices of IR4.0 and building the platform for IR5.0 will prepare companies for what is to come. Two competencies repeatedly emerge for all workers in future aerospace manufacturing: digital leadership and technology augmentation.

- Digital Leadership: Early technology adopters prove to be winners.¹⁹ Employers must be adept at promoting digital technology and upskill workers at all levels. Examples include the following:
 - Workers can improve outcome consistency through process optimization and digital integration.
 - Implementing digitized instructions can improve collaboration, communication, and efficiency.
 - Using "digital twins" to simulate results finds inefficiencies and improvements before production to improve quality, save time, and lower costs.²⁰
 - "Digital transformation, when combined with operational excellence and a culture of continuous improvement, can drive the future of manufacturing."¹³
- Technology-Augmented Workforce: Digital tools enable employees to work smarter, faster, and more efficiently. Enabling workers with better skills can enhance productivity exponentially. Providing employees with tools and real-time data helps them to perform more effectively, make better decisions, collaborate with others, detect root causes faster, and reduce delays and response times.²¹ Employers can integrate best practices such as:
 - Training employees on (and resourcing them with) digital tools such as tablets, smartphones, and AI software to provide immediate decision support to save time and improve output.
 - Empowering workers to optimize workflows, share knowledge, and provide feedback to improve functionality with coworkers, customers, managers, and other departments.
 - Automating predictive or prescriptive analytics on sensor data, such as maintenance schedules to compensate for fewer workers and save time.
 - Advancing technology through other business priorities, such as operational excellence, data needs, and value creation, can complement employee development efforts.¹³
 - Considering talent development from the perspectives of now and the future.¹³

Diversity and Equity Alignment²²

Diversity, equity, and inclusion (DEI) is an imperative for manufacturers. To be competitive, businesses must be able to connect with the skills and experiences of a wide range of communities.²³ Manufacturers must create pathways to tomorrow's jobs today to engage more groups and populations. Increasing access to traditionally underserved and underrepresented populations is the right thing to do in today's world, where technology makes the difference between personal and career success and failure. Economically, industrial success depends on the ability to develop a robust talent strategy that opens pathways and opportunities to create a talent pipeline that is culturally inclusive.

Historically, the manufacturing industry has lagged in its progress toward greater diversity and inclusion.²⁴ Prior research by McKinsey & Company has clearly shown that more diverse companies are more effective at attracting talent, improving customer orientation, maintaining customer satisfaction, and executing decision-making.²⁵ Until manufacturers focus on and actively build a culture of inclusivity – starting at their leadership corps – they will continue to face the same challenges as always and fail to create the inclusive workplaces needed to achieve success for today (and in the future).

The National Association of Manufacturers recognizes the need to increase equity for underrepresented communities and supports the “Pledge for Action” as manufacturers commit to specific actions by 2025.²⁶ The goal is to take tangible actions and create pathways to job opportunities that help manufacturing reflect the diversity of the overall U.S. workforce by 2030. Regardless of which program to follow, building equitable systems to improve access to underserved populations can increase opportunity for access, and fostering culturally diverse and inclusive workplaces can promote greater recruitment, retention, and growth of Washington's aerospace workforce.

Connecting a company's Factory of the Future vision to its existing core strategic imperatives allows it to recognize its current needs while building a platform to meet future demands. Identifying where the business is (current strengths and opportunities) balanced with future needs and directions can build a future-oriented alignment and strategy.

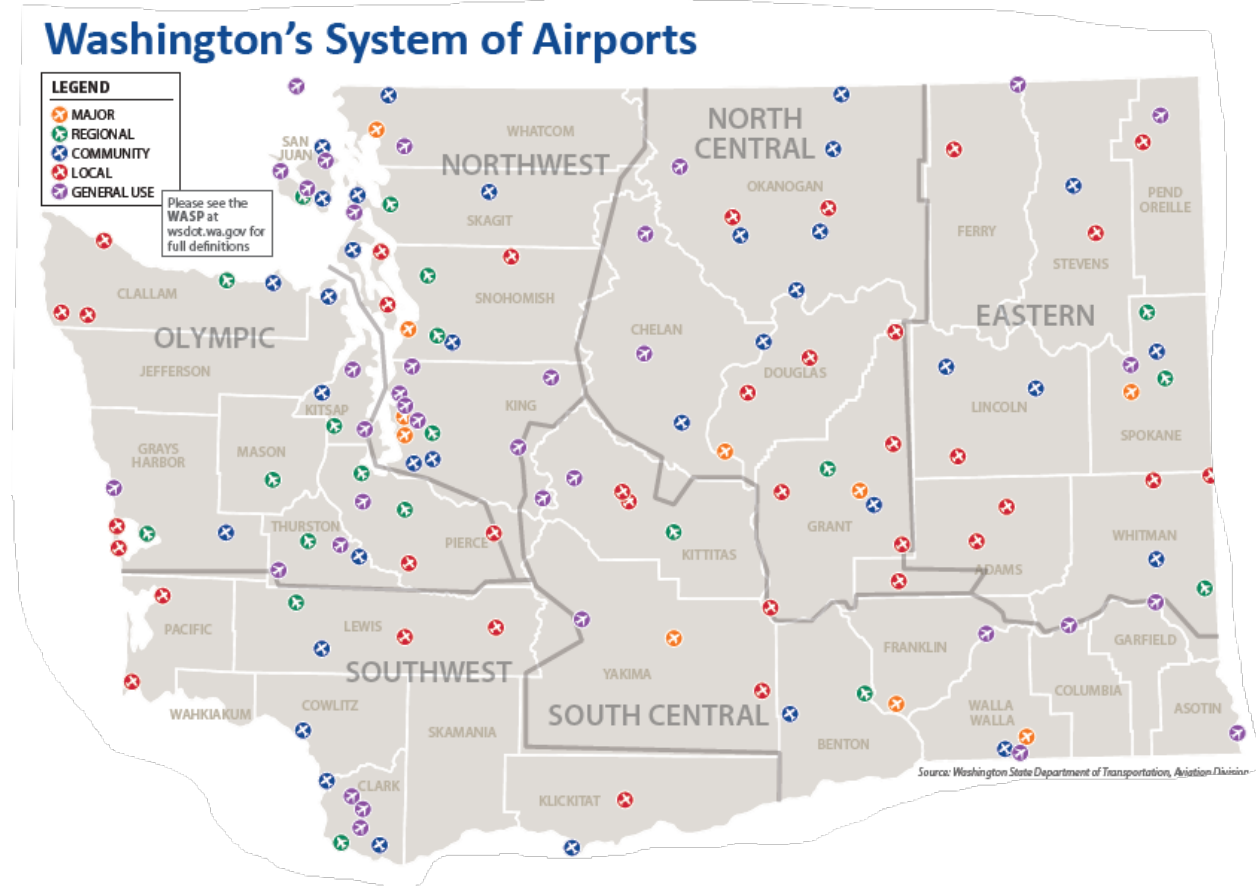
SWOT ANALYSES AND NEEDS ASSESSMENT

Following the completion of research conducted by each subcommittee, the data underwent a rigorous review, evaluation, and prioritization process. This was crucial to swiftly organize the most vital insights pertaining to Washington's aerospace industry. The following sections provide urgent and concise summaries based on the study's findings, analyses, and critical considerations from each subcommittee topic.

- **Summary:** A brief summary is provided for each section describing the overall status, findings, and considerations for Washington's aerospace industry.
- **SWOT Analysis:** A summary of the industry's strengths, weaknesses, opportunities, and threats are provided under each subcommittee as they apply to Washington state.
- **Needs Assessment:** The resulting list of priorities and needs to consider for both short-term and longer-term considerations for legislators, aerospace employers, and other public, private, and educational stakeholders.
- **Call to Action:** Serves as a clear directive aimed at guiding decision makers towards addressing the critical needs identified by industry leaders. These needs are essential for the growth and prosperity of aerospace companies throughout the state, enabling them to remain relevant and keep pace with increasing demand and emerging technologies.

Airport Services, Infrastructure, and Testing

Washington state airports proactively seek to adapt their infrastructure to accommodate rapid advancements in aircraft technologies. This includes preparations for the integration of electric, hydrogen, hybrid, vertical takeoff and landing vehicles (VTOLs), and autonomous systems. Recognizing the importance of environmental sustainability, airports across the state are actively exploring strategies to reduce the carbon footprint of airports. Notable initiatives, such as the Sustainable Aviation Fuel (SAF) Initiative, are implemented to promote alternative fuels. Concurrently, aircraft manufacturers are developing more fuel-efficient and environmentally friendly aircraft models.



To meet future aviation industry demands, airports must focus on a range of top priorities. Expanding capacity to accommodate increasing passenger numbers while simultaneously embracing sustainability practices to minimize environmental impact is paramount. Leveraging digital technologies and implementing advanced security measures are imperative to streamline operations and ensure the safety of passengers and staff. Enhancing intermodal connectivity and promoting sustainable ground transportation options further contribute to seamless and eco-friendly travel. Lastly, airports must remain adaptable to the rapid progress in aircraft technologies, adjusting their infrastructure to facilitate the integration of existing and emerging innovations, such as sustainable aviation fuels (SAF) and hybrid propulsion flight technologies.

Key Statistics for Sustainable Aviation Fuels



Source: International Civil Aviation Organization, July 2022

As mentioned previously, a major factor for site selection or retention by aerospace manufacturers is the state’s investment in and the company’s access to ongoing research and development resources. The National Institute of Aviation Research (NIAR) in Wichita, KS, is internationally recognized as a “gold standard” of public, private, and academic collaboration for the development and migration of new manufacturing technology²⁷. It has served as a magnet for attracting technical aerospace manufacturing to the region because of its ability to support rapid advancements in aircraft technologies and sustain future aviation demands. For airports and aerospace manufacturers to remain competitive, adaptive, and adjustable to the required infrastructure demands of emerging technologies, expanded and coordinated investments in R&D can accelerate progress toward those goals.

By addressing these needs, airports can effectively create a sustainable aviation ecosystem that caters to the demands of future travelers while prioritizing environmental responsibility.

SWOT: Airport Services, Infrastructure, and Testing

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> ● Services: <ul style="list-style-type: none"> ● With 130 public-use airports, there are multiple opportunities to grow and maintain services. ● More airports provide fuel service options. ● Infrastructure: <ul style="list-style-type: none"> ● Federal and state grants focus on infrastructure. ● Testing: <ul style="list-style-type: none"> ● Grant County International is known for its testing capability. ● Strong aerospace presence to continue to grow testing. ● SAF: <ul style="list-style-type: none"> ● Sustainable Aviation Tax Credit –ESSB 5447 ● Renewable Diesel and Sustainable Aviation Fuel Parity Act 	<ul style="list-style-type: none"> ● Infrastructure: <ul style="list-style-type: none"> ● Hangar space is limited ● Charging capabilities ● Inflation degraded near-term federal funding grants for projects. ● Testing: <ul style="list-style-type: none"> ● Lack of UAS testing facility connected to over the horizon flight operations. ● SAF: <ul style="list-style-type: none"> ● Commercial and financing avenues ● Incentives for fueling infrastructure ● Multi-stakeholder collaboration (planning, offtake agreements, financing)
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> ● Infrastructure: <ul style="list-style-type: none"> ○ Legislators are interested in transforming airports to become more environmentally sustainable. ○ Capacity requirements could influence state funding for airports. ● Testing: <ul style="list-style-type: none"> ● Emerging technology companies are interested in testing in WA State due to cheap power and aerospace presence. ● Green hydrogen production could be a catalyst for attracting additional hydrogen propulsion companies. ● SAF: <ul style="list-style-type: none"> ● Sustainable Aviation Tax Credit ● Renewable Diesel and Sustainable Aviation Fuel Parity Act ● Washington state tax credits and exemptions (e.g., Machinery & Equipment sales tax exemption) ● Currently, only 5 SAF production facilities in the U.S. ● R&D and new technologies ● Extra revenues for farmers ● Lowering GHG emissions ● Jobs 	<ul style="list-style-type: none"> ● Infrastructure: <ul style="list-style-type: none"> ● Airports don't compete well for state transportation funds (this will likely continue). ● Limited hangar space ● Encroachment of airports with incompatible land uses. ● Testing: <ul style="list-style-type: none"> ● Other states can be attractive for testing, given state incentives and cost of living. ● Companies seeking to test technology that is not viewed as a step towards environmental sustainability could meet mounting resistance...the return of supersonic travel is an example. ● With population growth, noise from aircraft testing becomes a greater issue. ● SAF: <ul style="list-style-type: none"> ● Specs and regulations limit new production pathways. ● Limited supply ● Commercial and financing avenues ● Europe is ahead of the U.S. with policies around SAF. ● Legislators concerned about use of agricultural products or fields to convert to SAF

NEEDS ASSESSMENT - AIRPORT SERVICES, INFRASTRUCTURE AND TESTING

The following provides an overview of the top priorities and needs to be considered.

Legacy Issues

- Currently, substantial airport revenue is diverted and does not come back to airports or aviation programs for reinvestment or use for maintenance.
 - WSDOT wrote an official letter to the FAA requesting the state's action plan to divert funds for reinvestment. At the time of this report, a decision has been received from the FAA, and the WA State plan was found to be compliant. DOR is developing the tax reporting requirements for implementation.
 - Moving forward, the potential exists for legislators to direct periodic state audits of airports to ensure diversion of funds takes place as anticipated.
- Incompatible land use surrounding airports creates challenges for ongoing development.
 - Rather than shut down all non-compliant activity, an evaluation can identify other solutions. Collaboration between industries such as rail and aviation (with WPPA's support) can help.
 - Development of affordable housing near airports is not equitable. This hinders manufacturers' ability to increase access to services and employment opportunities equitably, plus concerns from residents near airports continue to increase concerning emissions, noise, traffic and other issues.
- Revenue generation at general aviation airports should be considered.
 - Additional business education through WAMA and WSCAA can increase capabilities while generating additional funding.
 - Airports can partner with nearby universities to have students assist with business plans as part of their coursework. This engages students in a work-based learning exercise.
 - Airports should consider how to reduce expenses while increasing revenue.
 - Airports could consolidate construction projects across airports to reduce costs.
 - Airports should explore alternate-use cases such as business parks, particularly for rural airports that have available land.
- UAS Test Site
 - Evaluate the TransAlta site in Centralia, WA, for compatibility and use.
 - Evaluate Grant County International Airport as a possible test site location.
 - Follow the lead of Pendleton, OR, as they have transformed from a financially struggling rural airport into a national destination for drone research and drone pilot training. This is a use case for consideration by Washington's more remote airports.

Legacy Needs

- Preservation funding - primarily for airport pavement upkeep.
- Legislative approval is required to provide the Aviation Division spending authority on the 7-cent increase in aircraft fuel taxes.
- Fund general aviation hangar development at designated locations. Review the current hangar wait list system to analyze needs for location development and prioritize projects for implementation.
- Passenger service/air cargo capacity; this situation has been documented by WSDOT's latest studies
- Modernize airport terminals, towers, and navigational aids.
 - Update approaches to developing airport master planning processes.
 - Guide navigational approach updates with AIP funding outside of master plan updates.
 - Conduct independent reviews of airport approach update needs to prioritize projects.

- Airport connectivity to other modes of transportation.
 - Look for opportunities with public transportation services looking at their strategic plans and how they include airports.
 - RPTOs can also help develop options to look at airport transportation needs.
- Streamline the permitting process to avoid missed opportunities.

Legacy Opportunities

- Review options for increasing airport infrastructure funding, including:
 - WSAA board to review previous funding options/strategies.
 - Shovel-ready projects will compete best. Airports need to pursue shovel-ready projects.
 - Maximizing IIJA funding opportunities is a need.
- Leverage available funding from federal funds and WSDOT Aviation grants to provide state match.
- Develop airport commercial areas to develop non-aircraft storage areas on airport property and flexible storage options.

Emerging Issues

- Airport noise/aircraft emissions - also a legacy issue but growing in importance as aircraft operations expand. Significant ongoing work is being conducted to reduce noise and emissions with legacy and emerging technology.
- When, how, and should an airport invest in infrastructure to support emerging aeronautics such as electric aircraft charging, vertiports, and UAS facilities.
- Inflation requires additional funding to support construction projects.
- Counter drone capabilities. SEA is slotted as one of the pilot programs to detect unauthorized drone activities. This pilot program may be able to incorporate nearby smaller airports.
- Laser activity with approaching aircraft is a rising issue. Instances have occurred in growing numbers at SEA and, to a lesser degree, at other airports on the state's east side. Spot reports from pilots are needed. More powerful handheld lasers are now available. WSDOT to share with FSDO for their input and links to existing FAA information.
- **Sustainable Aviation Fuel (SAF):**
 - SAF currently sells at 2-6 times more than traditional jet fuel, which limits demand from airlines, and therefore affects the bankability of production facilities.
 - There currently is limited availability of sustainable feedstock and a concurrent lack of funding research for the development of new feedstock feeding into SAF production.
 - Currently, investing in SAF production is still a difficult proposition for lenders, which limits access to finance for SAF producers and continues to hamper efforts to boost supply levels.
 - Financiers have capacity and resource issues, so they prefer to invest in industries where developers can offer a "portfolio of ready projects" over industries where developers can only offer investment opportunities on a project-by-project basis. Given the still-early stage of the SAF market, financing arrangers are therefore limited in their ability to structure and originate opportunities in SAF production that would help create a viable pipeline of portfolio-ready SAF projects; and
 - Concerning the US market, demand for SAF is expected to increase. It could consume an amount of several hundred million tons of biomass per year, which would be equivalent to the amount of all biomass currently available in the US.

Emerging Needs

- Hangar development: Based on a 2020 study encompassing 37 general aviation airports in the state, it was revealed that the availability of general aviation hangar spaces was quite limited. The study indicated that only 15 hangar spaces were currently available, while a substantial waiting list of 850 individuals or organizations sought these spaces. This existing demand, which is expected to continue growing, highlights the importance of addressing the need for additional hangar facilities in a timely manner.
- Capital to cover maintenance and improvement costs.
- Infrastructure for Sustainable Aviation.
- Airport infrastructure for EVTOL and other new technologies.
- Transform airports to become more sustainable and reduce their carbon footprint. Several programs can include Airport Transformation and Airport Sustainability Grants through WSDOT.
- Grant writers and consultant teams can compete for competitive IJJA funds with support from WAMA, WSAA, WSCAA, and the Association of WA Cities (AWC).
- Enhance the production, storage, and distribution of sustainable aviation fuels (SAF) to reduce emissions. While Commerce is leading a team in coordination with WSDOT regarding SAF, there is a need to distinguish the need to solve for JET A and 100LL replacement fuels or SAF.
- Develop onsite or near-site airport power generation solutions for electricity and green hydrogen.
- Create solutions for EV charging and aircraft charging while identifying vertiport locations.

The 2015 Airport Investment Study (also cited in the 2020 Aviation Economic Impact Study) found that the "state's 134 public-use airports will need \$3.6B to cover maintenance and capital improvement costs through 2034. While Washington State's share of those costs is about \$240 million, budget forecasts estimate that WSDOT's Airport Aid Grant Program will only be able to contribute about \$28 million during that time. To address the shortfall, WSDOT Aviation and Airport Management must maximize state funding resources, proactively develop private sector partnerships, and implement strategies to produce additional revenue on airport property. Additional state investment into airports is also a critical component of ensuring Washington's aviation assets can effectively support the movement of goods and people and enhance the state's economic vitality."

Emerging Opportunities

- Pursue formula and competitive IJJA funds for airports.
- Pursue sustainable Aviation Grants for Airport Projects and Airport Transformation Grants.
- Incorporate non-traditional IJJA funding that can be used at airports (e.g., Strengthening Mobility and Revolutionizing Transportation (SMART) Grants Program).
- Implement commercial passenger services and air cargo operations at general aviation airports once electric aircraft come to fruition. Implement distributed air services when feasible.
- With the application of SAF and emerging aeronautics, seek to reduce aircraft noise and emissions.
- Seek FAA reauthorization following interest in Congress around Advanced Air Mobility (AAM).

CALL TO ACTION – AIRPORT SERVICES, INFRASTRUCTURE, AND TESTING

- Hangar development and prioritization
- Business development
- Warehouse space
- Workforce development: airport management (more fiscal education)—update report/business management
- Build infrastructure that can serve alternative fuels (e.g., electrification and hydrogen)—3-5 years out
- Install charging stations (5-7 years out)

The significance of rural airports cannot be overstated, as they play a pivotal role in sustaining and fostering economic growth within their communities. However, many of these airports currently face financial challenges. It is imperative to prioritize investments to maintain and modernize these vital transportation hubs. By doing so, we can ensure that these airports retain their ability to offer equitable access and opportunities to all regions of the state. Moreover, such investments have the potential to generate new revenue streams, fostering financial self-sustainability for these airports in the long run.

Commercial/Defense Manufacturing

Boeing's commercial and military divisions generate significant revenue, impact the overall economy in Washington, and are key revenue drivers within the overall regional aircraft supply chain network. Boeing is the 2nd largest employer in Washington and accounted for more than half of the growth in manufacturing jobs from May 2022 to May 2023.

In recent years, Boeing's long-standing dominance in the aerospace sector has encountered significant challenges, including the disruption caused by COVID-19 on air travel, quality issues with the MAX aircraft, and the rise of other aerospace manufacturing clusters both domestically and internationally. U.S. regions such as Texas, the Midwest, and the Southeast have been gaining market share due to their competitive advantages of low labor costs and attractive financial incentives for new business ventures.

The Southeast, in particular, has experienced rapid growth in its aerospace supply chain, largely driven by the presence of the Airbus plant in Alabama. It's noteworthy that Airbus has surpassed Boeing as the leading commercial aircraft original equipment manufacturer (OEM), mainly due to the success of its Airbus A320 tailored for single-aisle, mid-market routes that have become favorable for airlines post-COVID.

According to industry experts, regaining global market dominance for Boeing compared to Airbus may prove challenging until the introduction of a next-generation aircraft, a development anticipated to occur in approximately 7-10 years. It is speculated that Boeing's emphasis on the defense sector, where they offer competitive products, may explain the decision to relocate their primary headquarters to the DC region. Furthermore, the proximity to the Southeast aerospace ecosystem could have also influenced this strategic move.

Despite these challenges, Boeing will continue contributing significantly to Washington state's economy. However, uncertainties surround their future growth and investment in the region.

In addition, it is essential to acknowledge the delicate nature of the aerospace manufacturing and supply chain ecosystem. Tier 1 companies such as Safran and Crane Aerospace act as system integrators at the highest level, responsible for assembling significant aircraft sections such as lavatories, seating systems, and cockpit aviation systems. These Tier 1 companies often sell these sections directly to Original Equipment Manufacturers (OEMs) like Boeing, Airbus, and Lockheed.

On the other hand, Tier 2 and Tier 3 vendors play a critical role in the supply chain by providing subsystems. These vendors are typically small and medium-sized businesses (SMBs) or micro-businesses that rely on larger tiers to sustain their operations. Their success is intricately linked to the continued demand and support from the higher tiers.

By understanding this hierarchy and the interdependencies within the aerospace manufacturing ecosystem, policymakers can implement targeted strategies that address the needs and challenges faced by each tier. This approach ensures that support programs, incentives, and resources are tailored to benefit not only the Tier 1 companies but also the smaller SMBs and micro-businesses operating in the lower tiers.

Policymakers should remain aware of the varying levels of aerospace industry participation and address this discrepancy in their initiatives. Policymakers must design inclusive programs that have minimal requirements regarding revenue, headcount, and administrative overhead, ensuring that the majority of aerospace manufacturers in the state can qualify and actively participate in these initiatives. This will foster a diverse economic landscape promoting innovation and create a more resilient economy capable of withstanding economic shocks and uncertainties.

COMMERCIAL/DEFENSE MANUFACTURING: SWOT

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> ● Depth and Breadth of Supply Chain <ul style="list-style-type: none"> ○ The Puget Sound supply chain is the longest in existence, with a strong network. ● Diversity of Technology and Developing Markets <ul style="list-style-type: none"> ○ The aerospace industry includes commercial, space, satellite, defense, drones, hydrogen/electric power, and urban air mobility. ○ Leaders understand the need to look to the future and capitalize on new markets. ○ I-5 corridor boasts the best software talent and companies to support emerging segments. ● Quality of Life <ul style="list-style-type: none"> ○ Beautiful, natural environment. ○ Clean air, clean power, and vibrant intellectual and artistic culture are major attractants for cutting-edge companies. ● Innovation <ul style="list-style-type: none"> ○ Washington has a history of innovation and industry leadership. 	<ul style="list-style-type: none"> ● Costs of Doing Business and Living in Washington <ul style="list-style-type: none"> ○ WA ranks 32 out of 50 states for the overall cost of doing business²⁸. ○ WA ranks 46 out of 50 states in affordability, making it less attractive to new workers. ○ Example: Texas avg annual wage for aerospace engineers is \$121,000 vs \$137,000 in WA²⁹ (state average). ○ Example: The median home price in Texas is \$337,000 vs \$560,000 in WA (much higher in Puget Sound and I-5 corridor). ● Lack of a K12 STEM & Manufacturing Talent Pipeline: Washington’s weak talent pipeline affects its manufacturing capability. ● Lack of Incentives for Business Infrastructure Investment: Washington and local governments have shown less flexibility in offering incentives. <ul style="list-style-type: none"> ○ Example: WA lost the bid to NC in 2022 for Boom Supersonic. Other states (especially in

<ul style="list-style-type: none"> ○ Forward-looking business culture supports innovators of tomorrow. 	<p>the South) are aggressive in lucrative incentives. This was due – in part - to infrastructure in Everett not being ready in time versus incentives.</p> <ul style="list-style-type: none"> ○ “Total packages” should be more aggressive to compete with other states.
<p>OPPORTUNITIES</p>	<p>THREATS</p>
<ul style="list-style-type: none"> ● Tech Hubs: Pursue grant for “tech hub” (public, private, and education collaboration). <ul style="list-style-type: none"> ○ A Hub may include alternative propulsion systems, “factories of the future” like AI and robotics, advanced materials for aircraft, etc. ● Fund organizations like ICAP to help SMBs find and secure grants and funding from federal agencies. ● Asset Mapping and Supply Chain Resource Center: Map supply chain & public resources by capabilities and location, and provide a user-friendly directory to: <ul style="list-style-type: none"> ○ Connect supply chain companies with each other to keep business in Washington. ○ Connect state agencies with the supply chain and educate the industry on how to partner with those departments to be more competitive. ○ Provide a comprehensive directory of supply chain capabilities and events for out-of-state companies looking to investigate Washington for new business or expansion. ● “Factory of the Future” Support for Automation and Supportive Technology: Assist companies in adopting AI, robotics, and automation. 	<ul style="list-style-type: none"> ● Complacency: Perhaps the biggest threat to the aerospace industry in Washington is to assume that we are simply “too big to fail” when it comes to the state’s position as a leading aerospace cluster. As recent surveys show, States like Texas, Carolina, Ohio, Kansas, etc., are investing significant public resources in the aerospace sector. Particularly in the emerging markets of clean power, drone technology, urban air mobility, etc., these states already pose a significant challenge to Washington’s position as the center of aerospace manufacturing in North America. ● Cost of Business and Congestion: Consider developing industry hubs outside of Puget Sound. <ul style="list-style-type: none"> ○ The cost of land, housing, and more traffic are increasing problems. ○ Areas like Moses Lake find success in aerospace and high-tech industry. ○ Spokane grew during COVID in the healthcare tech market. Has a capable aerospace supply chain. ○ Time for a balanced, regional plan. ● Lack of Industry/OEM Diversification: From the relocation of its headquarters to Washington, DC, to a major investment in a new center in Texas, Boeing has signaled that much of its future expansion will be outside the state borders. While technology development could still be significant in Puget Sound, the revenue potential for that phase is not the same as full-scale aircraft production, and every indication is that the Southeast and Texas will be the geographic centers for those facilities. Supporting the growth of emerging segments like green energy/propulsion, satellite technology development and manufacturing, UAS devices and systems, and AAM are going to be critical to lessen dependence on Boeing for the aerospace sector. It will still be critical to support Boeing in maintaining a major presence here, as these sectors are fairly nascent and will likely take 5-10 years to develop a significant commercial mass.

NEEDS ASSESSMENT - COMMERCIAL/DEFENSE MANUFACTURING

The following provides an overview of the top priorities and needs to be considered.

- **Factory Automation: Build the Factory of the Future**
 - Companies are shifting to “factory of the future” technologies like automation and cobots/robots to supplement employees.
 - Significant gains in affordability and user-friendliness over the past ten years have made it easier and more acceptable to adopt these technologies.
 - Automation frees workers from repetitive tasks, allows them to focus on value-added roles, and supplements the lack of available talent to achieve production demands.
 - Smaller companies (tier 2-3) struggle with financial and human capital to allow them to implement these processes, which may be a barrier to economic growth.

- **SAF and Alternative Fuels**
 - Washington will continue to be a global leader in “green” technology. SAF (sustainable aviation fuel) provides the quickest path to near-term reductions in carbon output.
 - SAF is usable with current propulsion/engine systems in the commercial fleet. While electric/hydrogen technologies show promise, future commercial refinement, and application are years away.
 - Two key challenges will continue to be (a) scaling the production of SAF and (b) supplementing and upgrading fueling infrastructure at airports to accommodate new fuels.
 - Legislative support is needed to help the state (a) maintain leadership in global technology, (b) scale SAF production, and (c) upgrade fueling infrastructure.

- **Technology Hubs**
 - Technology hubs facilitate new process development and materials for manufacturing.
 - Like the workforce, technology innovation will require greater collaboration between education, industry, and state/federal government to align resources and priorities.
 - Washington must develop similar collaborations in commercial and military applications to achieve outcomes like The National Institute of Aviation Research in Wichita, KS (now with six regional campuses and a \$240M annual budget partnering with Airbus and Spirit AeroSystems).

- **Strengthen Cybersecurity within the Supply Chain**
 - The need to shore up IT security is at a critical stage, especially within the defense industry.
 - The CMMC (Cybersecurity Model Maturity Certification) will likely become a hard requirement for prime contractors and their subcontractors. While the model is still developing, it will require significant resources to implement, putting SMBs at risk.
 - Research conducted for this study among Tier 1 companies in the commercial market confirmed that requiring partners to establish and document cybersecurity protocols will create problems.
 - The supply of outside consulting firms with expertise in this domain is already severely inadequate to meet demand in the industry. Additional restrictions will create further setbacks.
 - The legislature should consider resources to assist companies (especially SMBs) in gaining the training needed to remain in the workplace.

- **Resource Directory**
 - SMBs are challenged to find public resources to support their business.
 - Resources such as export assistance, workforce training, tax incentives/credits, and research grants hide in multiple locations. Most SMB owners don't have time to search.
 - Creating a resource directory may help SMBs find access to additional resources specific to commercial and defense manufacturing resources.

- **Shore Up the Defense Industry**
 - A key challenge to Boeing's defense business over the last few years has been skyrocketing costs from the supply chain related to shortages created by COVID.
 - Where many defense contracts allow limited or no deviation from initial pricing, the outcomes have hit margins hard for military aircraft manufacturers, resulting in penalties and losses.
 - Additionally, as Boeing's internal defense business becomes more concentrated in the EU, there is potential to displace some domestic defense manufacturing to those regions.
 - A significant challenge is the administrative requirements for documentation, contract administration, and cybersecurity reporting, creating so much overhead. SMBs struggle logistically to qualify to enter this market.
 - Most military purchasing personnel also fail to meet DEI goals because of a lack of women and BIPOC vendors. Additional resources are needed to expand diversity and inclusion.

- **Investment/CapEx Incentives**
 - For aerospace manufacturers to remain competitive, they must constantly upgrade existing equipment and deploy new technologies.
 - Assisting employers (especially SMBs) to find and apply for grants and incentives to help automate, upscale technologies, and upskill workers is critical.

- **Regional Economic Equity**
 - The economic benefit of the aerospace industry is concentrated along the I-5 corridor on the west side of the state.
 - While areas like Eastern Washington are steadily adding aerospace suppliers, the net economic impact in those areas is a fraction of Western Washington.
 - Factors like land availability and cost of living will be problematic for the west side in the future.
 - A more straightforward strategy to diversify the supply chain into other parts of the state can strengthen the overall business model.

CALL TO ACTION - COMMERCIAL/DEFENSE MANUFACTURING

- **Marketing and asset mapping:** An effective marketing strategy for the industry is essential, encompassing cluster coordination and emphasizing key sectors such as space, satellite, commercial, military, UAS, and emerging technologies. It is crucial to maintain an up-to-date comprehensive asset mapping that accurately reflects the industry's resources. To ensure cohesive messaging and focus areas for various cluster groups, an advisory board comprising representatives from the state, private sector, and non-profit organizations should be established. A centralized resource database, resulting from the asset mapping, would provide

access to vital information on industry groups, start-up resources, and funding sources (including state, private, VC/Angel funding). This database would facilitate alignment among all groups when advocating for critical policy initiatives.

- **Innovation Center:** The establishment of R&D Infrastructure and Innovation Centers is crucial to foster collaboration between public, private, and educational institutions in Washington state. These centers serve as hubs for developing and disseminating new technologies, drawing inspiration from successful models like the National Institute for Aviation Research in Wichita. Additionally, it is vital to create a supportive start-up and entrepreneurial ecosystem, including the provision of incubator facilities. This holistic approach will facilitate innovation and the growth of emerging companies in the aerospace industry.
- **Support automation:** It is essential to provide support for automating the supply chain processes for tiers 2 to 3 suppliers, who often face resource limitations. This support should primarily focus on leveraging technologies such as cobots (collaborative robots) and optimizing process flows. Additionally, there should be a concerted effort to implement cutting-edge technologies like Industrial Internet of Things (IIoT) 4.0, digital twinning/threading, blockchain, and EDGE computing. These advancements will enhance efficiency, visibility, and traceability within the supply chain, benefiting suppliers at lower tiers.
- **DoD contracts:** To encourage the expansion of defense work, it is crucial to provide support through the development of grants, incentives, and potential assistance from organizations such as the Procurement Technical Assistance Centers (PTAC) and Pacific Northwest Defense Coalition (PNDC).
- **Capital expenditure (capex) incentives** that are specifically tailored to the industry. These incentives may include tax abatement programs designed to encourage investment in upgrading facilities, acquiring new technologies, and expanding manufacturing capabilities.

Space and Satellites

The aerospace industry is at the forefront of space exploration initiatives. Collaborative efforts between space agencies, private companies, and international partnerships have led to missions exploring distant planets, studying celestial bodies, and developing technologies for future space travel.

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> ● Washington’s space sector has a \$4.6B economic impact. ● Space employment and activity in the state has doubled in the last four years and continues to grow. ● Washington is already a leading producer of Low Earth Orbit (LEO) satellites. ● Washington’s overall aerospace industry experience, expertise, and existing supply chains are valuable to the space sector. ● The high-tech industry in Washington (cloud computing, software, etc.) is strong, which bolsters space innovation because of the alignment between the space and technology industries. 	<ul style="list-style-type: none"> ● The state is missing key research and development elements related to space innovation, including facilities for clean room, vacuum, hot fire test cell, hypersonic, and launch testing. ● Other states have strong congressional support for aerospace and space development. An example is the presence of congressional representatives from other states at Farnborough Airshow in Germany. ● Washington is the only US space cluster without a large federal presence (no NASA or Department of Defense research lab), which also means there are few prime contractors e.g., Northrop Grumman, Lockheed Martin.

<ul style="list-style-type: none"> ● Key space companies already have a presence here- Blue Origin, SpaceX, Aerojet RocketDyne, Amazon. ● The space sector has the support of several major private investors. ● The existing overall labor pool, in addition to aerospace and tech talent, is strong. ● The University of Washington’s Space Policy and Resource Center (SPARC) is a connector for industry. 	<ul style="list-style-type: none"> ● Space companies and suppliers are not aware of each other’s needs/capabilities as there is no central database or directory. ● The cost of living in the Puget Sound, where most aerospace business/talent is located, is high. ● Engineering talent has a "big aerospace" vs. entrepreneurial mindset, so individuals are less interested in space start-ups. ● Washington construction permitting regulations are extensive, time consuming, costly, and confusing. ● Washington state is not geographically close to space launch facilities like those in Cape Canaveral, Florida and Vandenberg Space Force Base, California. ● Existing aerospace suppliers do not know what is needed by or how to connect with space companies. ● Space companies do not feel there is a true commitment from the state to support the sector. ● There is a lack of state investment in transitioning unique local supply chain technologies previously developed for the airborne and tactical military to space systems. ● The University of Washington is behind in developing talent that demonstrates solid fundamentals and a practical skill set needed by space companies. The internship program and laboratory/hands-on experience are woefully underdeveloped compared to other programs.
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> ● Support/lead more public-private partnerships. For example, the state could coordinate leasing out available space at Aerojet RocketDyne to other space companies for non-competitive projects. ● Develop a better way to connect space companies, suppliers and customers. This could include a database/directory, more networking, sector marketing that targets those in and outside of the state. Existing industry support groups (Washington State Space Coalition, Pacific Northwest Aerospace Alliance, Space Northwest) could lead/support. ● Establish a space incubator and/or innovation hub located in proximity to a higher education institution or a business park. This resource could support space in addition to other sectors. ● Provide subsidized or reduced cost machining services for new or small space companies needed to produce prototypes or small-scale runs of parts. ● Provide tax relief for space companies starting in Washington as well as those looking at expanding in the state. 	<ul style="list-style-type: none"> ● Space start-up companies move or build production facilities elsewhere as they grow and develop their technology. ● Competition from other clusters draws investment and talent from Washington to other states. ● Technology setbacks and failures by key companies can stop or delay development and commercialization of new technologies. ● The aging workforce continues to create a skills gap. ● Aerospace and space industries are losing their competitive advantage for talent as students and workers shift to other sectors like high-tech. ● As space companies mature and bring new products to market, the local supply chain must grow accordingly, or companies will look elsewhere. ● Supply chain shortages that delay or limit access to materials can inhibit space company’s ability to produce products and scale their business.

<ul style="list-style-type: none"> ● Increase focus on commercial human spaceflight and space hardware production. ● The timing for space sector growth is good. Washington needs to act fast to take advantage of this. ● Improve efforts to market Washington state as a leading space cluster to attract additional industry investment. ● Connect Washington space companies with the Department of Defense, NASA, and other prime contractors. ● Fund an Innovation Center Accelerator Program (ICAP) for space. ● Bridge aerospace, computer science, and entrepreneurship programs in education to better prepare students for jobs in the space sector. ● Shift manufacturing, and potentially consider a facility that supports multiple companies, to rural or lower cost regions of the state. ● Scale down the length of time for job training. ● Increase engineering student slot capacity at public universities. 	
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NEEDS ASSESSMENT - SPACE AND SATELLITES

- Specialized machine shops - low volume, high complexity, rapid prototyping
- Specialized components & materials suppliers - optics, custom PCB design & fabrication, etc
- Testing facility
- Workforce - a combination of education and hands-on experience
- Business support f(x) - financial, legal, IT
- Help companies find physical locations - subsidize/incentivize

CALL TO ACTION - SPACE AND SATELLITES

Washington has been an active part of the space industry since the 1960’s and is home to leading companies, including Blue Origin, SpaceX, Amazon, and Aerojet RocketDyne. The state’s strong history in commercial aerospace and technology has fed a booming ecosystem of space entrepreneurs, but steps must be taken in order to better support start-ups and early-stage businesses.

- State investment in an innovation network that provides facilities/access to testing, prototyping, and business support services is critical to the continued growth of space start-up ventures.
- To attract new companies and additional space investments, the state has to do a better job marketing its existing space sector and the assets that make Washington a great place to locate a business. Telling the broader story of the state’s aerospace strengths is only one part of what’s needed. Focused sub-sector marketing efforts on space and other emerging technologies will provide a platform to highlight existing companies/resources and create new opportunities for businesses to set up shop in Washington.
- These marketing efforts should be coordinated with Department of Commerce work but should have engagement or oversight from industry leaders/stakeholders.

Uncrewed Aerial Systems

This sector has experienced remarkable growth and technological advancements in recent years. UAS refers to aircraft that operate without a human pilot on board and are controlled remotely or autonomously.

The UAS industry is not without challenges. Safety and regulatory concerns have been a significant focus due to the potential risks associated with airspace integration and privacy issues. Governments and aviation authorities worldwide are working on developing regulations and systems to ensure safe and responsible UAS operations. The integration of UAS into daily operations has the potential to enhance efficiency, reduce costs, and drive innovation across a wide range of industries.

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> ● Presence of USIC and work in bringing industry stakeholders together with the State’s support. ● Location: has both urban and rural areas and lakes and water separating urban areas, which is good for UAS flight paths. Also has a good deal of geographic diversity: mountains, plains, rivers, and lakes. ● <i>Airspace Lease Law</i>: Washington law allows public authorities to lease low-altitude airspace above state and local roads. Such a law allows state or local officials to create drone highways above these roadways. ● Aerospace workforce second-to-none (especially engineering talent). ● Strong and broad aerospace supply chain. ● One hundred five years of aerospace/aviation history in WA. ● Culture of innovation across industries in WA. ● Policy-maker interest in the sector. ● The government has shown a willingness to invest. 	<ul style="list-style-type: none"> ● No incentives for startups. ● Limited infrastructure, including hangar space. ● Limited R&D/technical resources to promote new product development - labs, incubators, testing corridor. ● Lack of investors in the ecosystem. ● Hard to scale with the limited talent available. ● Limited marketing/exposure for sector/companies in the sector. ● Capacity constraints in key degree areas (engineering). ● Local permitting processes. ● Lack of public relations to educate the public about the importance of UAS and the role it can play in WA. ● Lack of coordination between the local and federal governments. ● Limited uncrewed traffic management systems/policies. ● Lack of U.S. DoD program support for small emerging businesses without current government contracts. ● Technology (automation) integration. ● Energy Systems. ● Affordable housing.
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> ● Develop airway infrastructure for testing drones, UAVs, and remotely piloted vehicles (RPV)s. ● Pilot BVLOS projects. ● Develop a fully Advanced Air Mobility plan and lead the country in developing full-scale infrastructure. ● Establish a drone corridor network across the state. ● Push for streamlined regulatory approval to fly in TFRs after major disasters and during high-security events. 	<ul style="list-style-type: none"> ● Funding: lack of investors, funding, or subsidies to promote the proliferation of uncrewed programs or technology development. ● Absence of a trained or experienced workforce or educational/vocational training opportunities to sustain industry growth. ● Poor public perception of UAS: noise, safety. ● Inability to leverage technology to integrate UAS into the current operational environment.

<ul style="list-style-type: none"> ● Connect SMEs to existing supply chain/community colleges to fill needs via product gaps. ● Fund/reimburse key certifications (or portions of them) for companies. ● Remove red tape to let academia engage with industry (like agriculture). ● Digitization: combine efforts to capitalize on tech in WA. 	<ul style="list-style-type: none"> ● Competition for resources with aerospace and technology industries. ● Uncertainty around FAA regulations. ● Trade uncertainties. ● Complex funding landscape.
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NEEDS ASSESSMENT - UNCREWED AERIAL SYSTEMS

Needs identified through Washington’s Unmanned Systems Industry Council (USIC) and the AAAC’s UAS subcommittee include:

- Beyond Visual Line of Sight testing opportunities.
- Additional testing facilities and a system for finding and accessing existing resources.
- Workforce: a combination of education and hands-on experience.
- FAA development of updated regulations regarding UAS.
- Help companies find physical locations: subsidize/incentivize.

CALL TO ACTION - UNCREWED AERIAL SYSTEMS

Washington has many critical success factors already in place in order to support UAS and advanced air mobility (AAM) developments; an urban population core situated along the Puget Sound, numerous lakes, open space, and existing infrastructure in Central and Eastern Washington for testing and demonstrations, the availability of a highly skilled technical workforce, and a history of experience and success in aerospace.

To take advantage of these assets as UAS and AAM markets grow, the State has to act now with a focus on the future. Recommendations include:

- Amend growth management plans to allow land for future vertiports in both rural and urban areas.
- Allocate funds towards a pilot project(s) as an initial step.
- Allocate infrastructure funds to support the establishment of a UAS testing facility and drone corridor. This investment will create a highly valuable resource for companies engaged in the development of cutting-edge technologies and enhance the state's ability to secure federal funding for Advanced Air Mobility (AAM) initiatives.
- Take the lead in establishing a business incubator/innovation center with research and development components through a robust public/private partnership. This initiative would provide critical support to start-ups, fostering their growth and success in the UAS/AAM industry. Additionally, it would contribute to positioning Washington as a prominent leader in the UAS/AAM space, driving innovation and attracting further attention to the state's capabilities and expertise.

Overall, these strategic initiatives demonstrate a proactive approach to embracing the future of aerial mobility. By amending growth management plans, investing in infrastructure, and fostering innovation

through public/private partnerships, Washington can create a thriving ecosystem for UAS and Advanced Air Mobility development while bolstering its economic competitiveness in this emerging industry.

Emerging Segments (electric, hydrogen, VTOL, Advanced Air Mobility - AAM)

This subcommittee focused on the evolving field of next-generation transportation solutions, encompassing a wide-range of innovative technologies, concepts, and systems that aim to revolutionize how people and goods are transported, offering more efficient, sustainable, and advanced mobility options. Advanced mobility may include concepts such as electric or hybrid aircraft, urban air mobility (UAM) systems, vertical takeoff and landing (VTOL), autonomous flight, supersonic travel, and other cutting-edge developments in aerospace transportation.

These innovative solutions aim to address environmental challenges, optimize efficiency, and redefine the very concept of aerial transportation. These initiatives typically foster collaboration among industry leaders, governmental bodies, research institutions, and communities, collectively pushing the boundaries of aerospace technology.

If there is one central theme we have seen over the past few decades, it is the influence of technology and environmental concerns on global markets. In this context, Washington state emerges as a beacon of promise with a remarkably bright future. In what we term “emerging markets/segments,” we observe a remarkable surge in activity within the space and satellite, UAS, and electric- and hydrogen-powered market segments.

While major players like Blue Origin and SpaceX dominate these market verticals, they are complemented by a multitude of entrepreneurs and small enterprises that are tirelessly innovating and developing groundbreaking solutions. Remarkably, in 2019 alone, over 240 aerospace start-ups focusing on these nascent sectors were established in the State of Washington. The growth trajectory of these new segments has persisted into 2023, displaying unwavering momentum.

Washington state has emerged as a global leader in the realm of "green" aviation, epitomizing its position as a capital of environmentally conscious industries. Notably, Moses Lake has witnessed groundbreaking milestones with the first-ever test flights of both electric- and hydrogen-powered aircraft. This progress is further bolstered by the industry's impending transition to sustainable aviation fuels, underpinned by initiatives like the Innovation Cluster Accelerator Program (ICAP) and, specifically, the Sustainable Aerospace Technologies and Energies (SATE). The emergence of advanced air mobility systems and the rise of clean tech in both air and land vehicles contribute to the growing demand for infrastructure improvements and expansions at airports, further propelling the state's aerospace industry forward.

Challenges

Electric: current challenges include limited battery energy density and range, which restricts the size and endurance of electric aircraft. Continuous research and development endeavors are propelling advancements in battery technology, charging infrastructure, and aircraft design, putting the electric aircraft industry on an upward trajectory.

Hydrogen: challenges arise from the efficient production, storage, and distribution of hydrogen, as well as the technical complexities of integrating hydrogen systems into aircraft. Hydrogen-powered aircraft have garnered significant interest and investment, and ongoing research aims to overcome these challenges.

Furthermore, the aerospace industry encounters additional hurdles encompassing regulatory frameworks, infrastructure development, and public acceptance. These factors play pivotal roles in shaping the trajectory and the adoption of emerging technologies in the aerospace sector.

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> ● SAF <ul style="list-style-type: none"> ○ WSU/Ascent expertise ○ Alaska and Boeing investment and support for SAF ○ Leadership in green energy ● Resource rich (talent, natural resources) ● Green/sustainable energy availability ● Rich aerospace cluster & heritage ● Strong manufacturing base/supply chain ● Hydrogen ● Ability to develop a green hydrogen <ul style="list-style-type: none"> ○ Low carbon fuel standard (state level): a policy that will support this work ○ WSDOT Aviation: sustainable aviation grant (SAF and other infrastructure) ○ Technical strength: engineering talent, R&D for developing emerging tech (Amazon, Boeing, AeroTEC) ○ JACATI/Impact WA: resources for manufacturing & engineering companies ○ Access to military talent who may want to stay in the PNW 	<ul style="list-style-type: none"> ● Limited state incentives: there is a reason why manufacturing is exploding in regions like South Carolina, Alabama, etc. ● Doesn't always need to be financial incentives – it could be policies/rules that make business easier. ● The key for SAF – is lack of parity (vs jet fuel). So that airlines can afford to purchase it and use it. ● Permitting (need a yes culture) ● Supply Chain Disruptions ● Lack of broadband/IT infrastructure for rural areas ● State's span of influence (dependent on FAA to develop rules) – much is out of industry's hands ● Limited funding & support for promoting aviation & aerospace at the state level
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> ● Opportunity to brand WA State as the place to do emerging technology development in aerospace. Marketing/branding opportunity. ● The geography of the state lends itself toward multi-modal travel <ul style="list-style-type: none"> ○ I5 corridor congestion ○ Population bases that are “off the beaten path” or underserved communities – the opportunity to increase connectivity (i.e., eVTOL positioned 	<ul style="list-style-type: none"> ● Workforce readiness ● Increasing competition from other national and international clusters ● Increasingly split global market share ● Rural airports in peril ● Emerging aerospace clusters in other regions in the US ● Incoming recession ● Lack of support/funding for technical trade training & apprenticeships

<p>near transit centers to expedite the last leg of travel)</p> <ul style="list-style-type: none"> ○ Regional equity ● Air quality improvement opportunities due to reduced fossil fuel emissions ● Work with FAA to influence rulemaking ● Local policy makers can influence decision-making (Rep. Larson, Sen. Cantwell) ● Opportunity for the supply chain to diversify its OEM customer base through the development of alternative markets ● State R&D funding for start-ups (grants, incentives, etc.) focused on emerging aviation technologies to combat rising interest rates. ● Partnerships with higher education 	<ul style="list-style-type: none"> ● Increasing interest rates ● Rising energy costs ● Limited energy production/transmission capacity – competition from other industries ● Potential loss of snake river dams.
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NEEDS ASSESSMENT - EMERGING SEGMENTS

- Electric aircraft charging infrastructure
- hydrogen fuel supply
- regulations and standards for the operation and refueling/recharging of aircraft with alternative propulsion systems
- feedstock for SAF production

CALL TO ACTION - EMERGING SEGMENTS

- Innovation Center: the establishment of an innovation center will create a comprehensive network of facilities, laboratories, and suppliers, fostering innovation and attracting businesses to Washington state. This center will serve as a strong competitor to established aerospace clusters like Wichita, leveraging successful models such as the National Institute for Aviation Research (NIAR). It is crucial to secure funding for marketing the statewide network of R&D resources, raising awareness about the available resources and expertise. Additionally, the center should actively pursue federal contracts as a consortium, enhancing its competitiveness and expanding opportunities for collaboration and growth.
- Streamline permitting process: Efforts should be made to streamline the permitting process to minimize regulatory uncertainty associated with permits. Specifically, there should be a focus on streamlining the permitting process for new construction projects. This will help reduce delays and provide clarity to businesses and developers, allowing for smoother and more efficient project implementation.
- Workforce: Implementing robust apprenticeship programs can be instrumental in attracting highly skilled engineering resources from across the globe, effectively bridging the resource gap. These programs would serve as a means to cultivate talent, providing valuable training and hands-on experience to aspiring engineers. By attracting top engineering resources through apprenticeship initiatives, the industry can address the resource shortage and ensure a steady supply of qualified professionals to meet the demands of the aerospace sector.

- Leveraging state influence: Harnessing the state's influence in shaping federal decision-making and securing funding is crucial. This can be achieved by actively seeking to attract NASA and DoD contracts, for example, and investments, thereby strengthening the aerospace industry's ties with these key federal entities. Additionally, it is important to advocate for effective federal aviation wildfire response policies that align with the state's needs and priorities. By leveraging the state's influence in these areas, Washington can actively shape policies and secure resources that support the growth and resilience of its aerospace industry.

Workforce and Education

The aerospace industry requires a diverse and skilled workforce to meet the complex demands of the sector. To address the growing demand for skilled professionals, the industry emphasizes initiatives that promote science, technology, engineering, and mathematics (STEM) education. These initiatives aim to inspire and train the next generation of aerospace engineers, technicians, and innovators. Similarly, a continuous supply of skilled technicians will be needed to maintain production at all levels. Unfortunately, the current labor shortage is anticipated to continue for many years into the future, especially for those skilled in technical positions.

Workforce development in aerospace is critical to ensure a thriving and sustainable future. As the industry continues to evolve and innovate at a rapid pace, so too must the workforce evolve to maintain its ability to meet business needs. At the same time, companies must recognize the value of building a diverse work environment and find ways to create a strategic competitive advantage by sustaining an inclusive culture. The priority for the industry is to recruit, retain, and develop a highly skilled and adaptable workforce that can meet the industry's evolving demands.

WORKFORCE: SWOT

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> ● Strong Educational Infrastructure: WA is ranked highly in its educational resources. The state's higher-ed resources are robust and offer several programs. ● Reputation for Education Quality: The state maintains a strong reputation for its education, making it attractive to students to recruit from. ● Strong Value Proposition for Employers: WA is a desirable place to live, which helps balance high living costs to attract new workers. ● Current Push for Additional Pathways: WA has pushed for new career pathways and laid the foundation for alternative means of jobs. This helped shift the culture for options beyond 4-year college. ● Strong Industry Ranking: Despite the recent slip in rankings, WA still holds a strong Top 10 rank in aerospace and advanced manufacturing. ● Strong Employer Base: WA is home to Boeing, Blue Origin, and other large employers in aerospace. 	<ul style="list-style-type: none"> ● Status Quo: WA is slow to change in policy, direction, and way of thinking (especially business and education relationships). ● Misalignment: Many agencies & organizations work on "Workforce," but there is not a single statewide strategy. Resources are not working together. ● Funding Distribution: Large budgets are spent on Workforce, but there is no central state strategy. ● Lack of Partnership & Engagement: Business and education have not openly talked in many years. Education cannot prepare students for workplace success if they are unfamiliar with employer needs. ● Inflexible Development Options: Higher education typically offers a "one size fits all" model of accredited education. No other modular options are readily available. ● K12 Rigidity: The state community colleges (overall) do not easily articulate programmatically with high schools to offer trades programs in the high school. ● Higher Education Rigidity: The inability of educators to change curriculum, delivery, structure, or approach to meet business needs creates problems. ● Mindset: The rate of change in business is unprecedented. For education and government to become viable partners, they must be able to shift quickly enough to keep up with partner speed.
OPPORTUNITIES	THREATS

<ul style="list-style-type: none"> ● Need: Despite a slower-than-average start, manufacturers, educators, and government stakeholders have finally recognized a need to do things differently. This need creates momentum to generate a changing opportunity. ● Current Push for Alternatives: WA has shifted its focus to identifying alternative career pathways for high school students other than traditional college options. While registered apprenticeships have emerged as the primary option, it is most likely due to a lack of other readily available options. The acceptance of alternatives sets the tone for change. ● Current Success Models: WA does not need to start from scratch. Other states have created successful models and best practices that WA can learn from to avoid “reinventing the wheel.” ● Competition: With the surge in production demand across manufacturing, now is the opportunity to drive change in workforce development. Demand creates opportunity and motivation if the industry takes advantage of it. 	<ul style="list-style-type: none"> ● Workforce Shortage: The obvious threat is the continued worker shortage. The current shortage will be generational. The workplace will not have enough workers to go back to pre-pandemic levels of workers. This will require new ways to increase efficiency from companies and workers. ● Competition: Competition has already displaced WA as the top state in aerospace. Without addressing the issues immediately, WA will continue to decline. ● Resources for Employers, Especially SMBs: The aerospace and advanced manufacturing industries are known for avoiding or delaying investment in resources, especially spending on development and automation. This is especially the case for SMBs. <ul style="list-style-type: none"> ○ Employee Development: Employee development is regularly underfunded (or not funded at all). WA must find a way to incentivize employee development if it is to take place. ○ Operational Expertise: Most SMBs - which includes the majority - do not maintain operational expertise. They avoid investing in upgrading expertise. Funding opportunities to upgrade operational expertise will have strong ROIs. ○ Funding to Automate: Automation will be needed to both compensate for the lack of employees and to improve competitiveness. SMBs, in particular, will need assistance to fund this. ● Misaligned Resources: The state funds an incredible number of resources assigned to workforce development. However, there is not a single statewide strategy. Many resources are used and money spent, but no single defined problem is to be solved. ● Silo-ing: With so many departments working on the workforce, there are also overlapping and duplicate services. One threat is the resistance to change during the alignment process if a player believes power is being taken away. ● Lack of Acknowledgement: There remains a large perception that a workforce problem does not exist or that it is not anything more than a short-term problem that will be resolved on its own.
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NEEDS ASSESSMENT - WORKFORCE AND EDUCATION

Stakeholders must consider the following needs to advance their efforts to develop the workforce needed for both today’s and tomorrow’s aerospace manufacturer.

- **Focus on Employee Retention.**
 - Retaining current workers should be the top business priority for any organization.

- Creating professional development opportunities can help employees grow, develop, and engage in their roles to build a future in their careers and companies.
- **Adopt Inclusive Practices.**
 - Adopting inclusive practices to enhance diversity efforts within company cultures.
 - Increased DEI helps current employees increase engagement, encourages higher levels of talent development, and creates a workplace that is inviting to people from all backgrounds.
 - Promotes stronger recruitment and equity efforts.
- **Increasing Access to Underserved Communities.**
 - Increasing access to the workplace, career pathways, learning opportunities, development tracks, and leadership roles.
 - Increasing efforts to diversify and expand programs that assist traditionally underserved communities to increase access to talent that otherwise would be missed.
- **Improve Stakeholder Relationships.**
 - Building strong relationships between employers, K12, higher education, apprenticeship, and other learning communities.
 - Bridging the gap between employers and students.
 - Extending proactive opportunities to bring students into the workplace sooner and aligning high school and college programs with employer needs.
 - Increasing overall quality of candidates.
- **Rapid Skills Deployment | Workforce Training Centers.**
 - Creating opportunities to develop and deliver just-in-time training through centers that can deliver a rapid skills deployment approach to learning.
 - Managing a skills-based or competency-based workforce requires the ability to provide fast, modular learning.
 - As stakeholders develop and create workforce training centers that can deliver that model, everyone benefits.
- **Workforce Resource Alignment.**
 - Working with local, regional, and state representatives to align state workforce resources.
 - Washington can do more and improve its outcomes through a systematic, aligned strategy where all functions and agencies work toward a common goal.
 - Create an advisory panel or utilize the currently existing group (e.g., Workforce Board) to facilitate the overall coordination of a workforce strategy.

THE NEED TO ALIGN

The committee's conclusions on the state's aerospace workforce support previous findings from work completed by other studies:

- The aerospace manufacturing workforce shortage will endure for many years. Employers will continue to struggle to find qualified talent, especially in skilled production and technical positions.
- The pipeline for 4-year prepared professional positions (e.g., engineers) has increased or remained stable and should continue to meet future demands.
- Future community college enrollments in trades programs expect to be lower, primarily due to fewer students and less interest. It will not provide a sufficient pipeline to meet industry needs.

In summary, aerospace employers will continue to see the same problems if Washington continues down the same path. A familiar list of recommendations to address the same problems as previously identified will continue to result in little or no change. Something new is required to achieve different outcomes.

Using Best Practices

Manufacturing is known for applying best practices to bend the learning curve to save time and money, improve outcomes, and increase efficiency and effectiveness. The state's aerospace sector can benefit from adopting this methodology to address its workforce challenge. Throughout this study, workforce practices were reviewed among several states throughout the U.S. to identify best practices. Several states stood out as top examples where advanced manufacturing practices (including aerospace) excelled in achieving outstanding workforce results.

Though not an exhaustive list, states that topped the list in successful workplace development practices included Connecticut, Massachusetts, Wisconsin, Michigan, and Virginia. Other states had programs or best practices, including Florida, Tennessee, Georgia, North Carolina, Colorado, Alabama, Arkansas, and West Virginia. The most common factors in delivering robust workforce systems included the following:

- *Active Partnerships between Business, Education, and Public Sector*

Active business participation is the most common characteristic among states with successful workforce programs. In fact, active business leadership is the primary driving success factor in all examples where states have implemented effective strategic programs. Government can design programs and implement plans, but if the business does not drive its execution, the plan will not happen. Likewise, education can talk about business, but unless business works directly with education at the front lines, educators cannot know what businesses need and how to integrate those real-time competencies into their curriculum. When government aligns with business, policies, and regulations can help facilitate the need to develop and support a thriving workforce.

In Washington, a statewide collaborative relationship does not currently exist between business, education, and government to form a coalition for centralized planning purposes. Though the Workforce Training and Education Coordinating Board has representation by these groups, the format of the Board is not structured openly to provide aligned coordination. Building a guiding coalition among these three groups can enable an aligned approach to workforce development.

At a local level, the IT3 workforce development center in Ridgefield, WA, is a shining example of what is possible when business, education, and government come together to solve the problem.³⁰ Recognizing the need for short-term training and bridging the gap between high school and the workforce, the Port of Ridgefield, the Economic Development Administration, Washington State Community Economic Revitalization Board, U.S. Department of Agriculture, Washington State Legislature, the Siemens Corporation, the local tribe, and others came together to plan, organize, fund, and launch a workforce solution.³¹

- *Central Planning*

Creating a master plan to focus resources helps to define and achieve more. For example, Connecticut's annual Manufacturing Strategic Plan is an ongoing process where the manufacturing sector focuses on innovation through workforce growth, industry expansion, and supply chain

resiliency.³² The plan brings primary stakeholders of business, education, and government together to align resources to serve their needs best to achieve the state's goals. Massachusetts focused on advanced manufacturing to develop a workforce plan specific to its needs.³³

Washington lacks a master plan to guide its aerospace or advanced manufacturing efforts. Without a coordinated strategy, the industry will remain fragmented and misaligned. Engaging in an industry “whiteboard” session to determine the top priorities, goals, and investments can focus efforts and improve outcomes. Given the breadth of stakeholders, this is not as easy as it sounds. Engaging an existing entity such as the Center of Excellence for Aerospace and Advanced Manufacturing to launch an initial discussion or survey industry interests may be a starting point to begin the process.

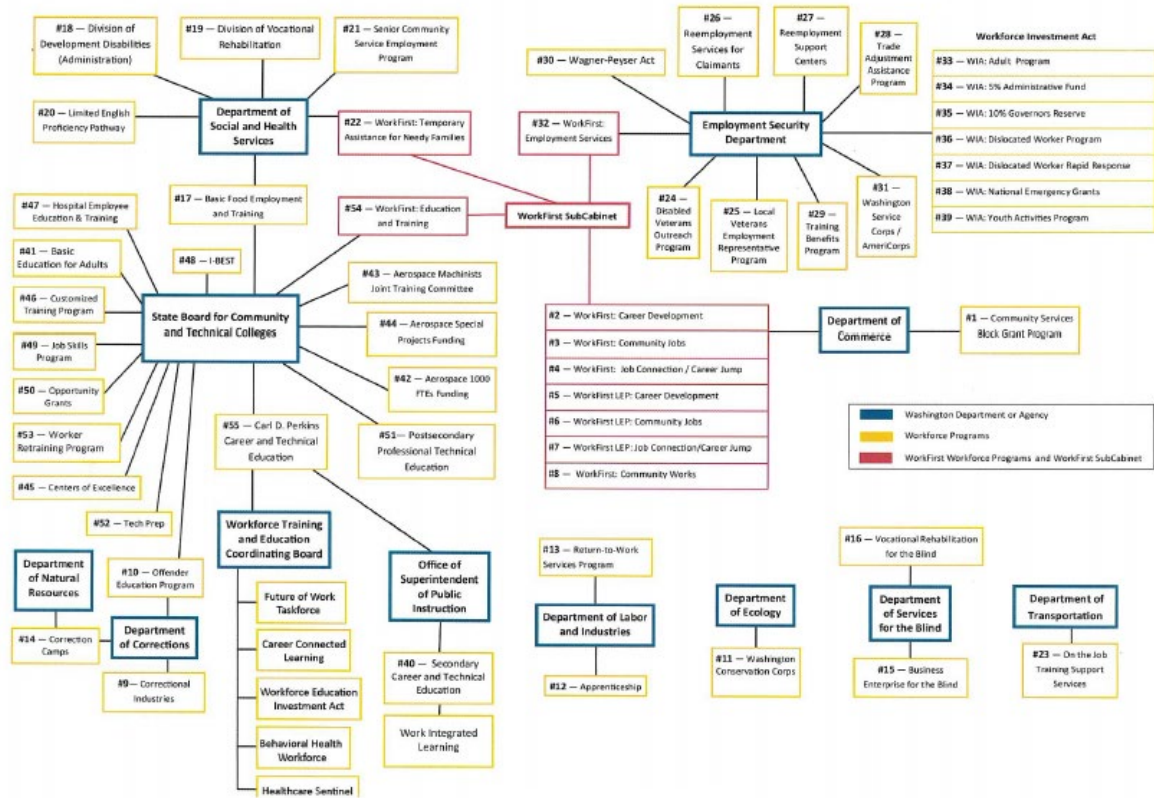
- *Resource Alignment*

Industry and partner resources must work together in a coordinated effort. In states with best practices, designated agencies, departments, and NGOs coordinate efforts and align outcomes to facilitate services efficiently and effectively to achieve common goals. Washington has many resources currently committed to workforce development. For example:

- Higher education institutions offer exceptional programming for 4-year STEM-related degrees.
- The State Board for Community and Technical Colleges coordinates community colleges for post-secondary professional technical education in the trades, apprenticeships in advanced manufacturing through AJAC, worker retraining programs, Centers of Excellence, I-Best, and related programs.
- The Department of Labor coordinates the approval of work-based apprenticeship programs.
- The Workforce Training and Education Coordinating Board oversees Career Connected Learning, Future of Work Taskforce, Regional Workforce Councils, and related programs.
- OSPI coordinates Career and Technical Education (CTE) through K12.

There is no lack of resources throughout the state to offer workforce development services. The challenge becomes poor coordination, duplication of services, and lack of alignment in working toward an undefined goal. The following graphic demonstrates the scattered approach to Washington's workforce development. This does not include resources such as 4-year higher education entities (e.g., public and private universities), non-profits such as AWB, or local and private programs.

Washington's Workforce Development Programs and State Agencies



By aligning resources, coordinating with partners in education and business, and working toward common goals, the State can help facilitate better outcomes with the same resources.

- **Early Exposure**
Another success factor among best practices states was the exposure to the trades at younger grades.³⁴ Introducing trades programs in middle school CTE curriculum and even grade school can enable greater interest and success in future career paths.

Washington is already well-resourced to enhance workforce development efforts. The challenge becomes creating a unified vision for aerospace manufacturing with common goals and priorities, followed by a realignment of resources with a partnership to support industry-specific needs to meet those goals. Aerospace employers must lead the effort by defining current and future workforce development needs, with education and government delivering specific resources to support them.

CLOSING THE SKILLS GAP

For Washington's aerospace sector to remain competitive and regain its place as the most competitive option for business, developing a future-ready workforce must be a top priority. The accelerating rate of change makes it challenging to keep up. Nationwide, by 2030, 2.1M manufacturing jobs could go unfilled if employers do not address the skills gap.³⁵ Ongoing automation will create more demand for workers to acquire additional skills.³⁶ In fact, half of all employees will need reskilling by 2025.³⁷

The rapidly changing nature of work has created a shift to move beyond education and experience requirements and focus more on the skills match between candidates and roles.³⁸ Manufacturing roles can benefit from skills-based hiring rather than depending upon traditional job descriptions. Jobs will change with automation and technology, but capabilities and competencies create stability and reliability in employees. Skills-based hiring also allows employers to use pre-employment assessments for greater accuracy in matching people to jobs using job simulations, job trials, and pre-employment tests that help both the employer and candidate find work that best suits them for improved outcomes and retention.³⁹

Though specific skills will vary by employer, a broad range is common to many in aerospace. Enabling workers with "adaptive skills" to support the transformation of "their abilities as their demands and environment change"¹⁰ will maintain ongoing performance and worker capability throughout their employment. This can create a competitive advantage by addressing today's needs while developing the flexibility to adapt to future demands.

Manufacturing will continue to evolve too rapidly to keep up with traditional approaches. A study by EY and The Manufacturing Institute¹⁰ found industry leaders agreed that:

- Skills needed for manufacturing jobs are changing rapidly. (74%)
- Skills required for manufacturing jobs are changing faster than the skill level of the workforce. (65%)
- Organizations struggle to fill job vacancies because of the quickly changing skills required for the industry. (65%)
- Their organizations seek innovative ways to invest in the careers of their workforces. (82%)

Manufacturers must make adaptive cultures, talent strategies, and individualized learning programs part of their overall strategies. While 60% of manufacturers surveyed by the National Association of Manufacturers (NAM) are creating or expanding internal training programs to address skills shortages, many are unaware of the essential role of adaptive skills.¹⁰ This means that manufacturers are most likely training employees on the wrong things while developing training programs.

Building a Workforce Development Solution

Manufacturers must enable employees to develop the skills needed to drive innovation, continuously grow both personally and professionally, and maintain the competencies required to meet future demands. Upskilling is perpetual and cannot be seen as an event - it is a process to be built within a company's culture. As workers build learning and professional development into their jobs, they can continuously prepare for ongoing changes. Employers who recognize the upcoming changes, identify the required skills needed for automation and technology shifts and encourage professional and leadership development have much better results in retaining skilled talent.

Employers must recognize that a one-size-fits-all approach to employee development is ineffective due to the diverse nature of workers, their jobs, and types of learning. Successful companies incorporate several tools to launch and manage a structured development program that includes:

- Active performance management and coaching that provide employees with structured competencies, guidance, and engagement.

- Individual development plans retain employees as they grow in their current positions and gain new knowledge and skill to move into new assignments.
- Succession planning helps employers and employees understand opportunities, resources, and planning for the future. When people know there is a future, they remain with the company.
- Competency models help managers build consistent performance, training, and development programs to enhance certifications, qualifications, and industry advancement.
- Guided educational development in partnership with formal education, apprenticeships, industry-recognized certifications, and other training partners.
- Other professional development opportunities through seminars, workshops, conferences, and professional engagements that develop networking and common industry knowledge development.
- Rapid skills deployment structures to deliver just-in-time training for single employers or groups of employers that are specific bodies of knowledge that meet employer needs.
- Tracking and management systems and processes to proficiently manage worker knowledge, employee advancement, and employer knowledge management.

Like anything else, these are new skill sets and operations that require training and development among and within organizations. Without additional supportive resources, most organizations (especially SMBs) will not have the time, funding, or knowledge base to design, build, implement, and manage such a system. Providing resources to assist employers in developing these types of robust development models can accelerate overall industry stability, growth, and advancement to support the technological and human shifts needed to achieve desired results within IR4.0/5.0.

Washington is only as good as its people. So, too, is the aerospace industry. Without a swift and decisive investment in a comprehensive effort to align and develop workforce capabilities, the industry will continue to fall further behind in its efforts to compete.

WORKFORCE AND EDUCATION ASSETS

The designated subcommittee highlighted the need for Industry and Education to partner in developing talent solutions to grow the State's capabilities. Washington ranks high in education resources, especially among 4-year institutions in science, technology, engineering, and mathematics (STEM) education. These initiatives actively target the next generation of aerospace engineers, technicians, and innovators.

Integrating Washington's education resources is essential to address the workforce challenge. Washington offers many solutions for workforce development, including universities (4-year programs), community colleges (including trade schools), registered apprenticeships, and K12 programs.

Research conducted throughout this study identified several best practices that support future-oriented workforce development. Examples stand out where other states have effectively aligned their workforces to meet industry needs. These best practices are founded on businesses, education, and government working together at the local, state, and national levels to align resources, achieve economic growth, and develop a strong workforce. The following resources are critical career development pathways identified as required to support the desired industry shift.

4-Year University Programs

Over the past two decades, Washington focused on strengthening STEM-related 4-year programs. As a result, Washington excels in producing mechanical engineers and other professional-level positions in the manufacturing workforce pipeline. Washington ranks among the top 10 states for the concentration of mechanical engineer employment, annual mean wages, and employment by area.⁴⁰ The Seattle metro area ranks 7th nationally as the top-paying metro area for mechanical engineers.

Research conducted for this study identified partner schools such as Washington State University, Eastern Washington University, and Gonzaga University as clear leaders in producing manufacturing engineers and conducting related industry research. In cases where individual companies, such as Schweitzer Engineering in Pullman, WA, launched efforts to expand workforce development initiatives, results occurred.⁴¹ Successful workforce alignment initiatives involve (or have been initiated by) employers and cannot be developed and implemented by education, government, or NGOs without the business as an active partner.

Efforts should continue current 4-year STEM efforts to ensure an ongoing supply of manufacturing professionals. Additional steps to partner with manufacturers to accelerate workforce development may also include the following:

- Increase interactions with aerospace businesses to identify specific industry workforce needs.
- Incorporate more “live” projects and real-world case studies into the curriculum with interaction, mentoring, and feedback from industry professionals.
- Increase opportunities for work-based learning and internships during the program to integrate students into the workplace sooner and gain additional practical, real-world experience.
- Introduce “micro-internships” requiring 10-40 hours of work to optimize exposure to multiple companies.
- Enhance curriculum that develops “soft skills” such as communication, problem-solving, critical thinking, leadership, conflict resolution, and similar interpersonal relationship skills. Employers have the most difficulty finding critical thinking, communication, and creativity, which are critical components of building the future workforce, technology, and innovation.⁴²

As 4-year educators and aerospace business leaders increase engagement and partnerships, curriculum, learning, and outcomes can more readily align with employer needs to meet future workforce requirements.

Community Colleges

Community colleges have historically offered a broad range of career-focused programs, including technical degrees related to aerospace and advanced manufacturing. However, Washington's community college trades programs remain challenged by the following:

- Declining enrollments in the trades, starting prior to (but accelerated by) the pandemic.⁴³
- Notable declines in underserved populations, with Indigenous and Latinx students at the State's two-year colleges experiencing the most pronounced declines.⁴⁴
- Employer demand that pulls students from programs into employment prior to degree completion.

- The low perceived value of college education or post-high school training, especially for production jobs.
- Perception of a lack of affordability of college programs from community colleges.
- Ongoing perception issues of careers in the trades as being dirty jobs or second-rate options.
- Emphasis by high school counselors to push four-year university programs.
- Lack of awareness of career pathways or earning potential of careers in the trades.

Community colleges hold a unique opportunity to create a strategic partnership with industry to build tomorrow's workforce, but it requires a mind shift. Resistance to change was apparent among several college programs that hindered the ability to deliver the rapid upskilling needed. Research for this study showed that Clover Park, Bates Technical, and Big Bend Community Colleges clearly demonstrate the forward-thinking necessary to forge new partnerships with businesses to solve the problem. Others remain inflexible and unable to adapt to rapidly changing industry needs.

If Washington's community colleges are to serve as partners, they must help businesses identify and meet shifting needs. Examples of best practices from other locations identified during this study include:

- Develop employer-driven curriculum.⁴⁵ Traditional advisory committees that meet annually and provide recommendations followed by micro-adjustments to programs that take years to implement cannot keep up with the rate of industry change. The curriculum must align with in-demand industry standards, and community colleges must find a way to continuously update their curriculum.
- Blending credit and non-credit training via stackable credentials, modular training, and other competency-based learning models can accelerate learning.²³ Offering just-in-time competency development can accelerate development and meet needs faster. This can also help students gain short-term skills faster to land entry-level employment sooner. Skills-based learning is critical.
- Address equity with career-focused pathways to open the door to more opportunities. College is often focused heavily on degree completion or transfer. With a competency-based approach, the goal is employment and development. A strong relationship between the college, employer, and student becomes long-term. The student attends school as long as needed, gains employment, and the employer supports the employee's ongoing development (and re-training) with the partner college. This focus helps to reduce barriers to access, maintain employment, and facilitate opportunity.
- Modify the curriculum to be industry-based, not academically centralized. Rather than following a standard "one-size-fits-all" approach to general courses such as math and English, consider designing math and English to apply to the trades. I-BEST has proven itself effective in programs such as nursing and precision machining. Applying a career-based approach to math can accelerate learning and reduce the chance of failure by making the learning more applicable to the student's career path. The same can be applied to other general courses.
- Develop digital literacy skills by incorporating technology into classroom assignments. Providing digital tools (e.g., laptops, tablets, software), building their use into assignments, improving online access, training on ERPs and related systems, and integrating the use of AI in problem-solving can accelerate student success. The more programs can simulate the employment environment, the better-prepared employees will be to succeed on the job.

- Incorporate work-based learning opportunities. The sooner students can integrate into the workplace, the better. While employer co-op programs are effective options, they are typically included at the end of the student program. Educators should consider the following:
 - Involving manufacturers throughout the program to enhance practical application using live projects, case studies, and other real-world applications.
 - Earlier work-based learning opportunities to create learning in a live work setting that exposes students to real work situations, mentors, working with professionals, and doing real work.
 - Incorporating business partners to deliver hands-on content, theory, practice, and application. Coordination of curriculum delivery can ensure alignment for academic integrity and quality standards, but “on-the-job” learning can be part of the program.
 - Engaging employers throughout the learning process to provide more mentoring, feedback, communication, and engagement will help students prepare for full-time employment.

Registered Apprenticeships

The previous Washington State Aerospace Strategy highlighted the need to expand apprenticeship programs in aerospace-related fields.⁴⁶ Facilitators such as AJAC and Machinists Institute grew apprenticeship programs to develop needed skills. The current emphasis on registered apprenticeships will continue to support future workforce development needs. However, while legislation such as 49.04.160 RCW may intend to expand high school registered apprenticeship programs, the process is still complicated, unclear for employers or educators, and impractical to use in its current form as a viable solution.

Additional support from apprenticeship programs can come in the form of flexible micro-apprenticeships. Much like industry-recognized certifications, micro-apprenticeships can be offered modularly as a form of skills-based or competency-based learning. Offering shorter courses (e.g., 4 weeks or other short-term options) can provide individuals and employers with the ability to:

- (a) Rapidly develop knowledge and skills in a specific area. This may assist with improving their current capabilities, qualifications for promotion, or ability to gain employment quickly.
- (b) Earn recognized professional credentials that lead toward completion of an apprenticeship program. As employees complete modules, they can earn hours and credits toward the completion of their program if full apprenticeship programs adapt to allow this flexibility.
- (c) Use micro-apprenticeship courses as flexible, stackable credentials within programs. When courses are transferrable from program to program (e.g., OSHA-10 Safety Module required within various programs), the employee can change apprenticeships without having to start over.
- (d) Develop employees within micro-apprenticeships as stand-alone resources to develop specific skills. Though some may not continue with the full apprenticeship, they will be exposed to the full program and can be encouraged to pursue additional training toward program completion.

Industry Recognized Credentials (IRCs)

IRCs have been used in several industries for years and provide a means to independently attest to a learner’s level of knowledge and skill outside of a formal degree or apprenticeship program. For example, the American Welding Society maintains independent training, testing, and professional certification standards to demonstrate competency and levels of skill for welders that are recognized throughout

manufacturing. IRCs serve as an alternative standard bearer to demonstrate competency to employers. (It should not, however, take the place of pre-employment testing to verify capability.)

As the industry shifts to skills-based models, employers will rely less upon traditional development methods. Instead, just-in-time options will look more attractive to provide the knowledge, skill, and competency needed by the employer. IRCs are designed for just that purpose. By identifying the specific skills needed, employers can match them with the desired curriculum and use the IRC model to meet their needs.

Unlike university, college, or apprenticeship models, IRCs deliver short, specific training opportunities that address a particular need. At the same time, IRCs provide the structure and content that go beyond the simple one-day or one-week workshop format common to most industries. They provide a tangible demonstration of learning, skills, and competence that can be used as an internal “credential,” acknowledging achievement or completion for use in evaluating performance, placement, or promotion.

Because IRCs are industry-based and flexible, employers must take charge of ensuring that the right training is delivered at the right time. This requires careful program vetting, alignment, workforce development management, and internal succession planning to meet the desired outcomes.

High School (K12)

Perhaps the greatest area of opportunity lies in K12 to meet tomorrow’s workforce needs. The strategic partnership between business, education, and government is most critical at this level. Unfortunately, conclusions from this study indicate that the partnerships at this level appear to be the weakest across the state, with few exceptions.

Best practices identified throughout the country during this study demonstrated the need for a critical shift in the way Washington aligns its K12 programs to better prepare graduates for a future in aerospace and advanced manufacturing. Characteristics and examples of best practices are listed below.

- **Cardinal Manufacturing**

A small group from the AAAC research team, Wagstaff, Inc., and East Valley High School (Spokane Valley, WA) visited Eleva-Strum High School in Wisconsin to tour Cardinal Manufacturing.⁴⁷ With a student body of only 600 (including all K12), the school has created one of the best and most renowned examples of aligned, applied manufacturing in the nation. Characteristics of the program that qualify it to be a “best practice” include:

- Outlined structured curriculum built around specific principles of advanced manufacturing.
- Local manufacturers helped to establish business operations and continue to work with Cardinal on its advisory board to ensure alignment with workplace expectations.
- Businesses provide volunteers to assist in teaching, mentoring, and coaching students.
- Courses build from year to year, ensuring that competence is met before allowing students to advance from one program to the next. (Students repeat what is not mastered.)
- Programs begin in 5th Grade (first year of middle school). Students begin to have access to the shop as early as possible to learn skills and gain exposure to the trades at an early age.

- Students are introduced to trades-related modules in grade school starting in first grade. For example, students will participate in building a simple bird house in first grade from kits that were prepared by students in a shop class in a higher grade. This creates an integrated model.
- Students spend time learning about people skills, professional development, and business to interact with others and succeed in a business or operations environment.
- Heavy emphasis is placed on principles of quality, not just quantity.
- The culmination of the program is a student-led business operation called “Cardinal Manufacturing,” allowing only 20 students to participate. It is a revenue-generating job-shop that relies on outside business. Last year, the operation made over \$100,000.
- This program provides hands-on integrated learning and applied skills development to achieve mastery of skills, problem-solving, and curriculum operationalization.
- The curriculum is aligned with the local community college for dual credit.
- All students from Cardinal Manufacturing leave with full-time jobs or a full-ride scholarship.

- **Peak Innovation**

A team from Wagstaff, Inc. and East Valley High School visited Peak Innovation Center in Ft. Smith, Arkansas.⁴⁸ This center is the culmination of business and education, partnering with the community and local government to optimize manufacturing (and healthcare) workforce development. Serving an urban region (not unlike Spokane, WA), Peak Innovation is open to students from several high schools who complete their CTE requirements during two periods each day (similar to Washington). Notable characteristics of Peak’s program include:

- The Center was built from a large industrial facility donated by a private company as a “shell.”
- Money was raised through a collaborative fundraising effort between the school and businesses.
- Grants were also obtained with the help of the regional chamber of commerce, local government, federal agencies, and others for the initial build.
- Large industrial partners helped establish equipment for key programs such as ABB (electrical automation), Haas (machining), etc.
- The curriculum is structured in a way that allows students to complete their trades-related associate’s degree (AAS) when they graduate from high school. Students were just completing degrees in machining and electrical automation this year (at the end of the second year of operation).
- College instructors were used to teach. This allowed students to earn degrees without a problem.
- Industry partners donated the use of personnel to help teach at the center. For example, ABB maintained an individual at the Center full-time to help manage, mentor, and teach.
- Students worked with industry partners who came onsite to assist in class and mentor.
- Students were assigned externships as a part of their coursework (similar to Washington’s work-based learning program).

- **Salem-Keizer**

A representative from Wagstaff, Inc. visited the Career Technical Education Center in Keizer, OR (north of Salem), which houses 10 CTE programs, including manufacturing, welding, and engineering (one program) as well as aviation.⁴⁹ The center was established in 2019 as a public-private partnership to

prepare students for high-skill, high-wage, and high-demand careers. The characteristics that make this operation a best practice include:

- Structured curriculum to learn essential skills within the trades.
 - A “job shop” environment where students work directly with external customers to estimate, design, fabricate, problem-solve, finish work, make mistakes, and deliver products.
 - Work with faculty with years of real-world experience and deliver instruction focusing on the future workforce.
 - Core required courses in math and English are applied to the profession (e.g., math is applied to industry, metal fabrication, and production).
 - Students learn job site skills by completing piecework for local manufacturers.
- **Kootenai Technical Education Campus (KTEC).**

Representatives from Wagstaff, Inc. and East Valley High School visited KTEC in Rathdrum, ID, to review its trades-related programs.⁵⁰ Best practices include:

- The curriculum is designed around industry-recognized credentials from AWS (industry standards).
- Students in the welding program work toward learning competencies to prepare to qualify for AWS certification.
- KTEC covers the cost of the first AWS certification test per student.
- Students are encouraged to set up employer work-based learning internships during their senior year.
- Students can graduate from high school with up to a Level 4 AWC certification. (Graduates can leave high school as fully certified professional welders if they complete work and pass tests.)

Improving Workforce and Education Relationships

To improve results in its partnership, aerospace and advanced manufacturing businesses and K12 educators must consider the guiding principles:

- Create an opportunity to bridge the gap and work collaboratively to facilitate success.
- Actively partner with one another to find solutions that bring students into the workforce faster.
- Reduce barriers to change that come from protecting past structures that are currently in place, and instead consider new options and opportunities to achieve results by adopting best practices.
- Forge a partnership between business, education, government, and community at the local and state levels to accelerate workforce development.

The initial priorities are foundational to making change a possibility. If the primary stakeholders cannot forge an initial partnership on those guiding principles, other recommendations are impractical. Ideally, stakeholders can incorporate other best practices that can accelerate workforce development in K12, such as:

- *Offer community college trades degree programs in high school.* While some Washington schools have articulated dual credit for courses, full programs must be articulated that allow students to earn a full

certificate (e.g., welding) or associate's degree (e.g., AAS in machining) while attending their own high school.

Running start programs are not enough. Until the 2023-24 year, Running Start was still cost-prohibitive to socioeconomically challenged students as it required fees despite the tuition waiver for high school students. Though the fees are now waived, the travel requirement is time and cost prohibitive for students without means, especially from outlying areas who cannot travel. It further makes it impossible to complete the full degree program while in high school. Without an onsite program, students will not be able to earn the full credentials and enter the workplace out of high school.

Allowing those students who are capable of completing a full college program while in high school – ensuring they meet all standards of academic quality and integrity – facilitates their ability to enter the job market sooner, avoid student loan debt, and meet employer needs faster. For students who are unable to finish the program but can complete some of the training, they can (a) continue to pursue the degree in a shorter timeframe, still saving time and money, (b) go to work at a lower starting level and return to school later, or (c) continue in another pathway with a solid background as a foundation (e.g., pursue engineering with a background in machining).

- *Accelerate work-based learning.* The goal should be to expose high school students to employers as soon as possible, as early as possible. In cases where students are not ready for regular employment, alternatives such as micro-internships (between 10-40 hours total) can introduce a student to the workplace. Whether it be for a project, short-term assignment, case study, or some other purpose, any opportunity to safely bring students into a live work setting is beneficial for learning, networking, and exposure to the real-world work experience.
- *Incorporate business into the classroom.* Partnering with businesses can bring professionals into the classroom. This, in turn, increases opportunities to learn from professionals, network, and align with real-world expectations. In many cases, best practices can include using businesses to help teach content, mentor students, incorporate case studies, provide tours, and deliver other partnership opportunities that enhance student preparation and learning.
- *Expand outside programs.* Expand the use of extracurricular programs that support skills development or application of competencies.
 - Skills-based programs such as Skills USA have been highly beneficial to increase exposure to students, raise interest, and improve skill levels.
 - Best Practices also partner with businesses to deliver hands-on, immersive experiences to help students engage in industry simulations.
 - Wagstaff, Inc. collaborates with dozens of other manufacturers in the Spokane region to deliver the Production and Manufacturing Institute each summer. The program immerses students in a manufacturing simulation where participants design, manufacture, sell, and otherwise own a product line within a company over the course of three weeks. Working in teams, students must manage their business unit, deal with quota changes and supply issues, and see how manufacturing is done in multiple settings.

These programs create a vision for what manufacturing can do that way.

CALL TO ACTION - WORKFORCE AND EDUCATION

- Statewide Workforce Development Strategy and Advisory Committee**
 Create a roundtable to develop a comprehensive statewide Workforce Development strategy (stop piece-mealing solutions).
- Regional and Micro-Workforce Training Centers**
 To offer rapid deployment IRC training options to meet immediate and long-term critical skills needs (could be part of innovation center)
- Improve Workforce and Education Relationship**
 Emphasizing the necessity of K-12 STEM education and career pathways is vital to establish a robust talent pipeline for higher education and trade programs.

Call to Action Summary

This section provides a series of targeted recommendations that aim to address critical challenges and capitalize on emerging opportunities within the industry. These recommendations are the culmination of comprehensive research, in-depth analysis, and consultation with industry experts. The objective is to provide a guide for policymakers in shaping a supportive regulatory framework and fostering an environment conducive to industry growth and investment, innovation, and competitiveness to secure a prosperous future for the aerospace industry and its stakeholders. The highest priority recommendations are highlighted in blue.

Recommendation	Details	Sub-committee
Develop a Statewide Workforce Strategy	Convene representatives from government, education, and business to create a comprehensive statewide workforce development strategy and align existing resources. Consider utilizing the Center of Excellence for Aerospace & Advanced Manufacturing as a coordinating body.	Workforce and Education
Establish a Network of Regional Workforce Training Centers	Offer rapid deployment Industry-Recognized Credentials training options through regionalized centers to meet immediate and long-term critical skills needs (could be part of innovation center).	Workforce and Education, Space and Satellites, Uncrewed Aerial Systems
Create a Statewide Innovation Network	The network would include 1-2 hubs and a series of spokes throughout the state with the following features:	Commercial and Defense,

	<ul style="list-style-type: none"> • Labs and testing facilities • Prototype manufacturing facilities • Offices and meeting rooms • Wrap around business support services • Collaboration and community spaces <p>The network would coordinate existing resources and create centers to fill in regional gaps.</p>	Emerging Technologies, Space and Satellites, Uncrewed Aerial Systems
Fund Marketing of Aviation & Aerospace Sector & Industry Segments	<p>Establish/utilize existing entities to advise and direct expanded promotion of the aviation and aerospace industry, including cluster coordination.</p> <p>-Develop targeted marketing strategies and messaging for key segments such as space & satellite, commercial, defense, uncrewed aerial systems, and sustainable aviation. The defense sector’s focus should be on attracting DoD or NASA, or other federal investments.</p> <p>-Develop a centralized resource database that includes supply chain assets, R&D resources, start-up resources, industry support groups</p>	Commercial and Defense, Emerging Technologies, Space and Satellites
Close Annual Funding Gap for Airports	Provide \$10M in annual funding to meet current airport infrastructure needs and to assist airports in transitioning to more environmentally-sustainable operations.	Airports and Infrastructure
Increase Hangar Capacity at Airports	Dedicate \$5M in annual state funding over a 10-year period to address the General Aviation Hangar capacity needs.	Airports and Infrastructure
Assist Business Development at Airports	Create business development opportunities for airports, particularly in rural areas. This may include incentivizing small businesses to locate on airport leased property that may otherwise be difficult to attract or prioritizing alternative energy or emerging technologies at airports.	Airports and Infrastructure
Increase Warehouse Capacity at Airports	Support the development of increased warehouse space to attract and accommodate businesses located in proximity to airports.	Airports and Infrastructure
Build Infrastructure for Alternative Fuels at Airports	Equip airports with infrastructure to serve alternative fuels including hydrogen and electrification in the next 3-5 years.	Airports and Infrastructure
Install Charging Stations at Airports	Outfit airports across the state with charging stations to serve increasing number of electric vehicles in the next 5-7 years.	Airports and Infrastructure
Offer Capital Expenditure Incentives to Aerospace Companies	Specific to aerospace manufacturing, including tax abatement to incorporate automation, upgrade competitiveness, and add new capabilities, particularly for SMB	Commercial and Defense
Provide Funding for Companies Competing for DoD contracts	Provide grants and incentives with support from the Procurement Technical Assistance Center (PTAC) to companies seeking Department of Defense Contracts.	Commercial and Defense, Emerging Technologies
Leverage State Influence	Actively seeking to attract NASA and DoD contracts. Advocate for effective federal aviation wildfire response policies that align with the state's needs and priorities.	Emerging Technologies
Streamline Permitting Process	Remove red tape and streamline the permitting process for new construction projects.	Emerging Technologies, Uncrewed

		Aerial Systems
Provide Grants for Start-Ups	Provide matching funds for phase I SBIR/STTR (need to not conflate with JCATI)	Space and Satellites
Improve Workforce and Education Relationship	Emphasizing the necessity of K-12 STEM education and career pathways is vital to establish a robust talent pipeline for higher education and trade programs.	Workforce and Education
Develop UAS Testing Facility	Provide infrastructure money for the development of a UAS testing facility/drone corridor.	Uncrewed Aerial Systems
Amend Growth Management Plans for Vertiports	Provide funding for counties and municipalities to identify and designate land for future vertiports. Allocate funds for test site(s).	Uncrewed Aerial Systems
Provide Tax Relief for Aerospace Employers	Continue or expand tax relief to aerospace companies looking to relocate or those retaining/growing jobs in Washington.	Uncrewed Aerial Systems
Create Opportunities for Early Exposure and Options to Launch Aerospace Careers from High School	-Accelerate work-based learning through earlier exposure to industry and bring industry professionals into the classroom -Expand extracurricular programs such as SkillsUSA, that provide an introduction to skills needed in industry and hands-on problem-solving opportunities -Offer community college trades degree programs in high school	Workforce and Education
Enhance 4-Year University Programs	<ul style="list-style-type: none"> ● Increase interactions with aerospace businesses to identify specific industry workforce needs. ● Incorporate more “live” projects and real-world case studies into the curriculum, ● Increase opportunities for work-based learning and internships ● Introduce “micro-internships” requiring 10-40 hours of work ● Enhance curriculum to include development of “soft skills.” 	Workforce and Education, Emerging Technologies
Modify Community College Programs	<ul style="list-style-type: none"> ● Develop employer-driven curriculum that adjusts to industry needs quickly. ● Blend credit and non-credit training via competency-based learning models ● Address equity with career-focused pathways that enable students to quickly gain employable skills, enter the workplace, and then return to school to upskill, re-train, or change course as needed or desired by the individual or employer. 	Workforce and Education
Develop and Implement Micro-apprenticeship/ Industry Recognized Credential Programs	Create short-term topical courses (average of 4 weeks) through existing apprenticeship programs or industry groups (AJAC, Machinists Institute, American Welding Society, etc.) that provide individuals and employers with the ability to: <ul style="list-style-type: none"> -Develop demonstrable knowledge and skills in a specific area -Earn recognized credentials that can lead toward completion of an apprenticeship program -Use courses as flexible stackable credentials within/among apprenticeship programs 	Workforce and Education, Emerging Technologies

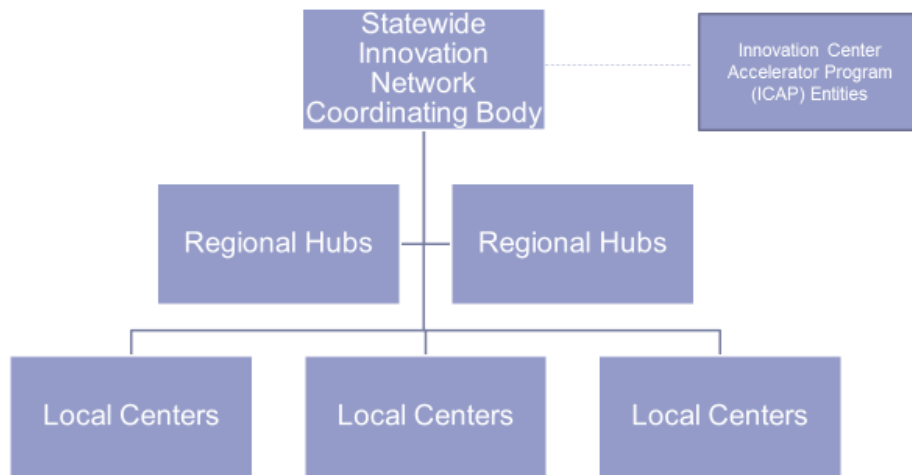
BUILDING UPON RECOMMENDATIONS FROM SUBCOMMITTEES (1/15/23 - 4/15/23)

Innovation Network

The dizzying pace of technological change is driving innovation throughout the aerospace industry. The need to provide infrastructure and tools for entrepreneurs and companies to design, test, and commercialize technologies was one of the most prevalent themes across all AAAC subcommittees. Examples of other countries, states, and regions establishing innovation centers and networks abound—Advanced Manufacturing Research Centre (AMRC) in the UK, FlyOhio in Ohio, and NIAR in Wichita, Kansas. In order for Washington to successfully compete in the global aerospace marketplace of the future, it’s imperative that the state provide the infrastructure to facilitate innovation and coordinate existing/developing innovation resources now.

This work is much more than a single, multi-faceted facility. Rather it needs to be a statewide system that allows access to all regions of the state and addresses both shared and unique needs/interests in communities across Washington. A statewide **Innovation Network** will stimulate, support, and attract entrepreneurs and companies committed to bringing the industry’s future to fruition. The network will be a partnership among public-private-education stakeholders with a coordinating body, two regional hubs, and a number of geographically-dispersed facilities or spokes.

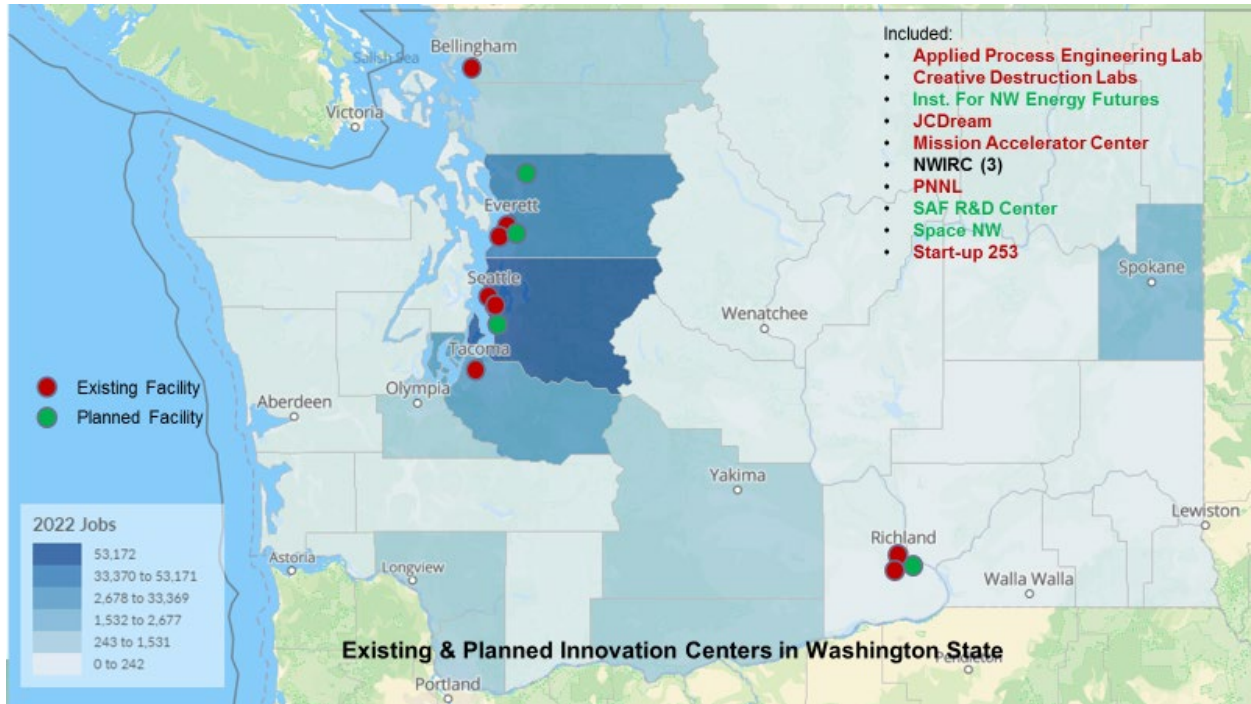
Potential Hierarchy for Washington Statewide Innovation Network



The centers will be an innovator and start-up’s treasure trove, housing equipment and labs for research and development, testing, access to academic research partners, and shared equipment for small-scale production. The innovation centers will also support entrepreneurs with shared workspaces and access to workforce training resources and community events. Given that start-up ventures are typically in dire

need of capital and business support services, the network would include a system for accessing funding sources and wraparound services.

The development of the Innovation Network is envisioned as a six-year project that will start with establishing one hub in each of the next two bienniums, along with augmenting existing/planned centers (see Figure below) and adding new locations to ensure geographic diversity.



These facilities will leverage existing resources, both physical and intellectual, and will ideally be co-located or situated near an educational institution and/or an existing airfield. Substantial investment will be required over a period of years to be successful. As an example, the state of Georgia committed \$100 million toward the creation of the Georgia Cyber Center⁵¹. Ohio has pledged a longer-term investment expected to have a \$13 billion economic impact, with 10,000 advanced air mobility jobs alone added over 25 years. Kansas’ NIAR has a \$190 million annual budget, a staff of 1,000, and 1.6 million square feet of laboratory and office space in six locations across the city of Wichita.

Further development of the Innovation Network is beyond the scope of this report but should be funded by the Legislature as soon as possible.

Marketing

Enhancing the industry’s marketing endeavors emerged as a prevalent theme across all the subcommittees. While this study’s researchers could not break down specific marketing budgets, it is worth noting that in 2019, Alabama (a significant aerospace competitor to Washington) allocated a

staggering \$4.4 billion for advertising. In contrast, Washington's advertising expenditure for the same year amounted to only \$10.1 million.⁵²

Industry stakeholders voiced a strong demand for a comprehensive statewide marketing strategy encompassing the following key components:

- **Fund and authorize** an industry-specific statewide marketing strategy.
- **Promote Washington's supply chain** on both national and global scales. While other states' marketing initiatives often target site selectors catering to large corporations, Washington's appeal to entrepreneurs and start-ups necessitates a more targeted approach aimed directly at business owners and managers. For smaller entities, factors such as talent availability, entrepreneurial culture, and quality of life hold greater significance than incentives or population statistics. Adopting this approach would leverage the inherent strengths of the region.
- Establish a comprehensive **marketing portal** (digital, web-based, etc.) for state and federal agencies and industry groups to enhance awareness of the vast array of services and resources available at all levels. The portal would serve as a centralized hub, streamlining access to information and facilitating navigation through the existing ecosystem, which is currently perceived as a complex maze of disparate websites and platforms, as indicated by feedback from numerous interviewed businesses.
- Craft a statewide **marketing plan** to incorporate diversity and equity at a regional level. Currently, there is a strong focus on the west side of the state, leading to challenges related to infrastructure, workforce, and housing limitations. Moreover, the state's eastern side has historically received limited direct economic benefits from commercial aerospace. By raising awareness of the appeal of areas such as Spokane, Moses Lake, and the Tri-Cities, the distribution of growth opportunities can be more equitable, benefiting underserved mid-size markets.
- Establish a **marketing council** comprising a minimum of 50% industry and aerospace manufacturing representatives to guarantee that insights and perspectives from the private sector drive the content and focus of the marketing efforts.

The Norstrat Team strongly emphasizes maintaining a substantial and continuous marketing budget, particularly for digital content. Regular and sustained SEO efforts are vital; digital content should be refreshed as frequently as possible. Committing to a consistent and long-term investment in a robust marketing campaign ensures ongoing success.

Conclusion

Washington's rich history in aviation and aerospace has positioned it as a leader in the industry, thanks to the establishment of the Boeing Company and the presence of a robust supply chain. The aerospace sector has been a major economic driver, employing a significant portion of the state's workforce and contributing significantly to the Gross Regional Product. Washington state must focus on key areas such as space exploration, uncrewed systems, and next-generation air mobility to maintain its leading edge.

The state must invest substantially to maintain competitiveness by driving innovation, marketing its aerospace sector's strengths, and equipping the current and future workforce with the skills necessary for the next generation of aircraft. The formation of the Aviation and Aerospace Advisory Committee (AAAC)

by the Washington State Legislature is a positive step in this direction, as it will provide valuable recommendations and strategies to support aviation and aerospace in the state.

The AAAC subcommittees, focusing on airport services and infrastructure, commercial/military manufacturing, space and satellites, uncrewed aerial systems, emerging segments (electric, hydrogen, hybrid, Advanced Air Mobility), and workforce and education, have diligently studied their respective priority areas. These subcommittees will play a crucial role in formulating legislators' recommendations, enhancing national and international competitiveness, addressing policy considerations, prioritizing funding and capital projects, reducing greenhouse gas emissions, and fulfilling workforce development needs.

By leveraging the expertise of these subcommittees, Washington state can position itself as a hub for emerging aviation and aerospace technologies, ensuring the safe and effective use of public use airports and aerospace facilities. Continued collaboration between the Departments of Commerce and Transportation and the AAAC can drive the industry forward by implementing recommended strategies.

In summary, Washington's aviation and aerospace industry has a promising future, but it must adapt to the evolving landscape and overcome current challenges. By investing in innovation, marketing its strengths, and prioritizing workforce development, the state can maintain its leading edge and remain a key player in global aviation and aerospace.

Embracing a culture of innovation is critical to the aerospace community's ability to overcome challenges, push boundaries, and secure its position at the forefront of human achievement. While Washington has a rich history of leadership in aerospace manufacturing, it faces significant challenges from other regions domestically and internationally. The competition offers attractive financial incentives, lower costs of living, and cheaper labor.

To regain and strengthen Washington's top position in aerospace, the state must leverage its core strengths, which include innovation, a highly skilled workforce, and global leadership in green and alternative mobility. The report provides several recommendations, but the following initiatives should be prioritized:

1. Strengthening innovation clusters and assisting the supply chain in pursuing federal funds for further technology development. This includes seeking funding opportunities from programs like CHIPS and Build Back Better.
2. Supporting entrepreneurs and start-ups through public-private partnerships that provide funding for testing facilities and startup incubators. This will foster a vibrant ecosystem for aerospace innovation.
3. Rethinking workforce development efforts to address both short- and long-term needs. While higher education plays a crucial role, investing in K12 STEM curricula and trade classes/apprenticeships is equally important. A diverse range of skilled trades and factory workers is essential for the industry's success. Additionally, efforts to promote diversity, equity, and inclusion (DEI) should consider regional diversity and include underemployed workers in the 18-30 age group.

4. Creating apprenticeship programs that cater to the needs of both small/medium employers and formal trade unions. Non-union options should be available to ensure inclusivity and support the growth of all aerospace businesses.

By prioritizing these initiatives, Washington state can revitalize its aerospace industry, recapture its leadership position, and foster long-term growth. It will require collaboration between industry stakeholders, government agencies, educational institutions, and private enterprises to drive the necessary changes. By doing so, Washington can solidify its position as a global leader in aerospace and contribute to the advancement of the industry as a whole.

End Notes

¹ Source: Lightcast, Q1 2023, includes all types of employment (QCEW, Non-QCEW, Employees, and Self-Employed)

² www.defense.gov/News/News-Stories/Article/Article/3327644/lethal-resilient-agile-joint-force-basis-for-defense-budget-request/#:~:text=President%20Joe%20Biden's%20national%20defense,the%20fiscal%202023%20enacted%20budget.

³ scholarcommons.sc.edu/cgi/viewcontent.cgi?article=1070&context=scjilb

⁴ www.lagniappemobile.com/news/mobile-county-awards-10m-incentive-for-airbus-a320-production/article_5f44b87e-095e-11ee-9321-4b8481fda5c4.html

⁵ docs.wto.org/dol2fe/Pages/FE_Search/FE_S_S009-DP.aspx?language=E&CatalogueIdList=234481&CurrentCatalogueIdIndex=0&FullTextHash=&HasEnglishRecord=True&HasFrenchRecord=True&HasSpanishRecord=True

⁶ www.fedconline.org/embraer-opening-aircraft-design-center-in-florida/

⁷ Sources include: “2020 Aerospace manufacturing attractiveness rankings.” *PwC Aerospace & Defense practice*. April 2020; “Where Aerospace Manufacturers Are Gravitating in 2020.” *Site Selection Magazine*. Nov. 2020; various state websites.

⁸ Pew Research Center. (October 6, 2015). Changes in the American Workplace. (www.pewresearch.org/social-trends/2016/10/06/1-changes-in-the-american-workplace/).

⁹ Society of Professional Engineering Employees in Aerospace (SPEEA). (2022). Workforce Report.

¹⁰ AeroDynamic Advisory. (2022). Aerospace Competitive Economics Study (ACES). (<https://www.dropbox.com/s/15e245lm3ce04ew/2022%20ACES%20Aerospace%20Competitive%20Economics%20Study%20.pdf?dl=0>)

¹¹ King5 News Article. (2023). Study: Washington is the most competitive in the country for engineering, manufacturing planes. (<https://www.king5.com/article/tech/science/aerospace/washington-engineering-manufacturing-planes-study/281-6a0a36b6-dd62-4a5f-8bec-d4d8f517462f>).

¹² PwC. (2023) PwC’s global aerospace and defense: Annual performance and outlook. (<https://www.pwc.com/us/en/industries/industrial-products/library/aerospace-defense-review-and-forecast.html>).

¹³ 2022 Workforce report, Society of Professional Engineering Employees in Aerospace (SPEEA).

¹⁴ EY (Ernst-Young) (2022) Resilient, connected and customer centric: the future of manufacturing is here. (www.ey.com/en_us/advanced-manufacturing/resilient-connected-and-customer-centric-the-future-of-manufacturing-is-here).

¹⁵ EY (Ernst-Young) & Manufacturing Institute. (2022). How adaptive skills can play a pivotal role in building the manufacturing sector of the future. (www.ey.com/en_us/advanced-manufacturing/the-manufacturing-institute-adaptive-skills-study).

¹⁶ World Economic Forum. (May 2023). Future of Jobs Report. (www.weforum.org/reports/the-future-of-jobs-report-2023/)

¹⁷ Manufacturing Leadership Council. (2023) Empowering Employees in the Manufacturing 5.0 Era. (www.manufacturingleadershipcouncil.com/empowering-employees-in-the-manufacturing-5-0-era-33654/)

¹⁸ EY (Ernst-Young). (Feb 2, 2022). Don’t let talent and skill become an afterthought in your Factory of the Future. (Retrieved June 24, 2023 from https://www.ey.com/en_us/advanced-manufacturing-realized/creating-people-centric-future-factories).

¹⁹ Bughin, J., Catlin, T., & LaBerge, L. (June 2019). The drumbeat of digital: How winning teams play. *McKinsey Quarterly*. (Retrieved June 24, 2023 from www.mckinsey.com/~media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/the%20drumbeat%20of%20digital%20how%20winning%20teams%20play/the-drumbeat-of-digital-how-winning-teams-play-final.pdf).

- ²⁰ Ekudden, Erik (CTO Ericsson). (2023). Evolving networks for a rapidly changing world. *Ericsson Technology Review*, 2023:01. (Retrieved 6/24/2023 from <https://www.ericsson.com/en/reports-and-papers/ericsson-technology-review/articles/ericsson-technology-review-2023-issue-1>).
- ²¹ “The Digital Transformation of Manufacturing Companies.” SAP (www.sap.com/products/scm/industry-4-0/industry-4-0-strategy.html).
- ²² Wellener, P., Reyes, V., Ashton, H., & Moutray, C. (May 4, 2021). Creating pathways for tomorrow’s workforce today: Beyond reskilling in manufacturing. Deloitte Insights. (www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-industry-diversity.html/#the-future).
- ²³ Manufacturing Institute. Diversity and inclusion: What you need to know. (www.nam.org/diversity-and-inclusion-what-you-need-to-know-12073/?stream=workforce).
- ²⁴ Graham, J.M. (nd). Enhancing diversity: The manufacturing mind-set advantage. Heidrick & Struggles. (www.heidrick.com/en/insights/diversity-inclusion/enhancing_diversity_the_manufacturing_mind_set_advantage).
- ²⁵ Hunt, V., Yee, L., Prince, S., Dixon-Fyle, S. (Jan 2018). Delivering through diversity. McKinsey & Company.
- ²⁶ Manufacturing Institute. Diversity, Equity, & Inclusion. (www.themanufacturinginstitute.org/diversity-inclusion/).
- ²⁷ https://www.wichita.edu/industry_and_defense/NIAR/
- ²⁸ <https://www.approve.com/business-cost-index/>
- ²⁹ <https://www.usnews.com/news/best-states/rankings/opportunity/affordability>
- ³⁰ <https://www.it3tech.org/>
- ³¹ Wolf, S. (March 1, 2023). Ridgfield high-tech trainign center IT3 aims to develop workforce for local manufacturers. *The Columbian*. (www.columbian.com/news/2023/mar/01/ridgfield-high-tech-training-center-it3-aims-to-develop-workforce-for-local-manufacturers/)
- ³² State of Connecticut. (2003). Strategic Plan for Manufacturing. (portal.ct.gov/-/media/Manufacturing/PDF/2023-CT-Mfg-Strategic-Plan---final---HR.pdf).
- ³³ [Advanced Manufacturing / Strategic Initiatives / Massachusetts Department of Higher Education](#)
- ³⁴ Hanover Research. (December 2020). Best practices in middle school career and technical education expansion. (portal.ct.gov/-/media/SDE/CTE/Best-Practices-in-Middle-School-Career-and-Technical-Education-Expansion.pdf).
- ³⁵ “2.1 Million Manufacturing Jobs Could Go Unfilled by 2030,” *National Association of Manufacturers Website*, www.nam.org/2-1-million-manufacturing-jobs-could-go-unfilled-by-2030-13743/?stream=workforce, May4, 2021.
- ³⁶ Manufacturing Leadership Journal. (2023) The Evolution of Manufacturing Jobs. (www.manufacturingleadershipcouncil.com/the-evolution-of-manufacturing-jobs-33574/?stream=ml-journal)
- ³⁷ World Economic Forum. (2020) The Future of Jobs Report. (<https://www.weforum.org/reports/the-future-of-jobs-report-2020>)
- ³⁸ Society for Human Resources Management (SHRM). (March 28, 2023) Skills-based hiring requires commitment to change. (www.shrm.org/resourcesandtools/hr-topics/talent-acquisition/pages/skills-based-hiring-requires-commitment-to-change.aspx)
- ³⁹ Hiring for the future of work. (www.testgorilla.com/blog/hiring-for-the-future-of-work/?utm_term=&utm_campaign=Performance+Max+%7C+US&utm_source=google&utm_medium=cpc&hsa_ac_c=4932434860&hsa_cam=13392445085&hsa_grp=&hsa_ad=&hsa_src=x&hsa_tgt=&hsa_kw=&hsa_mt=&hsa_net=adwords&hsa_ver=3&gclid=CjwKCAjw44mlBhAQEiwAqP3eVkc82RdWDnTrUDRJ7xPLwYqVxbo6T2owp54C1VFcYc9FP4lma8DqRoCo2lQAvD_BwE)
- ⁴⁰ Bureau of Labor Statistics. (www.bls.gov/oes/current/oes172141.htm)
- ⁴¹ <https://vcea.wsu.edu/facilities-modernization/schweitzer-engineering-hall/>
- ⁴² Rockwood, K. (May 28, 2021). The hard facts about soft skills. *HR Magazine*. Society for Human Resource Management. (www.shrm.org/hr-today/news/hr-magazine/summer2021/pages/why-soft-skills-are-important.aspx).
- ⁴³ <https://wsac.wa.gov/sites/default/files/2022.12.ResearchBrief.EnrollmentTrends.pdf>
- ⁴⁴ Kwakye, I., Kibort-Crocker, E., Lundgren, M. & Pasion, S. (2021, January). Fall Enrollment Report: Exploring the Impact of COVID-19 on Postsecondary Enrollment in Washington. <https://wsac.wa.gov/sites/default/files/2021-01-12-Fall-Enrollment-Report.pdf>
- ⁴⁵ <https://ccrc.tc.columbia.edu/media/k2/attachments/tomorrows-middle-skill-jobs-community-colleges.pdf>

⁴⁶ Aerospace Pipeline Report. (2020). Joint report by Washington Workforce Training and Education Coordinating Board and the Community and Technical Colleges Washington State Board. (www.wtb.wa.gov/wp-content/uploads/2021/01/FINAL-Aerospace-Report.pdf).

⁴⁷ www.cardinalmanufacturing.org

⁴⁸ <https://www.fortsmithschools.org/peak>

⁴⁹ <https://ctec.salkeiz.k12.or.us/manufacturing-welding-and-engineering/>

⁵⁰ <https://www.ktectraining.org/>

⁵¹ The Georgia Cyber Center reports that on average, for every 10 jobs created in cybersecurity, another 8 are established throughout the economy. Given this ratio, over 10,900 jobs can be attributed to the cybersecurity industry and another roughly 2,900 are created in other sectors throughout the economy. These cybersecurity occupations are also high paying. Cyber employment represents roughly 9% of overall employment in Richmond County but 11% of total labor income. In total, direct private sector cybersecurity activities contributed roughly \$371 million to gross domestic product (GDP), nearly 3% of the County's total GDP in 2020.

⁵² Statistica 2023