Department of Commerce
Innovation is in our nature.

WASHINGTON COUNCIL ON AEROSPACE

REPORT TO THE GOVERNOR AND LEGISLATURE

January 1, 2010

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Executive Summary

This report was prepared in response to **Executive Order 09-04**, establishing the Washington Council on Aerospace. The council was tasked with finding ways to:

- Improve coordination, responsiveness, and integration of the state's aerospace training, education, research, and development programs to meet industry needs;
- Enhance the state's economic climate for the industry;
- Provide a forum for industry, labor and government to collaborate to ensure the needs of this vital industry are met in a timely and effective manner; and
- Ensure that Washington remains the best place in the world to design and manufacture aircraft and grow jobs in the aerospace industry.

The Washington Council on Aerospace is an ongoing effort for private and public partners to collectively identify and take actions that make Washington state government more responsive to the needs of the aerospace industry in Washington. The work and recommendations in this report represent the first set of discussions.

Problem Statement

Washington's competitive advantage in aerospace is weakening. The industry is changing in fundamental ways. Some of these changes, such as globalization and the shift among original equipment manufacturers (OEMs) towards a more systems integration model, are beyond the influence of Washington state policy. These exogenous changes challenge policymakers and stakeholders to think outside the box on how to ensure the continued growth and international relevance of Washington state as a hub for aerospace activity.

Washington has not been competitive for several recent high-profile aerospace investments, including the Honda Jet program (North Carolina), the Bombardier C-Series (Quebec), a Rolls Royce engine plant (Virginia), a new Spirit Aerosystems facility (North Carolina), the Global Aeronautica joint venture (South Carolina), and most recently the second line for the 787. Against our competitor states and provinces, we are at a disadvantage in areas of incentives offered, R&D expenditures, and labor costs. Our aerospace labor force is aging, and our education and training system is not meeting current and future industry needs.

This report provides recommendations to the Governor and Legislature on how to strengthen and grow our aerospace industry in Washington state. Each recommendation addresses a defined problem and includes a set of projected outcomes.

The overarching objectives we seek to achieve are:

Grow and **improve jobs** in the aerospace sector; retain and grow our existing aerospace cluster; make our existing aerospace companies, suppliers, and supporting firms more competitive, both nationally and internationally (**economic development**); ensure and strengthen the aerospace education and workforce pipeline; better coordinate aerospace education and training with industry needs (**workforce training and talent**); turn Washington into a center for aerospace innovation; and better link research efforts with industry needs (**research**).

It is important to emphasize that all these objectives (and accompanying strategies) are highly inter-related, and ***many can only be achieved through public-private partnerships.***

Recommendations

Economic development:

- **Challenge: business recruitment**.
  - ➔ Lead a state-level process to engage local economic development organizations around the state that are interested in aerospace activity to prioritize and execute a list of specific opportunities inside the industry (e.g. green aviation, the air force tanker contract, connecting the supply chain to other tier I companies and OEMs, etc.).
  - ➔ Gain critical and timely market intelligence. Allocate resources to significantly enhance the state's market research capabilities.
  - ➔ Marketing. Enhance our recruiting activities at aerospace events (domestic and international), working with site selectors and directly with companies.
  - ➔ Develop a "technopole" strategy—develop increased collaboration between private and public partners in regions of the state where high concentrations of aerospace assets exist.
- **Challenge: business retention and expansion**.
  - ➔ Develop global sub-national aerospace partnerships, similar to the Washington's relationship with Queensland, Australia in the life sciences.
  - ➔ Help Washington state aerospace companies significantly expand their presence at major aerospace events.
  - ➔ Allocate financial resources to help companies obtain and maintain industry certifications.
- **Challenge: industry-wide coordination.**
  - ➔ The Washington Council on Aerospace should serve as a convener among all aerospace organizations in the state.

Workforce Training and Talent:

- **Challenge: training must be responsive to dynamic employer and industry needs.**
  - ➔ Build program capacity at our two new training facilities in Everett and Spokane to develop and provide industry-driven mid-level training to new students and current workers in a variety of instructional delivery formats to fit the needs of employers and working students.
  - ➔ Training providers must persist in offering relevant instruction.
  - ➔ Develop protocols to transfer relevant research findings from the research universities and other research organizations to the Center of Excellence.
  - ➔ Identify the Aerospace Center of Excellence as the single point of contact for employers to communicate their mid-level workforce training needs to 2-year college and apprenticeship providers.
  - ➔ Create more incumbent worker training programs and leverage the existing Job Skills and Customized Training programs providing incumbent workers with highly specialized aerospace training and certifications to provide workers with advancement opportunities.

- **Challenge: coordination, articulation, and growth of aerospace education and training programs across the state must be improved**.
    - ➔ Coordinate the state's mid-level education and training programs supporting the aerospace industry through the Center of Excellence.
    - ➔ Create clear educational pathways, increase transfer agreements between educational institutions, and award credit for students' prior learning.
    - ➔ Increase funding to expand access to and support for registered apprenticeship training programs, two-year, and four-year computer science, engineering and aerospace training programs as well as high school training centers offering training in aerospace and STEM fields to meet projected employer demand.
    - ➔ Engage business and labor to identify training requirements leading to new credentials requiring less than two years to complete.
    - ➔ Work with the Washington Legislature to develop a higher education "innovation fund" to enable public higher education institutions to test and replicate successful strategies to enhance student persistence and completion rates.
- **Challenge: an aging workforce.**
    - ➔ Create better partnerships between state workforce development agencies and higher education institutions to better connect employers with trained workers.
    - ➔ Develop mentorship and training opportunities between new and experienced employees.
    - ➔ Develop targeted marketing strategies to recruit individuals leaving the military, women, skilled dislocated workers from other industries, and other under-represented groups.
- **Challenge: Washington lacks an adequate number of students expressing interest in and training for occupations and trades necessary to support the aerospace industry and to meet its future supply needs.**
    - ➔ Launch an outreach campaign to recruit middle school, high school, and college-age students highlighting careers in the aerospace industry.
    - ➔ Develop more "train-the-trainer" and "teach-the-teacher" programs.
    - ➔ Support third-party initiatives in the K-12 system directly focused on enhancing the foundational skills leading to higher education degree attainment in the science, technology, engineering, and math fields.

<u>Research</u>

- **Challenge: turning Washington into a center for aerospace technology innovation.**
    - ➔ Create a Center for Aerospace Technology Innovation to support research at the UW and WSU, leveraging corporate support and/or grants from government or non-profit agencies, and building on existing strengths of the two research universities.
- **Challenge: sales tax exemption for aerospace research**.
    - ➔ Pass a legislative exemption from these taxes for research activities specifically related to the aerospace industry, which would result in savings to the two institutions (UW and WSU) of roughly $300,000 to $500,000 annually.
- **Challenge: relaying research outcomes to those companies that would most benefit from it and most likely to incorporate it into their operations.**
    - ➔ Create an information clearinghouse—whether freestanding or through an existing entity such as Washington Manufacturing Services, Washington Technology Center, or other—to freely share information between the research universities and those most likely to implement that research.

1.0 Introduction and Report Purpose

Washington state is a global leader in aerospace. The industry has been a crucial pillar of Washington state's economy for nearly a century. There are roughly 160 aerospace companies in Washington state specializing exclusively in aerospace and another 500 providing manufacturing, maintenance, and engineering services, covering such diverse fields as airframing, avionics, interiors, engineering & research, composites, unmanned aerial vehicles (UAVs), and tooling, along with 130 FAA repair stations. Our companies are represented throughout the production value chain supplying original equipment manufacturers (OEMs) across the world, including Airbus, Dassault, Embraer, Lockheed, and Bombardier. Washington is also home to some of the most cutting-edge and leading aerospace R&D activities in the world, especially in composites and advanced materials for aerospace products. In 2008, employment in the aerospace sector averaged more than 82,000 workers, equal to roughly one sixth of all aerospace workers in the United States.[1] Exports in 2008 totaled more than $33.8 billion in aerospace products, making Washington the largest aerospace exporter in the United States.[2]

Geographically, the industry and supplier network is concentrated primarily in the counties of King, Snohomish, Pierce, and Spokane, though there are pockets of aerospace activity across the state (e.g. Insitu in Klickitat County). Greater Seattle (including Everett and Renton) has one of the highest concentrations of aerospace workers and firms in the world, and Washington's relative concentration of aerospace engineers is the highest in the U.S.[3] Boeing alone employs more than 75,000 workers in Washington state, the vast majority within the Puget Sound Region, accounting for 2.7% of the state's total non-farm labor; after factoring in multiplier effects, Boeing's total impact on Washington state is roughly 285,000 jobs.[4]

However, periodic labor disputes, weakening cost competitiveness, a more globally elongated supply chain, and emerging aerospace clusters elsewhere in the U.S and overseas with potentially lower unit costs, threaten to weaken our state's competitive advantage. Boeing has already gradually been shifting aspects of its supply chain to other states and regions of the world. The 787 program exemplifies this shift, with the majority of component design, manufacturing, and sub-tier supply management done by firms located outside Washington state. The recent announcement of a second 787 line in North Charleston, South Carolina has made the mandate of this council all the more urgent.

Report Purpose

This report was prepared in response to **Executive Order 09-04**, establishing the Washington Council on Aerospace. The council was tasked with finding ways to:

- Improve coordination, responsiveness, and integration of the state's aerospace training, education, research, and development programs to meet industry needs;
- Enhance the state's economic climate for the industry;

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[1] Data source: U.S. Bureau of Labor Statistics, www.bls.gov.
[2] Wiser Trade, www.wisertrade.org, using U.S. Department of Commerce export data.
[3] As determined by the state's location quotient for aerospace engineers. The location quotient compares the share of a state's labor force against a benchmark measure, in this case the U.S. In 2008, Washington State's location quotient for aerospace engineers was 3.85 (indicating a concentration 3.85 times the national average), well ahead of the next closest peer state, Kansas. Data source: U.S. Bureau of Labor Statistics.
[4] *Washington Alliance for a Competitive Economy*, "What if Boeing Left Washington?" April 14, 2009.

- Provide a forum for industry, labor and government to collaborate to ensure the needs of this vital industry are met in a timely and effective manner; and
- Ensure that Washington remains the best place in the world to design and manufacture aircraft and grow jobs in the aerospace industry.

2.0 Problem Statement

Washington's competitive advantage in aerospace is weakening. The industry is changing in fundamental ways. Some of these changes, such as globalization and the shift among original equipment manufacturers (OEMs) towards a more systems integration model, are beyond the influence of Washington state policy. These exogenous changes behoove policymakers and stakeholders to think outside the box on how to ensure the continued growth and international relevance of Washington state as a hub for aerospace activity. Policymakers and stakeholders need a ***vision*** and targeted set of outcomes, factoring our strengths and weaknesses, for the future of the aerospace industry. The conventional practices of the past will not be enough to meet current and future challenges. This report aims to initiate a constructive dialogue on these issues, with a set of defined challenges, recommendations, and outcomes.

Challenges now and in the future:

- **Labor costs** are high relative to major competitor states, largely a result of Washington's more experienced work force. Regional salary data from the Bureau of Labor Statistics (BLS) can serve as a rough measure of comparison. Noting that reservation, BLS data show that Washington enjoys a labor cost advantage in the aerospace and aerospace-related fields of aerospace engineers, electrical engineers, electro-mechanical technicians, electronics engineers, and materials engineers and scientists (as determined by the difference in median wages), but a labor cost *disadvantage* in other important occupations (see **Appendix A**).
- Boeing **labor disputes** in recent years and the crippling effects of these disputes and production stoppages on the supply chain.
- Lack of a well-coalesced and unified industry voice and **fragmented industry organizational structure.**
- Fragmented system of aerospace **skills training**.
- **Resource-challenged education system**, leading to likely or impending scarcities of skilled aerospace-qualified workers for the future.
- **Periodic layoffs** in this cyclic industry, which drain experience and continuity from the workforce, and leave the impression of poor job security.
- **Over-dependence of lower tier suppliers on Boeing final demand** for goods and services, leading to excess strain during periods of abrupt production stoppages and/or declines in Boeing production. The combination of cyclic drop in demand, two-year long delays in the 787 program and finally, the 2008 machinist strike late in 2008 led to losses of nearly $2 billion in lost/delayed sales.
- **An aging workforce:** more than half of Washington aerospace workers are above the age of 45. Washington needs more than 21,000 new aerospace workers over the next decade to fill new jobs and meet employer demands, not including workers needed to fill turnover-induced openings.
- **Training costs**: small- and medium-sized enterprises (SMEs) that supply to Boeing often pay much less for the same positions. Workers with sufficient training and experience often migrate

to higher paying, same-skill positions at Boeing before returns on education and training investments made by a smaller firm can be fully realized, reducing the incentive for future investments.[5]

- **Greater mobility of OEMs**: OEM's and their suppliers no longer have to stay tied to a specific localized geographic cluster of aerospace parts manufacturers and can locate wherever they perceive the greatest competitive advantage to be. This raises concerns about Boeing's strategy and if the company will continue to assemble commercial aircraft in the Puget Sound region over the long term.
- **Upper tier and OEM risk management strategies:** while larger companies consider the impact on sub-tier levels, they usually do so without consulting sub-tiers, instead assuming or expecting sub-tiers to adjust. Boeing and Airbus have expressed a desire for ALL suppliers, regardless of tier level, to be ASQ certified, though the schedule for execution of this shift is not clear. The impact is scalable—for major suppliers this is less of an issue; the most affected firms will be small machine, heat treatment, and metal plating and coating shops. For many of these shops and small- and medium-sized enterprises (SMEs), the administrative and overhead costs associated with certification can be prohibitive (often exceeding 10% of annual sales).
- **Growing domestic competition for aerospace investments and manufacturing:** numerous states are looking seriously at aerospace as a desirable industry to attract, and are more aggressive in the incentives they offer.
- **Growing international competition:** market demand and opportunities for long term growth will be coming from India, China, and other Asian markets and will increase competition not only in the United States but around the globe in emerging clusters such as Mexico and China, as well as from well-established aerospace clusters in Canada, Germany and France. The mid- and large-size commercial aircraft industry as a whole remains a duopoly (Boeing and Airbus), though several small and nascent programs in China (AVIC), Japan (Mitsubishi), and Russia (Sukhoi) will increase competition over the next 20 years.
- **Attracting aerospace tier I and tier II investments**: in the last 4 years, Washington has experienced an uneven track record of attracting significant new aerospace investment projects. In the last 5 major competitions for attracting new aerospace companies, Washington was not considered due to unattractive economic factors such as cost of living, wage rates, and expensive infrastructure (see **Appendix B, C,** and **D** for further detail).

[5] Gates, Dominic and Justin Mayo, "Pay in aerospace is low for non-Boeing workers," *Seattle Times*, December 16, 2007.

3.0 Recommended Strategies

3.1 Economic Development

The primary economic development **objectives** are to:

1) Grow and improve jobs, both directly and indirectly within the aerospace sector;
2) Retain and grow our existing aerospace cluster;
3) Make our existing aerospace companies, suppliers, and supporting firms more competitive, both nationally and globally.

The implementation of these strategies should be considered through **public-private partnerships, and not dependent solely on state dollars. We recommend **exploring ways to leverage partnerships to achieve these goals.**

Challenge #1: Business recruitment. Washington has not been competitive for several high profile recent aerospace OEM and tier I investments. The state needs to develop a robust and well-funded strategy for recruiting a targeted set of companies and technologies into the state.

- Lead a state-level process to engage local economic development organizations around the state that are interested in aerospace activity **to prioritize and execute a list of specific opportunities inside the industry** (e.g. green aviation, the air force tanker contract, connecting the supply chain to other tier I companies and OEMs, etc.). **Resource needs = LOW/MEDIUM**
- **Gain critical and timely market intelligence**. Allocate resources to significantly enhance the state's market research capabilities. New and timely investment leads are often generated through close networking with OEMs and tier I suppliers well before any such information is made public. **Resource needs = MEDIUM.**
- **Marketing.** Enhance our recruiting activities for aerospace events (domestic and international), working with site selectors and directly with companies. We need to better position Washington state against the competition, with marketing and communications collateral.
    - Washington state marketing efforts are frequently outdone by competitor states. We have one of the most dynamic and robust aerospace clusters in the world, and yet we are not as well recognized globally.
    - Efforts should be coordinated with industry (e.g. Aerospace Futures Alliance of Washington, Pacific Northwest Aerospace Alliance, and the Inland Northwest Aerospace Consortium) and the Associate Development Organizations. **Resource needs = MEDIUM.**
- **Develop a "technopole" strategy**—develop increased collaboration between private and public partners in regions of the state where high concentrations of aerospace assets exist.
    - For example, support investment in the Snohomish Innovation Partnership Zone (IPZ)—marry "soft" incentives to locating within a cluster (e.g. positive externalities, shared workforce, etc.) with facilities and other business cost-reducing resources. **Resource needs = MEDIUM.**

Outcomes: 1) more diversified cluster at the tier I and tier II levels → a greater case for a second OEM to locate in Washington state; 2) growth in jobs and firms

Challenge #2: Business Retention and Expansion. Focus efforts on ensuring the health and business vitality of all companies within the aerospace cluster, including suppliers and machine shops (tiers I through IV).

- Develop **global sub-national partnerships.**
    - This is a new idea we think should be further developed. We have already developed partnerships in aerospace with the Andalusia region of Spain, and with Queensland, Australia in the life sciences. The Andalusia partnership was initiated during the Pacific Northwest Aerospace Alliance (PNAA) annual conference in February 2009. One Spanish company, Aerosertec, has already established an office in Seattle.
    - Partnerships will involve regular dialogues focused on collaborative opportunities between Washington state and counterpart aerospace regions around the world. Partnering regions will be identified and targeted based on the level of potential collaboration. Partnerships will involve two-way business-to-business missions and research into best practices for industry structure, organization, and economic development programs and tools. Potential targeted regions include Europe, headed by Commerce's Aerodesk there, China, and possibly India.
    - **Resource needs = MEDIUM.**

- Help Washington state companies significantly expand their presence at major aerospace events.
    - In conjunction with the third strategy under **Challenge #1**.
    - **Resource needs = HIGH.**

- Allocate **financial resources** to support programs focused on reducing the onerous costs of AS9100, NADCAP, and AS14000 certifications and the maintaining of these standards.
    - The 787 supply chain exemplifies a trend toward globally elongated supply chains and less reliance on local suppliers. In order to stay competitive, WA-based suppliers will need to obtain international certifications, but this process (and the maintaining of these standards) can be prohibitively expensive for smaller firms.
    - **Resource needs = MEDIUM.**

Outcomes: greater diversity of business among lower tier suppliers; more overseas, non-Boeing business among lower tier suppliers → **more jobs** and **increased health of aerospace and related companies.**

Challenge #3: create a **unified voice, messaging, and coordination** across the aerospace sector. There needs to be a consistent and unified message and branding materials on Washington state's aerospace strengths. Various aerospace organizations and entities are not coordinating their messaging to the maximum benefit for recruitment and retention. Coordination will enable more efficient deployment of resources and prevent redundancy in efforts.

- The Washington Council on Aerospace should expand its mandate to act as a **convener** among all aerospace organizations in Washington state. **Resource needs = LOW.**

Outcomes: efficient network to support the aerospace industry, with **well-defined** and non-**overlapping roles** and **responsibilities** → better business recruitment and business retention and expansion efforts, **more jobs**.

3.2 Workforce Training and Talent

Increasing emphasis on globalization speaks to the world's greater dependence upon the aerospace industry as a method of moving goods and people rapidly around the world. This increased demand on air transportation will require manufacturers to increase production to meet demand for the replacement of aging aircraft and the development of new aircraft models to meet emerging needs. Washington must plan proactively to meet the workforce needs resulting from the expansion of a vibrant, dynamic, and multi-faceted aerospace industry. The entire aerospace workforce, those starting out and experienced employees, must be skilled in the latest manufacturing materials, technologies, and processes. While all the challenges identified in the workforce training and talent section of this report are of importance, they are listed in order of priority. *NOTE—in this section, resource needs refer to the following: LOW = less than $100,000; MEDIUM = $100,000 to $999,000; and HIGH =$1 million or more.*

Challenge #1: Training must be responsive to dynamic employer and industry needs. Strengthening and streamlining partnerships between employers and education providers will improve the timeliness and quality of training. A clear process to transfer advances in research to workforce program content and delivery must be created. Training programs should be continually updated to include relevant concepts, processes, and skills to rapidly move innovations from the research lab to the manufacturing site.

- Build program capacity at the Washington Aerospace Training and Research Center in Snohomish County and the Spokane Aerospace Technology Center in Spokane to develop and provide industry-driven mid-level training to new students and current workers in a variety of instructional delivery formats to fit the needs of employers and working students. The training centers and the Center of Excellence will jointly convene an industry group to guide community and technical college aerospace training. The trainings, courses, and certifications will be offered in "stackable" formats allowing students to learn discrete, cutting-edge skills sets that can be bundled into certificates and degrees. Curriculum developed at the two centers will be shared with the Center of Excellence to be disseminated to mid-level aerospace training providers across the state. **Resource needs = HIGH.**
- With the pace of change the aerospace industry and economy are experiencing, training providers must persist in offering relevant instruction. Additional resources are needed to acquire new technologies and equipment used in the industry to maintain Washington's advantage of having a highly trained aerospace workforce. Curriculum and new program development must be supported to quickly prepare workers for emerging skill needs identified by the industry. **Resource needs = HIGH.**
- Develop protocols to transfer relevant research findings from the research universities and other research organizations to the Center of Excellence, in collaboration with the two new training centers and other mid-level training providers. **Resource needs = MEDIUM.**
- Identify the Aerospace Center of Excellence as the single point of contact for employers to communicate their mid-level workforce training needs to 2-year college and apprenticeship providers. **Resource needs = MEDIUM.**
- Create more incumbent worker training programs and leverage the existing Job Skills and Customized Training programs providing incumbent workers with highly specialized aerospace training and certifications to provide workers with advancement opportunities. **Resource needs = MEDIUM.**

Challenge #2: Coordination, articulation, and growth of aerospace education and training programs across the state must be improved. Several competitive states have well-funded training offerings that incorporate current technologies and are delivered in an integrated and organized manner (see **Appendix G**). For Washington's 2-year colleges offering similar aerospace programs, aligning and standardizing the curriculum will allow course content to be updated and deployed regularly as industry needs change.

Post-secondary pathways and career advancement opportunities for potential and incumbent aerospace employees must be clear. More pathways from two-year to four-year aerospace degree programs will be developed to improve transitions and shorten the time to degree completion. Program offerings must be flexible to meet the needs of working adults.

- Coordinate the state's mid-level education and training programs supporting the aerospace industry through the Center of Excellence. The Center will work with the Washington Aerospace Training and Research Center in Snohomish County and the Spokane Aerospace Technology Center in Spokane, other 2-year colleges, and partners offering similar aerospace programs to align curricula. As industry needs change, the Center will disseminate updated curricula and best practices as they are developed at the two new training centers, individual colleges, and registered apprenticeship programs to improve instructional content and program delivery. **Resource needs = LOW.**

- Create clear educational pathways, increase transfer agreements between educational institutions, and award credit for students' prior learning.

    - Increase transfer agreements between the state's two-year colleges, registered apprenticeship programs, and universities. Accelerate the development of major ready pathways and other program articulation strategies which facilitate movement of students from 2-year institutions to 4-year programs in the high demand science, technology, engineering and math (STEM) fields needed by the aerospace industry. **Resource needs = LOW/MEDIUM.**

    - Support dual credit programs for high school students enrolled in aerospace-related programs. **Resource needs = LOW.**

    - Modularized instruction. For example, modularize Airframe and PowerPlant licensing training programs, in collaboration with the FAA, into smaller instructional units and provide the training at strategic locations across the state to provide convenient and just-in-time training for current aerospace employees. **Resource needs = LOW/MEDIUM.**

    - Encourage colleges and universities to assess learning and award credit for students' prior learning especially students recently separated from the military or who have significant work experience. **Resource needs = LOW.**

- Increase funding to expand access to and support for registered apprenticeship training programs, two-year, and four-year computer science, engineering and aerospace training programs as well as high school training centers offering training in aerospace and STEM fields to meet projected employer demand. **Resource needs = HIGH.**

- Engage business and labor to identify training requirements leading to new credentials requiring less than two years to complete. Modularize instruction when possible and create stackable credentials. **Resource needs = LOW/MEDIUM.**

- Work with the Washington Legislature to develop a higher education "innovation fund" to enable public higher education institutions to **test** and **replicate** successful strategies to enhance student persistence and completion rates, especially among low-income students, resulting in more graduates with the skills and knowledge needed to support Washington's aerospace industry. **Resource needs = MEDIUM.**

Outcomes: Students will advance more quickly through their training programs, and new and current employees will have access to flexible, cutting-edge statewide training programs to update their skills on an as-needed basis.

Challenge #3: The aerospace workforce is aging. Workforce projections show a significant drop in highly skilled workers as they retire in the next ten to fifteen years. The industry currently experiences difficulty recruiting management and data analysts, engineers, assemblers and fabricators, and general machinists. Employers are fearful the current supply and demand gap will be compounded in the future with the high retirement rate of skilled employees and the significant shortage of workers trained to take their place.

- Create better partnerships between state workforce development agencies and higher education institutions to better connect employers with trained workers. Reinstate co-location of Employment Security staff on college campuses. **Resource needs = MEDIUM.**

- Develop mentorship and training opportunities between new and experienced employees. **Resource needs = LOW.**

- Develop targeted marketing strategies to recruit individuals leaving the military, women, skilled dislocated workers from other industries, and other under-represented groups. **Resource needs = LOW.**

Outcome: Aerospace employers are better able to find the skilled workers they need.

Challenge #4: Washington lacks an adequate number of students expressing interest in and training for occupations and trades necessary to support the aerospace industry and to meet its future supply needs. Too few students are pursuing science, technology, engineering and math (STEM) certificates and degrees, particularly in engineering disciplines, to meet the demand for workers in occupations related to these disciplines. Often students lack basic math skills needed to successfully complete aerospace training programs.

- Launch an outreach campaign to recruit middle school, high school, and college-age students highlighting careers in the aerospace industry. Work with K-12 students to prepare them for college-level work in aerospace programs, especially engineering. Maintain a web-based clearinghouse to provide information on post-secondary aerospace training programs offered throughout the state. **Resource needs = LOW.**

- Develop more "train-the-trainer" and "teach-the-teacher" programs. Evaluate aerospace faculty development needs and implement strategies to provide faculty with timely and relevant training to remain up-to-date with current and emerging industry trends. Promote teach-the-teacher programs to help middle and high school teachers gain knowledge about the aerospace industry and related occupations. Assist teachers to impart their understanding of career opportunities in the aerospace industry to their students. **Resource needs = LOW.**

- Support third-party initiatives in the K-12 system directly focused on enhancing the foundational skills leading to higher education degree attainment in the science, technology, engineering, and math fields. **Resource needs = LOW/MEDIUM.**

Outcomes: More students will participate in aerospace and aerospace-related (science, technology, engineering, and math – STEM) fields of study leading to a deeper hiring pool for the industry.

3.3 Research

UW and WSU are the state's research universities and are poised and ready to make greater contributions to the development and growth of the state's aerospace industry. Below are three proposals to strengthen and expand UW and WSU aerospace research efforts.

Challenge #1: turning Washington into a center for aerospace technology innovation. The state lacks the innovation infrastructure necessary to enable us to compete effectively against the Global Challenge States.[6]

- Create a Center for Aerospace Technology Innovation to support research at the UW and WSU, leveraging corporate support and/or grants from government or non-profit agencies, and building on existing strengths of the two research universities.
    - The mission of the Center will be to advance research on new technologies that offer the promise of innovative products in aviation, aerospace and defense.
    - **Resource needs = HIGH.** Funding of $3.0 million per year is estimated (see **Appendix E** for fuller explanation).

Outcomes: Major support to innovation-dependent industries, research and target funds to worthy grant proposals.

Challenge #2: Sales tax exemption for aerospace research. With some exceptions, the University of Washington and Washington State University pay retail sales or use taxes on all transactions not specifically exempt by statute. Specific exceptions for the UW and WSU are the "high technology" sales tax deferral program on the construction of research buildings and the purchase of research equipment. However, in contrast to state research universities in 48 other states that are exempt from state sales tax in one form or another, the UW and WSU continue to pay retail sales or use tax on all other transactions not specifically exempt by statute.

- **Pass a legislative exemption from these taxes** for those research activities specifically related to the aerospace industry, which would result in savings to the two institutions of roughly $300,000 to $500,000 annually. **Resource needs = MEDIUM/HIGH.**

[6] *Washington Learns: World-Class, Learner-Focused, Seamless Education,* November, 2006.

Outcomes: 100% of grant funding for aerospace research used directly for such research, allowing the UW and WSU to compete more effectively against institutions in competitor states that are exempt from such taxes, and would generate more funding for research benefiting the local aerospace industry.

Challenge #3: create an information clearinghouse for research findings. While the state's two research institutions are engaged in cutting-edge research in the aerospace sector, *it is difficult to inform the researchers of the most urgent issues and also to relay outcomes of this research to those companies that would most benefit from it* and be most likely to incorporate it into their operations.

- Create an information clearinghouse—whether freestanding or through an existing entity such as Washington Manufacturing Services, Washington Technology Center, or other—to freely share information between the research universities and those in industry who are most knowledgeable of the research frontiers—such joint problem solving is more likely to advance innovation. **Resource needs = LOW.**

Outcomes: State tax dollars targeted to the research institutions will redound to the benefit of the private sector, making Washington state more competitive → companies in the aerospace sector will prosper as new research is brought on line.

4.0 Benchmarking

4.1 Economic Development

Employment, firms, occupations

Washington has the largest concentration of aerospace workers in the U.S., followed by Texas and Kansas. Washington's employment grew dramatically since 2004, increasing from 60,781 in 2004 to 82,239 workers in 2008; much of this increase can be attributed to the ramp-up for the first line of the 787, along with the cyclical nature of the aerospace industry (prone to many periodic peaks and valleys in production and employment). Of the eight states identified as chief competitor states, none has exhibited anywhere near same level of increase in employment during this period (**Exhibits 1 and 2**).

However, much of Washington's employment is driven by a single OEM, Boeing, making up approximately 91.2% of all Washington's aerospace employment. With 240 firms in 2008, Texas has more aerospace firms (defined as such by NAICS) than any other state, followed by Washington with 160. After removing Boeing, the remaining 159 firms in Washington average about 44.6 workers per firm, compared with about 217.4 workers per firm in Texas.[7] In terms of occupations, Washington has the highest concentration of aerospace engineers of any state in the U.S., as measured by the labor location quotient (**Exhibit 3**); we rank third in overall number of aerospace engineers, behind California and Texas.

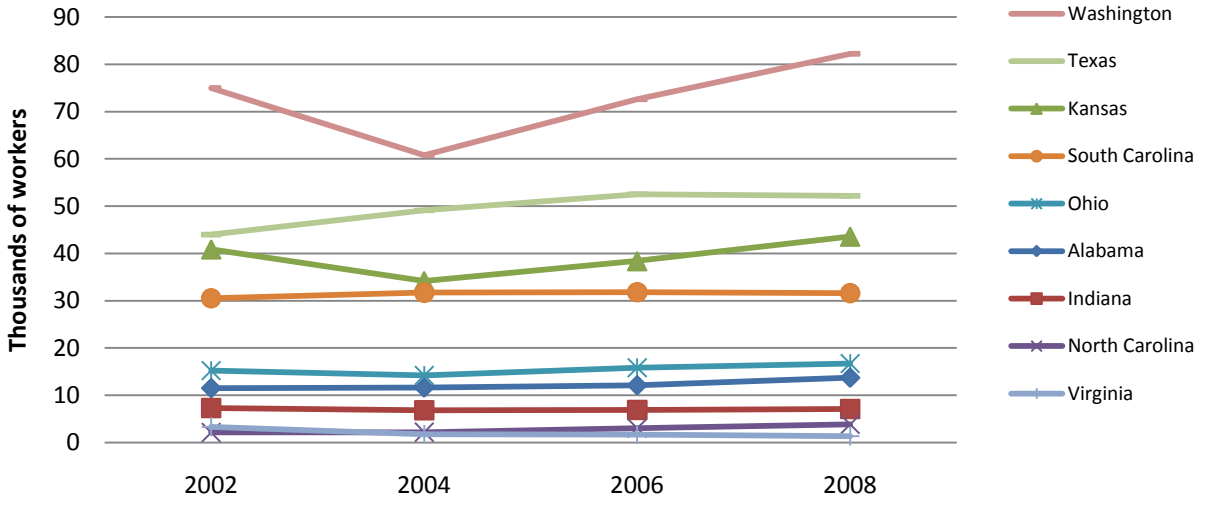
Wages

Washington labor is expensive relative to other states (see **Appendix A**). U.S. Bureau of Labor Statistics occupation data referred to in this report is for May, 2008, and does not separate out overtime pay; nonetheless, this data helps illustrate some rough comparisons of labor costs. Median annual earnings

[7] Data sources: Washington State Employment Security Department (ESD), U.S. Bureau of Labor Statistics (BLS), author's calculations.

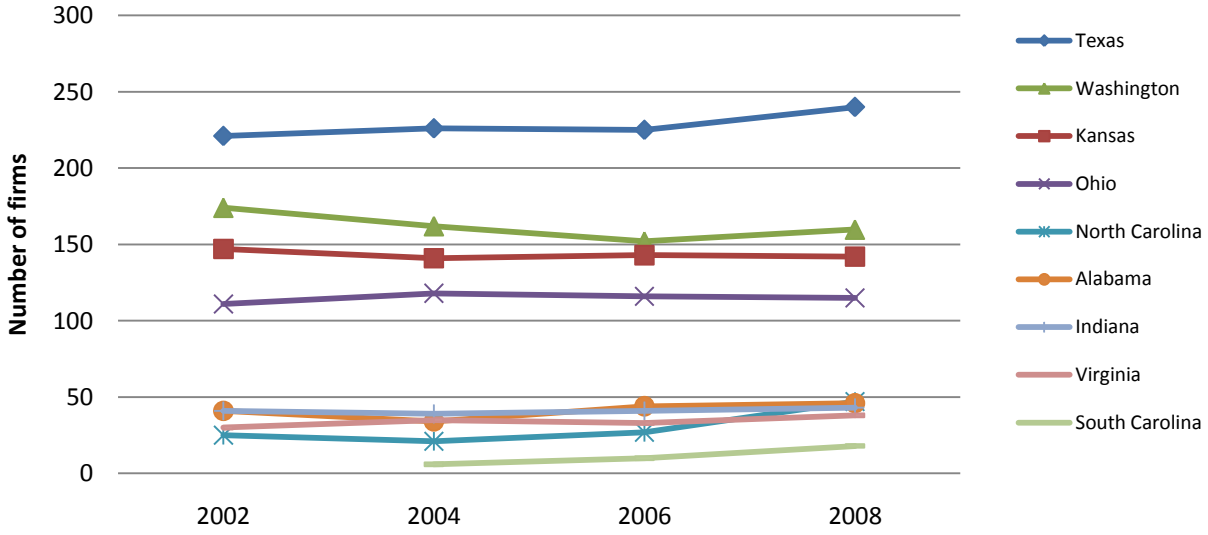
for machinists in Washington is higher than any of our chief competitor states, with an average gap in annual median earnings of more than $10,300 (excluding Maryland); we are also not cost competitive in the broader category of "production occupations." Washington state is more competitive on costs for aerospace engineers and electrical and electronic equipment assemblers, but more expensive for electromechanical equipment assemblers and painters for transportation equipment.

Exhibit 1: State Aerospace Employment, 2002-2008



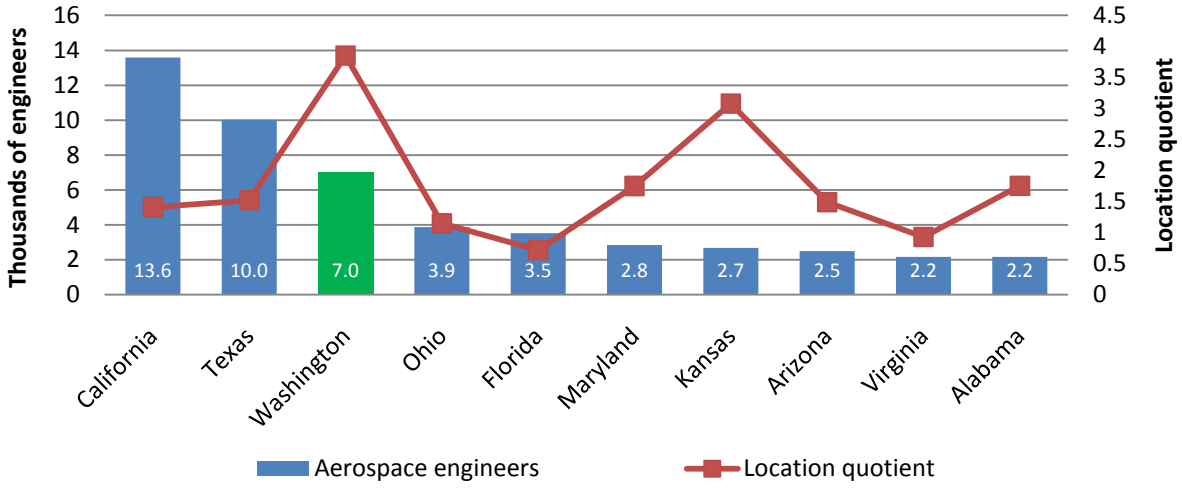
Data sources: Washington State Employment Security Department, U.S. Bureau of Labor Statistics

Exhibit 2: Aerospace Firms, by State, 2002-2008



Data sources: Washington State Employment Security Department, U.S. Bureau of Labor Statistics

Exhibit 3: Aerospace Engineers and Location Quotient by State, May 2008



Data sources: Washington State Employment Security Department, U.S. Bureau of Labor Statistics, author's calculations

Recruitment

Washington has landed several recent recruitment wins, though we have also lost out on several high profile aerospace investments, most notably the recent (October 2009) Boeing decision to locate the second line of the 787 in South Carolina. Recruitment "wins" include the following (**Exhibit 4**):

Exhibit 4: Recent Aerospace Investments in Washington State

Company	Jobs	Facility Size (square feet)	Location	Announcement Date	Investment
Messier-Bugatti	50	30,000 leased	Snohomish	Fall 2005	Wheels and brakes shipping and receiving facility with parts going to many OEM's including Embraer and Airbus
Goodrich	70	140,000	Snohomish	Fall 2005	Manufacture of nacelles for 787 engines
Fokker Elmo	5	3,000-6,000	Kent	Opened Fall 2005	Distributing wiring and harnesses for 787, U.S. HQ
Messier-Dowty	50	12,000	Snohomish	June, 2006	Part of Safran Group, provides landing gears for 787
Cascade Aerospace USA	138	52,000	Spokane County	2008 (opening 2009)	MRO

Sources: Washington State Department of Commerce, Snohomish County Economic Development Council

Incentives

Meaningful comparisons of incentives across states and regions are difficult. In terms of "on-the-books" incentives (i.e. already in law), we compare well in terms of tax credits. However, we are not as competitive when it comes to large tier I and OEM recruitment efforts, largely because many of our competitor states are able to craft new, robust incentive packages to attract these companies. The recent South Carolina incentive package to Boeing helps illustrate this. We are also not competitive with *discretionary funds* offered elsewhere. Our own fund, the Governor's Strategic Reserve, is much smaller than those offered in other states. Take the Honda Jet program in North Carolina. The state government put together an $8 million incentive package from the Job Development Investment Grant (JDIG) program to recruit the company. As part of the agreement: 1) Honda must retain the 50 workers at their Greensboro headquarters for the duration of the 12-year grant; and 2) 283 new workers will design, engineer and manufacture the new plane. The average annual salary for the new jobs will be around $70,000 a year plus benefits. Over the life of the grant, the N.C. Department of Commerce estimates the project will: generate a combined cumulative gross state product value of $943 million; produce a combined positive, cumulative net state revenue impact of $21 million; and contribute up to $2.2 million to the Industrial Development Fund for infrastructure improvements in rural and economically distressed areas of North Carolina.

Other examples of high profile investments that went elsewhere (and incentives used to recruit these investments) include Spirit's investment in North Carolina (2008), the Vought-Alenia joint venture Global Aeronautica in South Carolina (2004), Rolls-Royce's new engine facility in Virginia (2009), and the new Bombardier C Series manufacturing plant in Quebec, Canada (2008). For each of the investments, Washington state was not on the short list (see **Appendix B** and **C** for more detailed discussion). It should be noted that in most cases, incentives play a role only *after* a state has been included on the "short list"—other factors other than incentives play a significant role in the decision-making process beforehand (see **Appendix D**). For a review of aerospace and related incentives offered in Washington state, see **Appendix F**. An inventory of technologies and companies in Washington state can be found in **Appendix H**.

4.2 Workforce Training and Talent

Across the competitive states, many provide robust, well-funded training programs that incorporate current technologies and coordinate instruction (**Appendix G**). Workforce training is a critical component of the selection process as businesses evaluate the merits of potential manufacturing sites. For a detailed discussion of *education and training requirements in aerospace*, see **Appendix I, Exhibit I1**.

Several states have invested millions of dollars to create aerospace research and training facilities through public and private partnerships. Many of the facilities incorporate state-of-the-art equipment and manufacturing processes into training curricula. Washington has just embarked on efforts to develop two industry-driven training centers serving employers and students on both sides of the state.

Some of the competitor states have created smooth processes transferring advances in research to training content improvement; often housing both types of activities in the same facility where researchers, curriculum developers, and training providers can more easily interact with one another. New curriculum and program content is seamlessly deployed throughout the education system. Although efforts are underway, there is not yet a coordinated approach aligning aerospace research results with the development of mid-level workforce training in Washington.

Many competitor states have established strong partnerships between aerospace businesses and training providers. Workforce training offerings can be strategically and quickly expanded in response to industry need, especially at the 2-year college level. Program offerings are delivered in a wide variety of formats. In terms of workforce development, Washington's workforce training system currently has all the critical components seen in other successful states. Washington is even ahead of many states by being nationally recognized for developing innovative strategies to provide access to and successful completion of training programs (online courses, Integrated Basic Skills programs, Job Skills and Customized Training programs, the Community and Technical Colleges' Student Achievement Initiative). The major challenges for Washington are better coordination of these efforts in partnership with business and industry and more program capacity.[8]

4.3 Research

While WA ranks about 14th nationally in academic R&D spending, much of this is in the life sciences (health, food, and the environment). Only 15% of our academic R&D is in engineering, yielding an overall rank of ~25th, and in aerospace about 30th. We are well behind Johns Hopkins, Georgia Tech, Pennsylvania State University, and MIT in terms of total engineering R&D expenditures. Smaller programs have chosen the aerospace field as a singular focus. Wichita State University, while not known for its engineering program, has invested heavily in its aeronautical/aerospace R&D, leveraging its position within one of the largest clusters of aerospace firms and suppliers in the U.S., with significant returns (**Exhibit 5**). For a detailed discussion of Washington's current research assets, see **Appendix J**.

Exhibit 5: University Engineering and Aeronautical/Aerospace R&D Expenditures

Top Ten Engineering R&D Expenditures, FY07 (thousands of dollars)		Top Ten Aeronautical/Aerospace R&D Expenditures, FY07 (thousands of dollars)	
Johns Hopkins University	535,222	Johns Hopkins University	56,072
Georgia Tech	309,986	Georgia Tech	40,584
Pennsylvania State University	235,341	Wichita State University	32,433
MIT	216,475	MIT	18,749
Texas A&M	164,434	Texas A&M	16,569
University of Michigan	161,738	University of Colorado	16,215
Ohio State University	160,353	University of Maryland	15,431
University of Texas, Austin	155,968	University of Texas, Austin	11,166
Purdue University	153,503	Purdue University	11,053
University of California, Berkeley	152,752	Mississippi State University	10,298

Source: National Science Foundation (NSF)

[8] Higher Education Coordinating Board analysis from IPEDS data.

Appendix

A. Aerospace-Related Occupations, May 2008

(Cells in the far right column for each table in yellow indicate a price disadvantage for Washington.)
Note: these data do not separate out overtime pay.

State	Aerospace engineers	Labor location quotient	Median annual earnings	Difference with Washington
California	13,590	1.41	$104,550	$12,930
Texas	10,020	1.52	$91,770	$150
Washington	***7,000***	***3.85***	***$91,620***	***
Ohio	3,880	1.15	$91,610	-$10
Florida	3,530	0.72	$86,300	-$5,320
Maryland	2,840	1.75	$112,680	$21,060
Kansas	2,680	3.08	$80,770	-$10,850
Arizona	2,490	1.49	$72,960	-$18,660
Virginia	2,160	0.93	$100,060	$8,440
Alabama	2,160	1.75	$97,890	$6,270

Data source: U.S. Bureau of Labor Statistics (BLS), author's calculations

State	Machinists[9]	Labor location quotient	Median annual earnings	Difference with Washington
Texas	35,220	1.09	$32,440	-$12,790
California	35,020	0.74	$36,030	-$9,200
Ohio	32,060	1.94	$35,200	-$10,030
Indiana	14,310	1.58	$37,120	-$8,110
North Carolina	12,780	1.01	$34,300	-$10,930
Florida	9,720	0.40	$34,860	-$10,370
South Carolina	7,380	1.26	$32,690	-$12,540
Alabama	7,290	1.21	$35,570	-$9,660
Virginia	7,250	0.64	$37,100	-$8,130
Georgia	6,890	0.55	$31,880	-$13,350
Washington	***5,530***	***0.62***	***$45,230***	***
Arizona	5,270	0.64	$35,480	-$9,750
Colorado	4,270	0.60	$37,280	-$7,950
Kansas	4,060	0.95	$33,050	-$12,180
Maryland	3,790	0.48	$44,310	-$920

Data source: U.S. Bureau of Labor Statistics (BLS), author's calculations

[9] Note: The U.S. Bureau of Labor Statistics category "Machinists" is much narrower than the group represented by the Association Machinists Industrial District Lodge 751 IAM & AW, hence explaining the difference in employment numbers.

State	Electrical and electronic equipment assemblers	Labor location quotient	Median annual earnings	Difference with Washington
California	24,070	0.99	$27,210	-$1,480
Texas	21,210	1.28	$26,850	-$1,840
Florida	11,040	0.89	$25,530	-$3,160
North Carolina	6,850	1.06	$29,390	$700
Ohio	6,680	0.79	$27,060	-$1,630
Arizona	6,380	1.52	$34,180	$5,490
Indiana	5,990	1.29	$22,330	-$6,360
Washington	***5,790***	***1.27***	***$28,690***	**
Virginia	4,510	0.77	$26,760	-$1,930
Colorado	4,100	1.12	$27,540	-$1,150
Alabama	2,820	0.91	$31,380	$2,690
Georgia	2,750	0.42	$27,040	-$1,650
Maryland	2,730	0.67	$30,200	$1,510
Kansas	2,560	1.17	$32,320	$3,630
South Carolina	2,230	0.74	$30,050	$1,360

Data source: U.S. Bureau of Labor Statistics (BLS), author's calculations

State	Electromechanical equipment assemblers	Labor location quotient	Median annual earnings	Difference with Washington
California	10,090	1.44	$29,420	-$3,550
Texas	7,000	1.46	$24,620	-$8,350
Florida	2,190	0.61	$25,130	-$7,840
Ohio	1,850	0.75	$30,140	-$2,830
North Carolina	1,780	0.95	$30,030	-$2,940
Arizona	1,720	1.41	$30,950	-$2,020
Georgia	1,400	0.75	$29,690	-$3,280
Virginia	1,290	0.76	$27,410	-$5,560
Washington	***990***	***0.75***	***$32,970***	**
Indiana	720	0.53	$30,570	-$2,400
Colorado	660	0.62	$29,320	-$3,650
South Carolina	360	0.41	$34,790	$1,820
Kansas	300	0.47	$26,130	-$6,840
Alabama	290	0.32	$24,750	-$8,220
Maryland	180	0.15	$34,680	$1,710

Data source: U.S. Bureau of Labor Statistics (BLS), author's calculations

State	Painters, transportation equipment	Labor location quotient	Median annual earnings	Difference with Washington
California	6,280	1.11	$41,100	-$2,570
Texas	4,360	1.13	$31,930	-$11,740
Florida	3,340	1.15	$36,040	-$7,630
North Carolina	1,630	1.08	$38,410	-$5,260
Indiana	1,580	1.45	$33,330	-$10,340
Washington	***1,580***	***1.48***	***$43,670***	***
Ohio	1,510	0.76	$34,210	-$9,460
Virginia	1,370	1.00	$41,170	-$2,500
Alabama	1,130	1.56	$32,750	-$10,920
Georgia	1,090	0.72	$35,700	-$7,970
Arizona	930	0.95	$35,680	-$7,990
Kansas	920	1.80	$39,650	-$4,020
Maryland	840	0.88	$36,600	-$7,070
South Carolina	820	1.16	$34,750	-$8,920
Colorado	780	0.91	$48,190	$4,520

Data source: U.S. Bureau of Labor Statistics (BLS), author's calculations

State	Production occupations (macro group)	Labor location quotient	Median annual earnings	Difference with Washington
California	952,870	0.85	$27,050	-$6,210
Texas	727,580	0.95	$26,560	-$6,700
Ohio	550,280	1.41	$30,920	-$2,340
North Carolina	382,910	1.28	$27,000	-$6,260
Indiana	374,060	1.74	$30,610	-$2,650
Florida	324,110	0.57	$26,920	-$6,340
Georgia	315,680	1.06	$26,170	-$7,090
Alabama	218,350	1.53	$26,540	-$6,720
Virginia	205,750	0.76	$28,560	-$4,700
South Carolina	200,070	1.44	$28,860	-$4,400
Washington	***177,440***	***0.84***	***$33,260***	***
Kansas	130,160	1.29	$29,500	-$3,760
Arizona	124,750	0.64	$27,840	-$5,420
Colorado	103,660	0.61	$29,460	-$3,800
Maryland	99,580	0.53	$32,110	-$1,150

Data source: U.S. Bureau of Labor Statistics (BLS), author's calculations

B. Recent High Profile Aerospace Investments in the U.S. and Canada

Company (and place of origin)	Investment Location	Year	Type of Investment	Investment Amount	Job Creation (estimated)	Incentives	Incentive Amount
Honda Aero Inc (Japan)	North Carolina	**future**	Manufacture turbo jet engine	$27 million	70	JDIG grant	$12.7 million
Bombardier (Canada)	Quebec	2008-2009	Launches new C-Series Jet	$3.3 billion	3,500	Financial	$771 million
GE Aviation Systems (US)	New York	2009	Expand/develop facility	$180 million	250	Fund	$10 million
General Electric Aviation (US)	Ohio (Evendale)	2009	Engines	$200 million	ND	Tax credit	$115 million
Northrop Grumman & EADS (US/Europe)	Alabama (Mobile)	2008	Tankers	$600 million (contingent)	5000 (contingent)	Financial	$120 million
GKN Aerospace (US)	Alabama (Tallassee)	2007	Facility expansion	$21 million	250 with GKN	Tax Credits	$1.5 million
TECT Aerospace (US)	Kansas	2007	Structure for Airbus A350 XWB	$7 million	80	Taxable Bond	$7 million
Grupo Aernnova (Spain)	Michigan	2007	Improve engineering center	$10 million	600	Tax Credits	$18.5 million
Honda Jet (Japan)	North Carolina	2007	Assembly of business aircraft	$100 million	283	Financial	$8 million
Lockheed Martin (US)	Florida	2006	Facility dev. for mftg. CEV	$55 million	350 jobs locally	Financial	$45.5 million
Global Aeronautica (Italy)	South Carolina	2005	Assembly for Boeing 787 fuselage	$510 million	650	Subsidies	$116 million
Lockheed Martin (US)	Alabama (Troy)	2004	Manufacture THAAD missile	$19 million	250	Financial	**

Sources: various online sources

C. In-Depth Review of Five Recent Aerospace Investments in the U.S. (4) and Canada (1)

Company	Where	When	Why	Sources
Spirit Aerosystems	Kinston, NC – Global TransPark	May, 2008	• Desired location on the East Coast to service Airbus and Gulfstream • Felt Spirit could find a qualified workforce anywhere • Runway, rail, and port access all available at TransPark • Government Coalition that was creative and responsive • Incentives valued at more than $200 million • Desired location on the East Coast to service Airbus and Gulfstream	Exit Interview conducted with Spirit
Rolls-Royce	Crosspointe, VA	January, 2009	• RR wanted to broaden its political influence beyond Washington state • Tax issues regarding the test engines that would be used for the test flight 787 would be charged a use tax on the full value of the engine, with four sets of engines RR would have been subject to at least $2 million on each set.	Secondary research and correspondence
Global Aeronautica	South Carolina	2004	Access to long runway, deep water port, and rail were the key factors in their decision making. Also: • Approximately $116 million in incentives • State-backed bonds for land and infrastructure • Much lowered assessment ratio for property taxes • Subsidized lease rates	Secondary research
Bombardier – C Series final assembly	Mirabel, Quebec	2008	• Bombardier is already located in Mirabel • Experienced workforce, training infrastructure • Incentives played a key role—Canadian government contributing $350 million and Quebec government contributing $117 million	Secondary research, email exchange

Honda Jet program (North Carolina)

The state government put together an $8 million incentive package from the **Job Development Investment Grant** (JDIG) program to recruit the company. As part of the agreement:

- Honda must retain the 50 workers at their Greensboro headquarters for the duration of the 12-year grant
- 283 new workers will design, engineer and manufacture the new plane. The average annual salary for the new jobs will be around $70,000 a year plus benefits.

Over the life of the grant, the N.C. Department of Commerce estimates the project will:

- Generate a combined cumulative gross state product value of $943 million;
- Produce a combined positive, cumulative net state revenue impact of $21 million; and
- Contribute up to $2.2 million to the Industrial Development Fund for infrastructure improvements in rural and economically distressed areas of North Carolina.

D. Factors Influencing Aerospace Investment Location Decisions, Based on Discussions with Site Selectors

- **Globalization**
  - Markets and production costs
  - More new competitors
  - Dollar zone
  - China
- **Accessibility to technology**
  - Communications
  - Allows high tech activities to be movable and accessible
- **Incentives**
  - Help companies offset much higher development costs
- Geography – location near OEM, mature/extensive supply chain, prime market, and/or other intangibles (e.g. within 8 hour flight to Toulouse)
- Political
- Union or non-union labor force
- Site-specific factors (e.g. infrastructure, available airstrips, roadways and ports)
- R&D capabilities
- Market intelligence – being apprised of opportunities
- Perception

E. Center for Aerospace Technology Innovation—Detailed Plan

The mission of the Center will be to advance research on new technologies that offer the promise of innovative products in aviation, aerospace and defense.

Approach:

- The Center will act primarily as a funding source to support research at the University of Washington and Washington State University.
- It will use expert review, both scientific and industrial, to evaluate research proposals and make awards.
- Among the criteria considered will be technological innovation, potential for impact on product development and financial leverage by means of corporate support and/or grants from government or non-profit agencies.
- The Center will seek to enhance its impact by soliciting corporate support and aiming to make awards to projects that have potential for follow-on funding from other sources.

Structure:

- The Center will be overseen by an executive board consisting of five members – a University of Washington representative, a Washington State University representative, a Boeing representative, a representative of aviation industry and a person chosen by the Governor to represent the economic development interests of the state.
- The Center will have minimal staff, just sufficient to facilitate rigorous decision making and timely management of awards.

- The Center will solicit the interest of units within the two research universities – departments, institutes, etc. – and establish Center membership criteria whereby such units can be pre-qualified as potential recipients of Center awards, thus simplifying award management.

Operations:

- The Center will establish mechanisms for soliciting and evaluating proposals and for making awards and reporting on technological progress, financial leverage and other measures of impact.
- Among those mechanisms will be a Selections Committee charged with choosing awardees; this committee will be made up of half academic researchers and half corporate representatives who have decision making authority for technology choices in their firms.
- The University of Washington will be asked to provide administrative infrastructure for the Center.

Funding:

- State support at the level of $3 million per year, $6 million per biennium, will be budgeted.
- Additional support will be solicited from companies, foundations and donors.
- Beyond possible donations, the Center will seek to leverage its financial impact through joint support arrangements on a project-by-project basis as appropriate.
- The two universities will limit indirect cost charges on awards to administrative costs, foregoing facilities costs, provided the research is done in facilities supported by state operations and maintenance funds.

Reporting:

- The Center will report biennially to those committees of the Legislature concerned with economic development, summarizing its work, providing indicators of its impact and outlining ideas for enhancing benefits to the state.

F. Washington State Incentives

Category	Incentive
Manufacturing (general)	Machinery and Equipment (M&E) Sales & Use Tax Exemption
	B&O Credit for New Employees in Manufacturing and Research & Development in Rural Counties
	B&O Credit for New Employees in Software Programming & Manufacturing in Rural Counties
	Rural County Sales & Use Tax Deferral/Waiver for Manufacturing Facilities
Aerospace-specific	Reduced B&O Tax Rate for Aerospace Businesses
	B&O Credit for Preproduction Development Expenditures
	B&O Credit for Property/Leasehold Taxes paid on Aerospace Manufacturing Facilities
	Sales & Use Tax Exemption for Aerospace Manufacturers for Computer Hardware/Software/Peripherals
High-technology	High Technology Sales & Use Tax Deferral/Waiver
	High Technology B&O Credit for R&D Spending
Other	Governor's Strategic Reserve
	Community Empowerment Zones
	CERB grants/loans
	Job Skills Program
	Sales & Use Tax Deferral/Waiver for Corporate Headquarters Locating in Community Empowerment Zone

Source: Washington State Department of Revenue, www.dor.wa.gov

G. Review of Training Programs in Competitor States

A review of competitor states and their aerospace workforce training programs reveal Washington lags behind in infrastructure and investments targeted to industry-specific workforce training initiatives.

Arkansas:

- Arkansas community and technical colleges formed the Arkansas Aerospace Training Consortium to collaboratively provide aerospace related certificates and degrees.
- The Arkansas Aerospace Alliance partners with the consortium to market the state as a viable location for new and existing aerospace companies by highlighting training opportunities, workforce and economic development strengths, and other state incentives.

Alabama:

- A $71 million investment of industry, local, and state resources supports the Advanced Technology Robotics Research and Development Complex.
- The Aerospace Training Center, located at Calhoun College, was developed to train entry level workers for the Boeing Delta Rocket facility.

Kansas:

- A $54 million investment of county, state, and federal resources created the National Center for Aviation Training; a 207,000 sq. ft. research and training facility that will further expand offerings.
- The National Institute for Aviation Research is a partnership of local, state, national, and international businesses; government agencies; and academic institutions providing workforce training and proprietary research for aerospace companies, leveraging fifteen advanced labs.

North Carolina:

- The Institute of Aeronautical Technology is located at Craven Community College and is governed by the North Carolina community and technical college system and the Federal Aviation Administration.
- North Carolina's Advanced Machining Center develops curriculum for a state-wide consortium of fourteen schools providing aerospace workforce training.

South Carolina:

- One of South Carolina's most successful initiatives is readySC™ which works through the state's technical colleges to develop training curricula tailored to meet a company's workforce requirements. The readySC™ program has been ranked one of the nation's top four worker training programs.

Texas:

- The Alamo Area Aerospace Academy was developed to provide aerospace industry-related education, training, and work experience to area high school students. The Academy program provides college credit and a paid internship experience for participants.

The aerospace industry is important to Washington, but our state is not keeping its competitive edge in attracting and retaining the commercial aircraft industry. Across the competitive states, many provide robust, well-funded training programs that incorporate current technologies and coordinate instruction. Workforce training is a critical component of the selection process as businesses evaluate the merits of potential manufacturing sites.

Several states have invested millions of dollars to create aerospace research and training facilities through public and private partnerships. Many of the facilities incorporate state-of-the-art equipment and manufacturing processes into training curricula. Washington has just embarked on efforts to develop two industry-driven training centers serving employers and students on both sides of the state. Governor Gregoire's allocation of discretionary Workforce Investment Act (WIA) funding will get planning efforts underway, but strong partnerships, industry commitment, and additional funding are essential for the success of the training centers.

Some of the competitor states have worked hard to create smooth processes transferring advances in research to training content improvement; often housing both types of activities in the same facility where researchers, curriculum developers, and training providers can more easily interact with one another. New curriculum and program content is seamlessly deployed throughout the education system. Although efforts are underway in Washington, there is not yet a fully coordinated approach to aligning aerospace research and development with workforce training.

States that have been successful locating aerospace businesses in their communities have carefully and quickly addressed industry and business workforce needs. Strong partnerships exist between aerospace businesses and training providers. Workforce training offerings have been strategically expanded in response to industry input to include modularized instruction that is stackable allowing students and workers to receive training, return to the work setting with new skills, and later come back for additional training resulting in completion of industry certificates or higher education degrees. Additionally, "just-in-time" courses are offered as requested by individual companies. In terms of workforce development, Washington's workforce training system currently has all the critical components seen in other successful states. Washington is even ahead of many states by being nationally recognized for developing innovative strategies to provide access to and successful completion of training programs (online courses, Integrated Basic Skills programs, Job Skills and Customized Training programs, Student Achievement Initiative). The major challenge for Washington is better coordination of these efforts in partnership with business and industry.

H. Inventory—Technologies and Companies in the State

The primary subsectors within the statewide aerospace cluster are: 1) airframing; 2) advanced materials and composites; 3) avionics; 4) tooling; 5) interiors; and 5) engineering & research. The unmanned aerial vehicle (UAV) is also an emerging new subsector in Washington. Over the summer, Boeing expanded its unmanned aerial vehicles (UAV) operations in Washington state. The company opened a new UAV facility in Kent, WA, in June of 2009. The expansion follows Boeing's 2008 acquisition of Bingen, WA-based Insitu, manufacturer of the ScanEagle reconnaissance drone aircraft. The new division in Kent will also oversee Boeing's rotor-based UAV programs in California and Arizona.[10] Based on a database compiled and maintained by the Department of Commerce, there are roughly 291 machine shops that belong to the aerospace cluster, along with 90 engineering & research firms, 87 aircraft interiors companies, 41 composites companies, 40 firms engaged in tooling, and 18 airframers (note: many firms work across subsectors). There are also 130 FAA repair stations. Sixty-seven companies in Washington are currently certified in AS9100, the aerospace industry-specific manufacturing standard.[11]

Exhibit H1: Examples of Leading Companies in Each Subsector in Washington[12]

Avionics	Air framing	Composites and Advanced Materials	Engineering & Research	Tooling	Interiors
Esterline Technologies	AIM Aviation	Composites Atlantic Ltd.	D3 Technologies	Contour Aerospace	AIM Aviation
Honeywell Inc.	Aviation Partners	Hexcel Corporation	Electroimpact Inc.	D3 Technologies	Astronics
NAT Seattle	Boeing Company	Janicki Industries	Fatigue Technology Inc.	Electroimpact	B/E Aerospace
Naverus	Contour Aerospace	Toray Composites	Honeywell Aerospace	Machinists, Inc.	Carlisle Interconnect
Panasonic Avionics	Exotic Metal Forming	Triumph	Northwest Engineering Technologies	Pacifica Engineering	General Plastics Manufacturing
Thales Group	Hexcel Corporation		Raisbeck Engineering Inc.		Heath Tecna
Universal Avionics Systems Corp.	Jamco				Vaupell
	Primus International				

Source: Washington State Department of Commerce

[10] Wilhelm, Steve (July 3, 2009), "Kent Wins New Boeing Unit," *Puget Sound Business Journal*
[11] Online Aerospace Supplier Information System (OASIS), www.sae.org/**OASIS**
[12] Note: some firms appear in multiple subsectors.

I. Inventory—Workforce Training and Talent

To meet workforce demand, Washington's registered apprenticeship, community and technical colleges, and universities offer a comprehensive array of aerospace training programs:

- The aerospace industry relies heavily on engineers from many disciplines including electrical, mechanical, computer, industrial, materials, and aeronautical. In 2007, 918 of these engineers were trained at the state's public and private universities. Four-year institutions also offer baccalaureate, graduate, and doctorial degree programs such as business and accounting, mathematics, computer science, and materials science providing highly skilled employees for positions within the industry

- Washington's community and technical colleges invest $22-24 million per year to provide training programs directly supporting aerospace manufacturing workforce needs. From 2004 to 2008 almost 13,000 full-time equivalent students enrolled in programs such as aviation maintenance, robotics and electronics technology, material science technology, and advanced manufacturing technology.

- Registered apprenticeship programs offer students supervised, on-the job training combined with related supplemental technical instruction leading to a state-issued, nationally recognized occupational credential. These programs provide job preparation in occupations such as machinists and aircraft mechanics.

- The Job Skills and Customize Training programs provide highly specialized training customized to meet employers' specific needs and is often offered at employers' worksites.

- The Center of Excellence for Aerospace and Advanced Materials Manufacturing is a one-stop point of contact for industry employers to share their workforce needs with state education and training providers. The Center of Excellence:

    1. Coordinate training programs across the state.
    2. Shares curriculum and best practices with training providers.
    3. Markets aerospace career opportunities to high school students and adults.
    4. Supports seamless educational transitions through the development of educational pathways from high school to higher education programs.

- Two new training centers will develop and provide industry-driven training to new students and current workers. One center will be located at Paine Field in Snohomish County and operated by Edmonds Community College in partnership with the Aerospace Futures Alliance. The other will be located adjacent to Spokane International Airport and operated by the Spokane Community College District. The training centers will provide aerospace companies with facilities where they can send workers for advanced employee training. As a result of advances in research, the centers will implement and evaluate new curriculum to rapidly move innovation to the "factory floor." After new curriculum has been put into training courses offered at the two new training centers, it will be shared with the Center of Excellence to be deployed to training providers across the state. The trainings, courses, and certifications will be offered in "stackable" formats

allowing students to learn discrete, cutting-edge skill sets that can be bundled into certificates and degrees.

There were a total of 985 aerospace-related engineering degrees conferred in 2007 across the state, in the fields of: electrical, electronics and communication engineering; mechanical engineering; computer engineering; aerospace, aeronautical and astronautical engineering; industrial engineering; and materials engineering. Of these, 70% were Bachelor's degrees, of which 87% were awarded by the UW and WSU.[13]

Education and Training Requirements

The education and training requirements of the core aerospace industries are significantly different from those of the supplier firms that support them. About one-third of Washington's core aerospace industry employees are production technicians and assemblers. The remaining workers are primarily engineers and engineering technicians, business operations specialists, computer programmers, marketing and sales analysts, and managers. An analysis of training requirements for core aerospace industry occupations shows that of this workforce, 32% require mid-level preparation of at least one year of post-secondary education but less than a bachelor's degree, and 44% require a bachelor's degree or more (**Exhibit I1**).

Exhibit I1: Entry Education/Training Levels of the Washington Aerospace Workforce Q2 2008

U.S. Bureau of Labor Statistics (BLS) Entry Training Level	Number of workers	Percent of Aerospace Workforce
Short preparation (work experience, short/moderate-term OJT)	***20,688***	***24.5%***
Mid-level preparation	***26,813***	***31.7%***
Postsecondary vocational award	6,858	8.1%
Long-term on-the-job training	16,277	19.3%
Associate degree	3,678	4.4%
Long preparation	***37,038***	***43.8%***
Bachelor's degree	31,235	36.9%
Bachelor's or higher degree, plus work experience	5,615	6.6%
Master's degree	131	0.2%
First professional degree	39	0.0%
Doctoral degree	18	0.0%
Washington Aerospace Workforce	***84,539***	

Source: Higher Education Coordinating Board from Employment Security Department data for the 3364 NAICS code industries

Note that these are nationally normal entry-level education and training requirements. The education and training levels necessary to be competitive in the Washington aerospace labor market are quite possibly higher, resulting in greater demand for graduate level education than is indicated in the table above.

[13] Higher Education Coordinating Board (2009), *Analysis for the Washington Aerospace Council of Aerospace-Related Engineering Degrees Awarded in Washington by Discipline*, From IPEDS data and OFM *Higher Education Enrollment Report 2006-2007.*

We also have ample evidence suggesting that the supplier network supporting the core aerospace industries has a much higher concentration of mid-level training occupations than these core industries. As indicated above, because these firms provide parts and services to many industries, not just aerospace, it is difficult to get an accurate count and training profile of the workers at supplier firms engaged in aerospace-related activities. The result of this analysis is that the level of effort and education capacity required to support the core aerospace industries and their suppliers, is roughly equally shared between the 2-year colleges and 4-year colleges and universities.

J. Inventory—Research

The University of Washington's total five-year aerospace research funding is $125 million, while Washington State University has received funding of $2.5 million. The largest source of funding at the UW has been through federal monies (**Exhibit J1**).

Exhibit J1: Breakdown of Aerospace Funding by University

UW Funding Profile	WSU Funding Profile
Total UW 5 year aerospace research funding: **$125 million**	Total WSU 5 year aerospace research funding: **$2.6 million**
$1.5M/year grant funding from the aerospace industry	$0.54 million/grant funding from the aerospace industry
$2.8M/year from NASA and FAA	73% ($1.89 million) of those awards were contributed by the Boeing Company
$20.8M/year of other funding (mostly federal)	Total of 58 awards granted

Source: University of Washington, Washington State University

Both the UW and WSU have extensive collaborations with the Boeing Company and each other in research areas including clean technology, alternative/renewable fuels, next generation materials, fuel cells, and next generation technologies, among others. The Washington State University, University of Washington, and Pacific Northwest National Laboratories are collaborating with key private sector firms, leading research universities/labs across country, Boeing, the Port of Seattle, and the airlines industry to develop scalable jet biofuels production and distribution channels—with Seattle's SeaTac first to market. Below are several more examples of cutting-edge aerospace research going on at the UW and WSU:

- **Structural foam promising dramatic weight savings**. Research entities: collaboration between WSU and Boeing; UW Microcellular Plastics Lab.
- **Sustainable approaches to aircraft life-cycle management**. Research entities: UW doing research on life cycle assessment for Boeing and the Air Force.
- **Composite materials and fabrication methods**. Research entity: UW-based Center of Excellence for Advanced Materials in Transport Aircraft Structures (AMTAS).
- **Novel materials offering electronic control, high reliability, weight saving, and cost reduction.** Research entity: UW-based Institute for Advanced Materials and Technology (IAMT).

- **Nanophotonic devices for computing, communication, and light control**. Research entities: UW-based Materials and Devices for Information Technology Research (MDITR) and Center for Nanotechnology.
- **New networking approaches**. Research entities: UW, in partnership with Boeing.
- **Innovative methods for ice prevention**. Research entity: WSU.
- **Unmanned aerial vehicles (UAVs)**. Research entity: UW.

Through its Aviation and the Environment Initiative, launched in 2008, the Boeing Company has been supporting collaborative research efforts between UW and WSU in biofuels, composite materials, photonic devices and life cycle assessment. This initiative and the longer-term funding record pave the way for a more comprehensive Center with a broader technology reach to address critical technologies with positive impact on the state's aerospace industry. Boeing has also teamed with Washington Universities on several federally funded projects. University-company partnerships are highly effective because: a) academic labs can undertake technology innovation that is too risky or long-term for the corporate entities; b) it is often possible to leverage additional financial resources from federal granting agencies and others; and c) the universities provide highly trained individuals who can move, with the new technologies, to the companies.

The **Washington Technology Center** has also been very active in supporting the development and commercialization of new, indigenous aerospace technologies and firms, including Mukilteo-based Electroimpact, a project between Boeing and HEATCONA Composites, and UAV manufacturer Insitu.[14]

[14] Cheatham, Lee, PhD., presentation to the Washington Council on Aerospace meeting in Spokane, WA on the Washington Technology Center's aerospace-related activities, October 6, 2009.