AEROSPACE PIPELINE REPORT

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Dave Wallace
Research Director
Workforce Training and Education Coordinating Board
dwallace@wtb.wa.gov

Travis Dulany
Policy Research Associate, Policy Research Department
State Board for Community and Technical Colleges
tdulany@sbctc.edu

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BACKGROUND

The Aerospace and Advanced Materials Manufacturing Pipeline Advisory Committee monitors the workforce needs of Washington's aerospace industry. The 15-member committee pays close attention to emerging trends in manufacturing and production, pinpoints training required of today's aerospace workers, and looks ahead to retirement and other factors that will impact the talent pipeline. In particular, the committee works to better align the state's community and technical college system and apprenticeship training with industry demand.

The committee was formed in 2012[1] and issued an annual report each year through 2016. This year's report is the first since 2016. All reports are jointly written by the state's Workforce Training and Education Coordinating Board (Workforce Board) and the State Board for Community and Technical Colleges (SBCTC).

All of the reports since 2013 have evaluated how many people were trained in community and technical college aerospace programs, and their outcomes, along with the employment and earnings of students trained by apprenticeship programs. The 2012-2016 reports included industry hiring needs, and employer satisfaction with aerospace program graduates derived from a survey with industry employers. This year's report does not include the survey component.

[1] The committee was formed to implement Chapter 50, following the passage of 2SSB 2156 (2012).

EXECUTIVE SUMMARY

Key Themes

Industry Outlook

- Core aerospace employment levels fell by about 7,000 employees between 2016 and 2017, and stayed nearly the same in 2018. When adding in additional aerospace-related industries, the number of employees in 2016-2019 was nearly flat. State forecasters see very small net job gains in the aerospace industry for 2020, then employment leveling out through 2023.

Pipeline Issues

- Many aerospace workers are expected to retire soon. This will require a larger pipeline of skilled employees to fill their positions.
- While the state does not expect large net increases in aerospace employment, new jobs will likely require more education and be higher paying.

Summary of Findings

Washington saw slight decline in aerospace employment, wages still strong

- Washington state's core aerospace employment was essentially flat in 2018. However, when combined with related industries, net employment reached 130,819 workers.
- The state had the highest relative concentration of aerospace employment and earnings in the country, over nine times the national proportion.
- Production and architecture/engineering occupations made up more than half of all job types in the core aerospace industry in 2018.
- Assessment of supply and demand showed the greatest need for industrial engineering technicians and engineering managers.
- Average annual earnings for those working in the core aerospace field have risen by 20 percent over the past five years, reaching $119,633. This was more than twice the average wage for all industries in Washington. ($55,020).
- In the most recent program year, 70 aerospace apprenticeship participants completed their training programs. Participants typically took four years (48 months) to complete training.

Training accelerates in apprenticeships and at community & technical colleges

This report looks at the Aerospace Joint Apprenticeship Committee (AJAC)'s apprenticeship program, and five select aerospace programs offered at Washington's community and technical colleges.

Key findings

- For the 2018-2019 program year,[2] 537 participants participated in the Aerospace Joint Apprenticeship Committee (AJAC)'s apprenticeship program.
- All programs, with the exception of one — Engineering Tech — experienced declining full-time equivalent (FTE) enrollment and headcounts over the last five years.
- Median wages among those employed in the aerospace industry, adjusted for inflation to the first quarter of 2018, saw modest improvements over the most recently available three years.

[2] The most recent year of available education and training data is the 2018-2019 program year. The most recent year available for employment data is 2018.

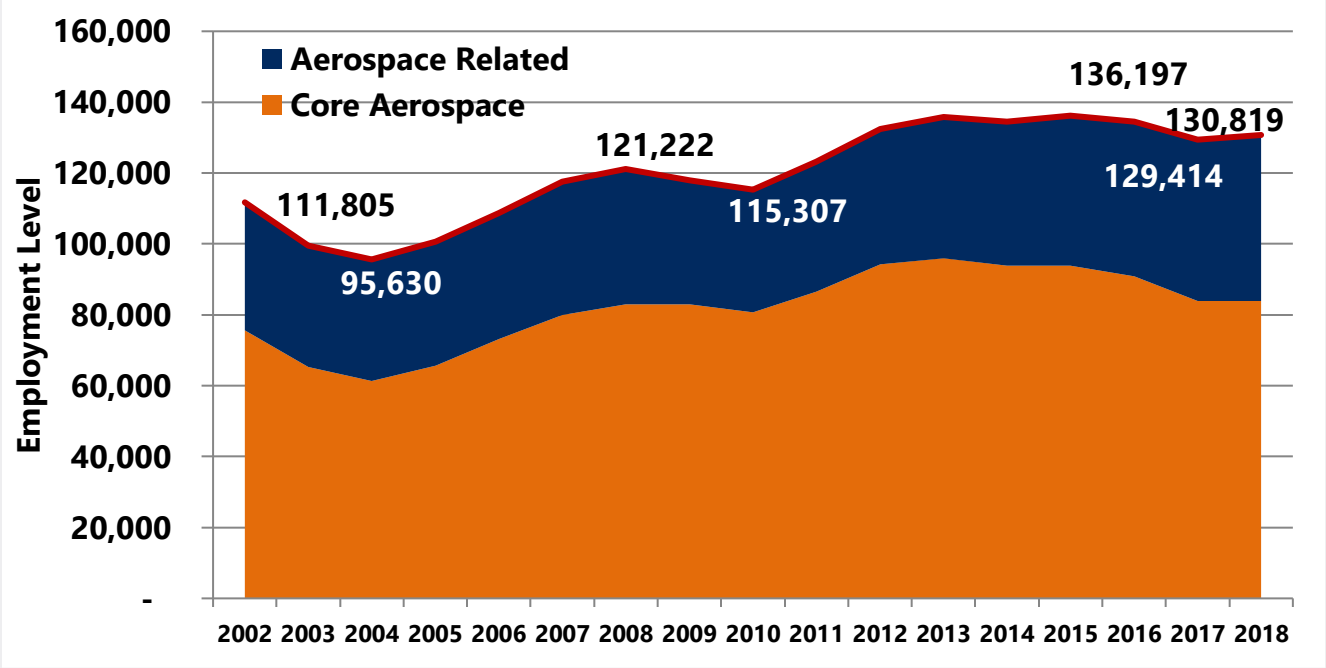
OVERVIEW OF WASHINGTON'S AEROSPACE INDUSTRY

Firms and Employment

Washington's first aerospace company, Boeing, was established a little over a century ago, in 1916. Since then, the industry has expanded to include 1,406 firms, with 206 of these firms located in the core industry.

The core of Washington's aerospace industry is the "Aerospace Manufacturing and Parts" (North American Industry Classification System Code 3364) industry, employing 83,904 people in 2018.[3] Surrounding that core are an array of aerospace-related industries comprised of materials and parts suppliers, air transportation, and related infrastructure, on average employing over 130,819 Washingtonians in 2018.

Figure 1: Aerospace Employment Trends
Washington, 2002-2018



Source: Washington's Employment Security Department
**See Appendix B for a complete list of industries included in the aerospace-related group (shaded in gray).*

Relative Concentration

By most measures, Washington is the nation's aerospace industry leader. One more indication of this is the state's relative concentration in the aerospace industry. Relative concentration is measured using a location quotient (LQ). This metric measures the relative concentration of a given industry in a given area (measured by the number of jobs or total wages generated by an industry). That concentration is then compared against the relative concentration of the same industry at the national level.

[3] 2015 Annual Average Employment, Washington State Employment Security Department.

Figure 2: Aerospace Core Industry Employment and Location Quotients
Washington and Other States, 2018

State	Annual Establishments	Annual Avg Employment	Total Annual Wages	Avg Annual Wages	Employment LQ	Wage LQ
U.S. TOTAL	**3,274**	**503,765**	**$52,351,530,720**	**$103,920**	**1.00**	**1.00**
Washington	199	83,879	10,036,142,294	119,650	7.21	7.19
Kansas	160	31,438	2,508,214,851	79,782	6.59	6.22
Connecticut	143	30,588	3,486,437,166	113,981	5.30	4.91
Arizona	123	28,112	2,979,231,526	105,978	2.89	3.25
Oklahoma	67	13,004	1,150,233,502	88,454	2.35	2.45
Alabama	72	12,376	1,150,131,234	92,934	1.83	1.98
Missouri	45	16,127	1,904,307,836	118,080	1.67	2.22
Utah	69	7,332	589,102,956	80,349	1.44	1.31
Georgia	104	21,255	2,074,587,837	97,607	1.39	1.4
California	611	75,662	8,388,999,521	110,875	1.26	1.13
Vermont	10	1,262	104,290,816	82,634	1.18	1.13
Texas	226	46,060	4,986,860,783	108,269	1.09	1.12
Ohio	133	19,238	1,923,588,350	99,989	1.03	1.12
South Carolina	41	7,178	670,176,531	93,363	1.00	1.15
West Virginia	8	2,208	177,262,858	80,297	0.92	0.89
Massachusetts	30	10,356	1,395,161,178	134,724	0.84	0.86
Colorado	37	7,568	1,020,649,047	134,870	0.82	1.04
Florida	367	23,152	2,257,288,754	97,497	0.77	0.83
Arkansas	24	2,997	182,285,573	60,828	0.72	0.55
Indiana	45	6,323	585,926,714	92,672	0.60	0.64

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages

As seen in Figure 2, Washington's 2015 Employment LQ was 7.21 – down from 8.76 in 2015. That means the share of aerospace employment in Washington was over seven times larger than the aerospace share nationally. While Kansas, the state with the next highest LQ, isn't too far behind, Washington's actual aerospace employment was about three times as high. Washington also had the highest wage location quotient (which shows the relative size of wages earned compared to all sectors) at 7.19.

Occupational Composition

The majority of aerospace positions in Washington were concentrated in production (33.3 percent) or architecture and engineering (20.1 percent). Business/financial operations (16.5 percent) followed by installation/maintenance/repair (8.9 percent) occupations round out the state's top aerospace occupational groups. Overall, these occupations account for approximately 70 percent of industry employment.

Figure 3: Aerospace Core Industry Occupational Composition
Washington, 2nd Quarter 2018

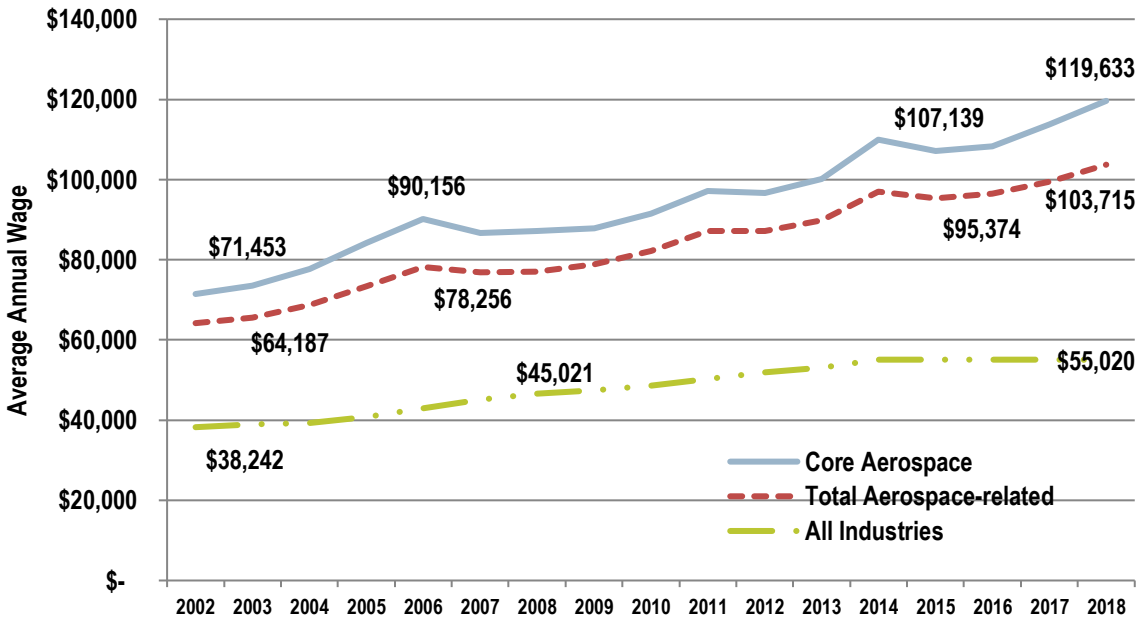
Major Occupation Group	% of Total Aerospace Employment	2018-2nd Quarter Employment
Production	33.3%	27,638
Architecture and Engineering	20.1%	16,666
Business and Financial Operations	16.5%	13,707
Installation, Maintenance, and Repair	8.9%	7,422
Subtotal	**69.7%**	**65,433**
Computer and Mathematical	6.6%	5,447
Office and Administrative Support	5.1%	4,202
Management	4.6%	3,783
Transportation and Material Moving	2.1%	1,756
All other major occupation groups	2.9%	2,385
Total	**100.0%**	**93,909**

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages
Occupations from NAICS 3364 industry group: aerospace product and parts manufacturing

Wages

Average annual wages earned by aerospace workers (see Figure 4) continue to significantly outpace the overall average wages of all Washington workers. In 2002, average aerospace wages were 87 percent higher than the average wage across all industries. By 2018, core aerospace wages were more than double that of the average wage across all industries ($119,633 compared to $55,020).

Figure 4: Annual Wage Trends for Aerospace and All Industries
2001-2018, Washington



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages

The following chart (Figure 5) shows the highest and lowest paying industries within the aerospace and related industries. The non-scheduled air transportation sub-sector was the highest paying, with employees earning $131,771 on average. However, there were only 85 employees. Aircraft manufacturing was the highest paying sub-sector with significant employment, averaging $129,798 among 68,416 employees. At the other end of the scale the "other airport operations" included 3,452 employees who earned on average $32,688 in 2018.

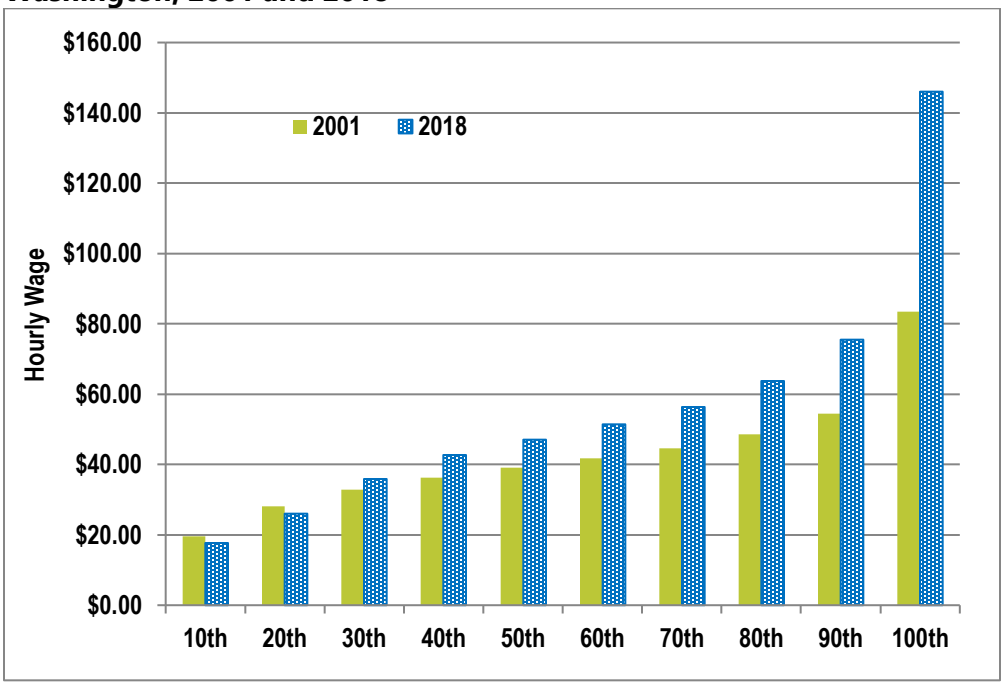
Figure 5: Highest and Lowest Paying Aerospace Industries
Washington, 2018

6-digit NAICS	Industry description	Total 2018 wages paid	Average annual employment	Average annual quarterly wage	Average weekly wage
481219	Other nonscheduled air transportation	$11,148,902	85	$131,771	$2,534
336411	Aircraft manufacturing	$8,880,196,248	68,416	$129,798	$2,496
481112	Scheduled freight air transportation	$14,582,665	137	$106,346	$2,045
334515	Electricity and signal testing instruments	$209,069,677	1,977	$105,751	$2,034
927110	Space research and technology	$303,480	3	$101,160	$1,945
333618	Other engine equipment manufacturing	$1,351,186	14	$101,153	$1,945
334511	Search, detection, and navigation instruments	$182,038,183	1,858	$97,997	$1,885
333517	Machine tool manufacturing	$118,224,032	1,228	$96,256	$1,851
481111	Scheduled passenger air transportation	$1,323,484,766	14,812	$89,398	$1,719
481211	Nonscheduled air passenger chartering	$24,058,021	279	$86,229	$1,658
333613	Mechanical power transmission equipment manufacturing	$3,883,096	62	$62,592	$1,204
334417	Electronic connector manufacturing	$17,604,435	319	$55,186	$1,061
332710	Machine shops	$270,450,681	4,960	$54,558	$1,049
332999	Miscellaneous fabricated metal product manufacturing	$37,787,148	772	$48,971	$942
332813	Electroplating, anodizing, and coloring metal	$46,172,304	952	$48,547	$934
334418	Printed circuit assembly manufacturing	$39,251,225	903	$43,468	$836
611512	Flight training	$16,150,486	403	$40,010	$769
325211	Plastics material and resin manufacturing	$28,202,996	721	$39,116	$752
333612	Speed changer, drive, and gear manufacturing	$4,275,603	117	$36,519	$702
488119	Other airport operations	$112,945,107	3,452	$32,688	$629

Source: Bureau of Labor Statistics, Quarterly Census of Employment and Wages

The difference between average total wages vs. how much people earned per hour can be further clarified by looking at wage deciles—a way of looking at how wages are distributed by putting earners into 10 different groups based on hourly wages. For example, this allows one to compare the 10 percent lowest wage earners against the highest 10 percent of earners. Figure 6 shows not only how hourly wages vary significantly across the wage spectrum but have diverged even more in recent years. The bottom two deciles saw real wages fall between 2001 and 2018, while wages among higher earning workers rose, with the largest gains going to the top 10 percent.

Figure 6: Wage Trends for Aerospace Workers across Wage Groups Washington, 2001 and 2018



Source: Washington's Employment Security Department

There is consensus that the core aerospace industry is likely to see some declines in net employment. At the same time, it is likely that wages will continue rising and the remaining jobs will require more education and be higher paying. Workers with stronger math and analytical skills will be needed to operate increasingly sophisticated manufacturing systems. These positions will continue to be hard to fill unless the workforce is more highly educated.

Employment Forecasts

Prior to COVID-19, the Washington State Economic and Revenue Forecast Council forecasts very small net job gains in the aerospace industry for 2020, then employment flattening out through 2023.[4] This is driven by rising worldwide demand with offsetting productivity growth. In the near term, a shutdown of the 737 program or further curtailment of production could result in temporary layoffs. It's expected that production be ramped up quickly once Boeing receives regulatory approval. Of course, COVID-19 has changed everything and has driven down demand significantly for aerospace products.

[4] https://erfc.wa.gov/sites/default/files/public/documents/forecasts/t0919.pdf

"The disruption of airline travel is expected to reduce demand for new aircraft for some time. Boeing has indicated that there will be significant reductions in employment, particularly in the commercial airplane division. As of July, Washington aerospace employment had already declined by 6,300 since April when Boeing first announced major job cuts, according to the state's Economic and Revenue Forecast Council. The Council projects a decline of another 9,300 aerospace employees by the end of the year. The forecast makes no assumption concerning a possible consolidation of 787 production in South Carolina.

Forecasts, of course, are attempts to predict the future and subject to varying levels of success. This is especially true for Washington's aerospace industry, which is largely dominated by one firm whose outcomes can have more influence than that of wider economic conditions. It should also be noted that the projected job declines are net figures. Given the graying of the workforce and normal industry churn, both turnover and retirements will drive a number of openings.

Boeing employs nearly 71,700 people in Washington state and more than 31,500 of those people are in the manufacturing and quality organizations. Boeing's retirement eligibility age is 55 years of age. The average Boeing employee retires at age 61. However, they see spikes at ages 55, 60 and 62. Approximately 31 percent of Boeing's current employees are eligible to retire. Last year, Boeing's retirement rate was about 2.7 percent. It is possible that they may see a modest increase in those electing to retire due to the average age of Washington's workforce. Boeing continues to seek skilled aerospace workers to ensure competitiveness and is especially interested in the following skill areas:

Assembler Installer General B
Assembler Installer Structures B
Aircraft Test Technician A
Aviation Maintenance Technician and Inspector - Flight Test
Tool Maker C
Electronic Technician Precision Machine Tool Maintenance
Machine Repair Mechanic A

Figure 7: Washington State Employment Projections, Aerospace and Selected Manufacturing Industries, 2018-28

Industry	Estimated employment			Average annual growth rate	
	2018	2023	2028	2017-2022	2022-2027
TOTAL NONFARM	3,402,200	3,676,200	3,896,900	1.6%	1.2%
MANUFACTURING	286,800	296,900	302,100	0.7%	0.3%
Durable Goods	201,200	207,900	209,600	0.7%	0.2%
Wood Product Manufacturing	12,900	12,700	12,200	-0.3%	-0.8%
Nonmetallic Mineral Product Manufacturing	9,400	9,600	9,800	0.4%	0.4%
Primary Metal Manufacturing	5,100	5,100	5,100	0.0%	0.0%
Fabricated Metal Product Manufacturing	20,900	22,100	23,000	1.1%	0.8%
Machinery Manufacturing	15,900	16,300	16,700	0.5%	0.5%
Computer and Electronic Product Manufacturing	19,800	19,800	19,700	0.0%	-0.1%
Electrical Equipment and Appliance Mfg	5,100	5,200	5,500	0.4%	1.1%
Aerospace Product and Parts Manufacturing	**83,900**	**88,700**	**88,700**	**1.1%**	**0.0%**
Other Transportation Equipment	9,700	9,600	9,500	-0.2%	-0.2%

Source: Washington's Employment Security Department, Long-term Industry Employment Projections

EDUCATION AND TRAINING

The aerospace industry plays a significant role in the nation's economy. It's an even more dominant player in Washington, where it is a key industry. Undoubtedly, meeting the workforce needs of the aerospace industry is important to the economic vitality of the state, as well as the economic wellbeing of Washington residents and their families. After all, not only are aerospace jobs relatively abundant, the majority of these jobs pay well. However, most require a variety of industry-specific skills and changing technology is calling for higher levels of training.

To meet these training needs, education programs have grown over the past few years. This expansion in training programs is increasingly critical to the industry as Washington's workforce ages and a greater percentage of workers reach retirement age each year. The state's education and training system continues to face increasing pressure to provide a fresh supply of skilled workers.

Washington has responded to this challenge by investing in several aerospace-focused training programs:

- *The Aerospace Joint Apprenticeship Committee* or AJAC, is a statewide, registered apprenticeship program which combines supervised on-the-job training with college-level classroom instruction.
- *The Washington Aerospace Training & Research* (WATR) *Center* at Edmonds Community College offers short-term aerospace training based at Paine Field in Everett.
- Washington's community and technical colleges have continued to invest in aerospace training, expanding programs, and updating curriculum and equipment, to meet industry needs.

This report analyzes training activities, employment, and annual earnings of state-funded efforts in Washington.

Aerospace Apprenticeship Programs

Aerospace apprenticeship combines supervised on-the-job training with college-credited classroom instruction, known as related supplemental instruction (RSI). The following section analyzes aerospace apprenticeship dynamics and enrollments of the Aerospace Joint Apprenticeship Committee (AJAC) for the program year 2018-19. AJAC is a 501c3 whose board and committee are half business and half labor representatives in an industry not highly represented. AJAC has seen two industry apprenticeship programs established in the 1940s merge with AJAC (Tacoma Machinist and Seattle Machinist) as they struggled with the traditional employer-funded model of apprenticeship training. AJAC also partners with Boeing's Joint Programs to provide RSI training in four courses to Boeing Joint Program apprentices helping to ensure continued apprenticeship training for the aerospace and advanced manufacturing industries.

AJAC works with employers and their incumbent workforce to provide registered apprenticeship programs which are employer driven by occupation and location and are open to all Washington aerospace and advanced manufacturing employers. AJAC instructors are hired from industry to ensure that training reflects current industry needs and technologies and serve as subject matter experts when developing and revising employer driven curriculum.

AJAC partners with local community and technical colleges, employers, school districts, high schools and Skills Centers, as well as regional Workforce Development Councils and community-based organizations, to also provide pre-apprenticeship training and youth apprenticeship in an effort to supply industry with a pipeline of diverse, entry-level skilled workers.

In helping to ensure multiple pipelines into industry, AJAC has been approved by the Washington State Apprenticeship Training Council to provide youth apprenticeship programs in partnership with Washington's high schools. AJAC is also looking to expand these programs to Out of School Youth by 2020. In addition to the wide range of benefits of adult apprenticeship, youth apprentices receive dual high school and college credits. Youth have the option of completing and/or transferring into adult apprenticeship programs and currently receive credit towards five of AJAC adult programs. Students who complete the training earn 15 college credits, have at least 2,000 hours of supervised on-the-job training from an industry expert making real world parts for industry, and earn a nationally recognized, portable certificate.

AJAC offers Washington employers the opportunity to:

- "Grow their own" workforce by tapping into the knowledge and skills of their most experienced craftspeople and transfer expertise to the "new" generation of employees prior to retirements.
- Increase productivity and retention while reducing spending on hiring and training new workers.

AJAC offers apprentices the opportunity to:

- Earn while they learn on the job and in the classroom.
- Earn college credit at a reduced rate.
- Embark on an educational pathway which can lead to an associate degree with no college debt upon completion.
- Earn a nationally recognized industry certification upon completion.
- Earn on average over $300,000 more than non-apprentices over a lifetime.[5]

AJAC Apprenticeship Completions and Outcomes:

- A total of 537 apprentices participated during the 2018-19 program year.
- There were 411 active apprentices at the end of 2018-19 program year.
- 379 completers since the first graduating class in 2012
- 274 partnering employer Training Agents with 31 new TAs during this time period.
- 15 partnering School Districts
- 11 partnering Community and Technical colleges

Currently, AJAC maintains 11 active apprenticeships programs with two being occupations specific to youth. Of the participants in these apprenticeships, 57 percent are Machinist, Machinist (Aircraft Oriented), 5 percent are Tool and Die Makers; 15 percent are Industrial Maintenance/Automation Technicians; 2 percent are Precision Metal Fabrication Technicians, 5 percent are Industrial Manufacturing Technicians, 1 percent are Plastic Process Technicians, 14 percent are Production

[5] This is for all apprentices, not strictly aerospace apprentices. http://wtb.wa.gov/Documents/Apprenticeship2015.pdf

Technician (Youth) and 1 percent are Maintanance/Automation Technician (Youth) There were two new programs approved in 2018-19 beginning in 2019-20 calendar which are CNC Programmer and Automation Technician (Youth).

- Within the nine occupations (excluding the youth programs), participants take an average of nearly three and a half years (41 months) to complete. (One apprenticeship requires a five-year commitment, four require a four-year commitment; two require a three-year commitment; one requires a two-year commitment one requires an 18-month commitment).
- The skills required in the available occupations cross multiple industries. As a result, AJAC works under the umbrella of advanced manufacturing with employers primarily in the aerospace industry and includes other industries such as biomedical, food processing, manufacturing and in the future will be working with employers in the agriculture and space industries.

Figure 8: Snapshot of Aerospace Apprenticeship Program Completions Washington, 2016-17

Program	Did Not Complete	Completer	% Employed
Aerospace JAC	51	45	84%
IAM/Boeing JAC	2	19	95%
Seattle Machinists Apprenticeship	3	6	89%
Total All Programs	**56**	**70**	**87%**
For All 2014-2015 Program Completers			
Median months to completion			48
Median annual wage (adjusted 2018 q1)			$70,035
Median quarterly hours			538

Source: Washington Department of Labor and Industries

A total of 70 people completed an aerospace apprenticeship in program year 2016-17. Of that number, AJAC trained 45 individuals, IAM/Boeing JAC trained 19, and the Seattle Machinists Apprenticeship program trained six. Overall, 87 percent of those that enrolled in these programs became employed.

Median annual wages for those who obtained full-time work was $70,035, (the lowest 25 percent earned $57,762 and the highest 25 percent earned $101,183). In 2016-17, apprenticeship completers clocked a median 538 hours per quarter, up a little from the median full-time 511 hours clocked two years prior.

Figure 9: Aerospace Occupational Openings and Program Completers

Occupation	Employment 2018Q2	% in Aerospace	Avg Ann Openings 2022-2027	Completions		Typical Education Level	Typical On-the-job training (OJT)
				Average 2014-2018	2018		
Aircraft Structure, Surfaces, Rigging, & Sys. Assemblers	11,837	97%	1,178	261	208	High school diploma	Moderate-term OJT
Aerospace Engineers	6,859	67%	424	413	451	Bachelor's degree	None
Tool and Die Makers	1,964	78%	181	94	101	High school diploma	Long-term OJT
Aircraft Mechanics and Service Technicians	5,801	62%	493	129	103	Postsecondary nondegree	None
Logisticians	6,599	57%	753	21	25	Bachelor's degree	None
Industrial Engineering Technicians	1,818	80%	152	1162	909	Associate's degree	None
Avionics Technicians	2,466	73%	234	1	3	Associate's degree	None
Industrial Engineers	7,539	51%	754	31	33	Bachelor's degree	None
Inspectors, Testers, Sorters, Samplers, and Weighers	12,062	35%	1,524	9		High school diploma	Moderate-term OJT
Computer-Controlled Machine Tool Operators	1,853	60%	187	87	115	High school diploma	Moderate-term OJT
Materials Engineers	1,006	74%	80	9	11	Bachelor's degree	None
Mechanical Drafters	2,243	44%	204	240	223	Associate's degree	None
Machinists	10,585	21%	1,223	226	201	High school diploma	Long-term OJT
Electrical Engineers	6,094	25%	477	146	158	Bachelor's degree	None
Production, Planning, and Expediting Clerks	11,008	21%	1,347	47	39	High school diploma	Moderate-term OJT
Operations Research Analysts	3,201	31%	370	3	3	Bachelor's degree	None
Buyers and Purchasing Agents	16,695	18%	1,930			n\a	n\a
Painters, Transportation Equipment	2,474	34%	317	54	42	High school diploma	Moderate-term OJT
Architectural and Engineering Managers	4,709	22%	399	898	941	Bachelor's degree	None
Fiberglass Laminators and Fabricators	1,290	39%	139			High school diploma	Moderate-term OJT
Electrical and Electronics Drafters	893	45%	79	81	78	Associate's degree	None
Industrial Production Managers	2,891	24%	229	174	192	Bachelor's degree	None
CNC Machine Tool Programmers	328	76%	33	15	20	High school diploma	Long-term OJT
Supervisors of Production and Operating Workers	15,893	12%	1,680	52	61	High school diploma	None
Mechanical Engineers	8,313	15%	733	224	248	Bachelor's degree	None

Source: U.S. Bureau of Labor Statistics and the Integrated Postsecondary Education Data System (IPEDS), 2018

Unlike years past, this year's Aerospace Pipeline Report does not include a survey component. Previous reports included a survey to aerospace industry employers to get an on-the-ground look at whether the state is meeting the need for trained workers. The survey was not conducted this time around due to limited resources and time constraints. As an alternative, the above table provides estimates for annual openings and program completers for Washington's top aerospace occupations.

Note for example from Table 9 that aircraft structure assembles were the top aerospace occupation. This is based on a combined ranking of overall employment in the industry and percent of the occupation working in the industry. Aircraft structure assemblers was not the largest occupation in aerospace (buyers and purchasing agents had more), but it had a large number as well as the highest percent working in the industry (97%). There will be an estimated 1,178 annual openings for this occupation in the near future, but in 2018 there were only 208 program completers according to the IPEDS data.[6] However, one should be careful in interpreting this data – IPEDS data only includes post-secondary institutions that participate in the federal Title IV student financial assistance programs. In the case of assemblers, the typical education level is "high school diploma or equivalent," meaning that the IPEDS data, in all likelihood, would not count all of the relevant supply.

Like assemblers, the biggest under-supplies occur for those with typical education of high school diploma: supervisors, production clerks, and machinists. That said, most of the other aerospace occupation have an under-supply of program completers compared to openings. Of note are mechanical engineers (485), aircraft mechanics (390), and avionics technicians (231). The over-supply of completers would be industrial engineers and architectural/engineering managers.

[6] https://nces.ed.gov/ipeds/

Aerospace Manufacturing Skills: Community and Technical College Enrollment and Outcome

The Aerospace and Advanced Materials Manufacturing Pipeline Advisory Committee provides periodic reports on the supply, demand, and outcomes for Washington's aerospace training programs. Washington's community and technical colleges (CTCs) play a critical role in preparing skilled employees in this important sector of our state's economy. This brief examines enrollment and outcomes in key academic programs (based on Classification of Instructional Program, or CIP, codes) identified by the Pipeline Committee for inclusion in its next report (see Table 1).

Figure 10: CIPs identified by the Pipeline Committee

Program	CIP Code(s)
Aircraft/Frame/Powerplant Mechanic	470687
Aircraft/Frame/Powerplant Mechanic	470607
Draft & design tech, genl	151301
Engineering tech, genl	150000
Machine tool tech	480501
Plastics engineer tech	150607

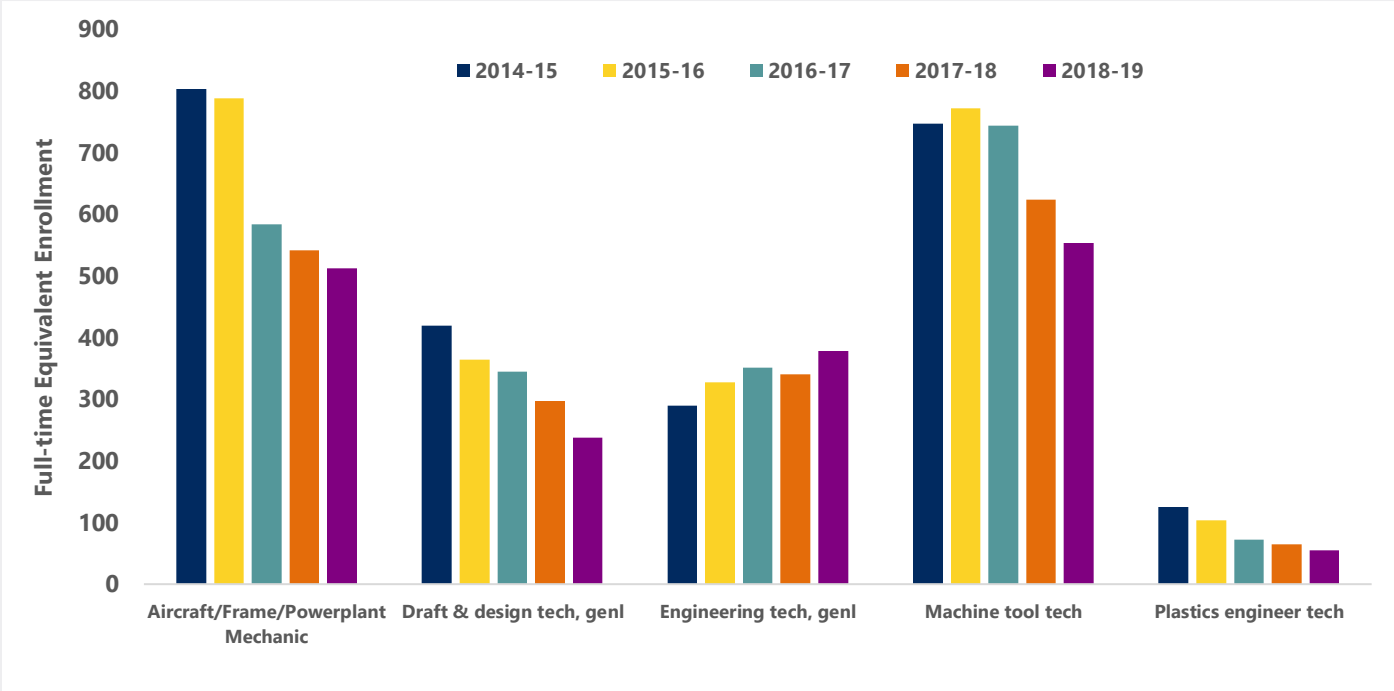
Source: State Board for Community and Technical Colleges

In addition to enrollment figures, this brief evaluates wage and earnings data for those who exit the CTC system, comparing wages between those working in an identified aerospace industry with those outside the industry. Finally, the brief summarizes enrollment and outcomes for the Washington Aerospace Training & Research (WATR) Center at Edmonds Community College.

Enrollment Trends

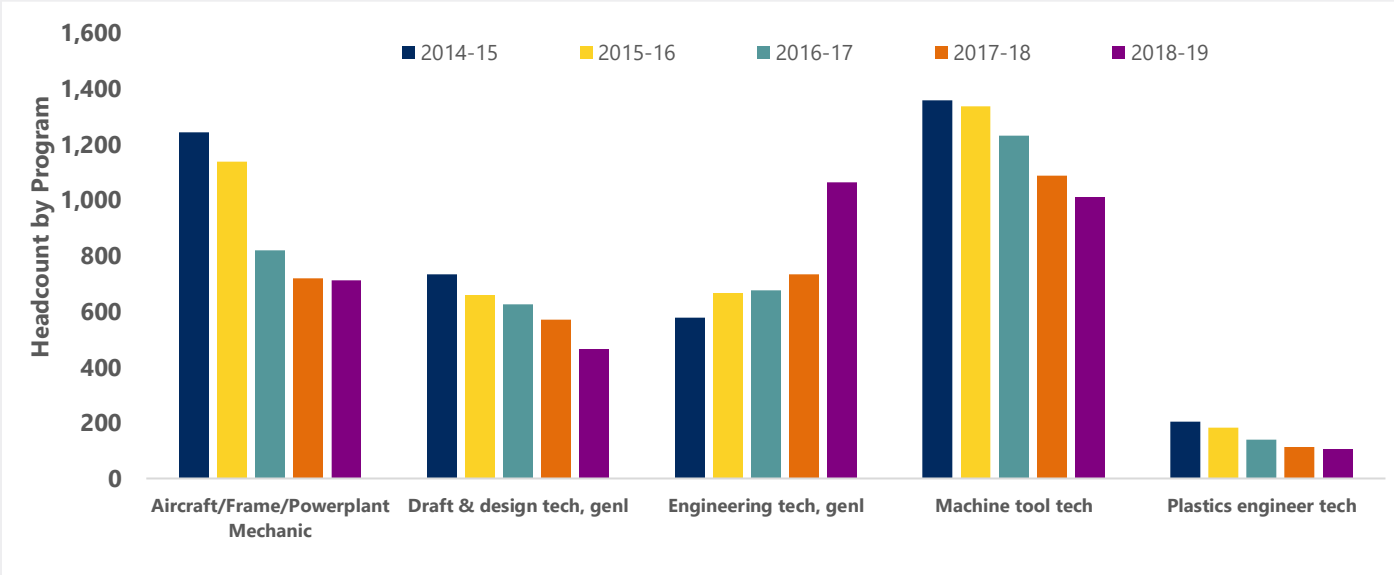
All programs, with the exception of one — Engineering Tech — experienced declining full-time equivalent (FTE) enrollment and headcounts over the last five years. FTE enrollment was down 27 percent and headcounts were down 18 percent since academic year 2014-15 (see Figures 1 and 2).

Figure 11: FTE by Program



Source: State Board for Community and Technical Colleges

Figure 12: Headcount by Program



Source: State Board for Community and Technical Colleges

The first two digits of the CIP code represent the "CIP area," the most general grouping of like programs. Because of the limited scope of this brief in examining six CIP codes, research staff questioned whether broadening the criteria to evaluate enrollment patterns by CIP area would yield similar results.

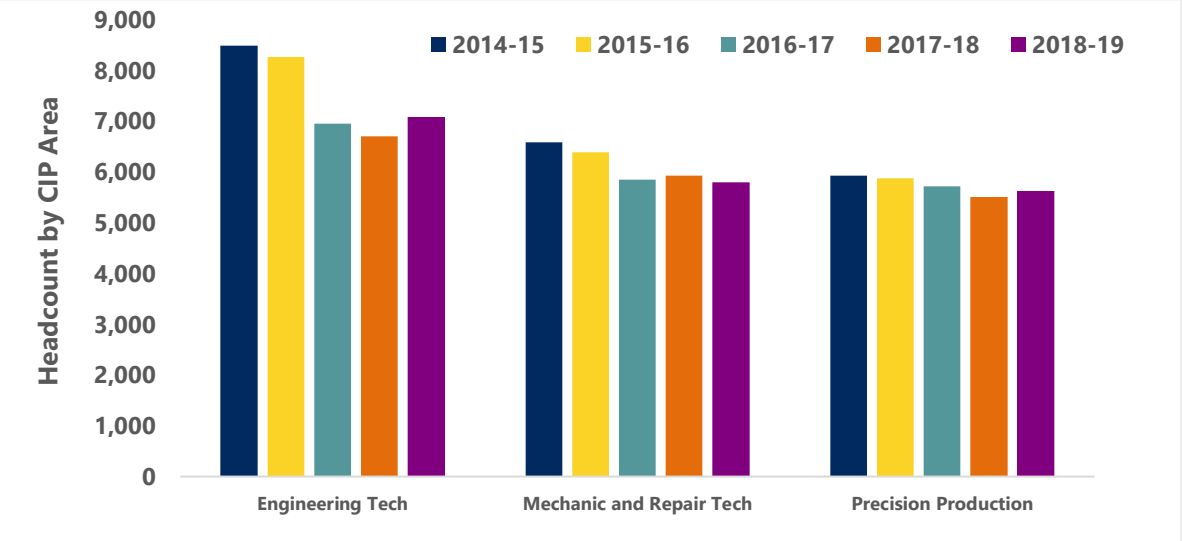
Figure 13: CIP area by CIP code

Program	CIP Area
Aircraft/Frame/Powerplant Mechanic	Mechanic and Repair Tech
Draft & design tech, genl	Engineering Tech
Engineering tech, genl	Engineering Tech
Machine tool tech	Precision Production
Plastics engineer tech	Engineering Tech

Source: State Board for Community and Technical Colleges

As shown in Figure 3, a similar downward trend exists for these programs' CIP areas, though the trend is smoothed by the volume of students. Again, the program "Engineering tech, genl" stands out with its positive enrollment trend despite decreasing enrollment in its CIP area. The overall decline in enrollment in both program and CIP area is consistent with both CTC system-wide and general higher education drops in enrollment, both in Washington and across the country.

Figure 14: Headcount by CIP Area for Comparison



Source: State Board for Community and Technical Colleges

1,000 FTEs

Engrossed House Bill 2088, enacted in November 2013, provided additional funding to CTCs to increase high-demand aerospace enrollments by an additional 1,000 FTEs. The Washington State Board for Community and Technical Colleges (SBCTC) tracks such enrollments to ensure colleges are meeting their targets. If colleges meet or exceed targets over time for a particular program, the FTE are permanently awarded to that college program. As of the 2018-19 academic year, SBCTC is monitoring 22 aerospace-related programs across 15 colleges (see Appendix I).

Figure 15. Headcount and FTE tracked for 1,000 FTE awards

College	Annual FTE	Annual Headcount
Bates	95.4	121
Bellingham	105.2	125
Big Bend	22.2	31
Clark	47.1	74
Clover Park	1.3	2
Everett	466.7	792
Green River	92.7	161
Lake Washington	107.7	197
Olympic	74.4	152
Peninsula	13.1	13
Renton	32.9	51
Seattle North	100.3	198
Seattle South	164.0	214
Tacoma	238.6	441
Whatcom	113.5	219
Total	**1,675.1**	**2,791**

Source: State Board for Community and Technical Colleges

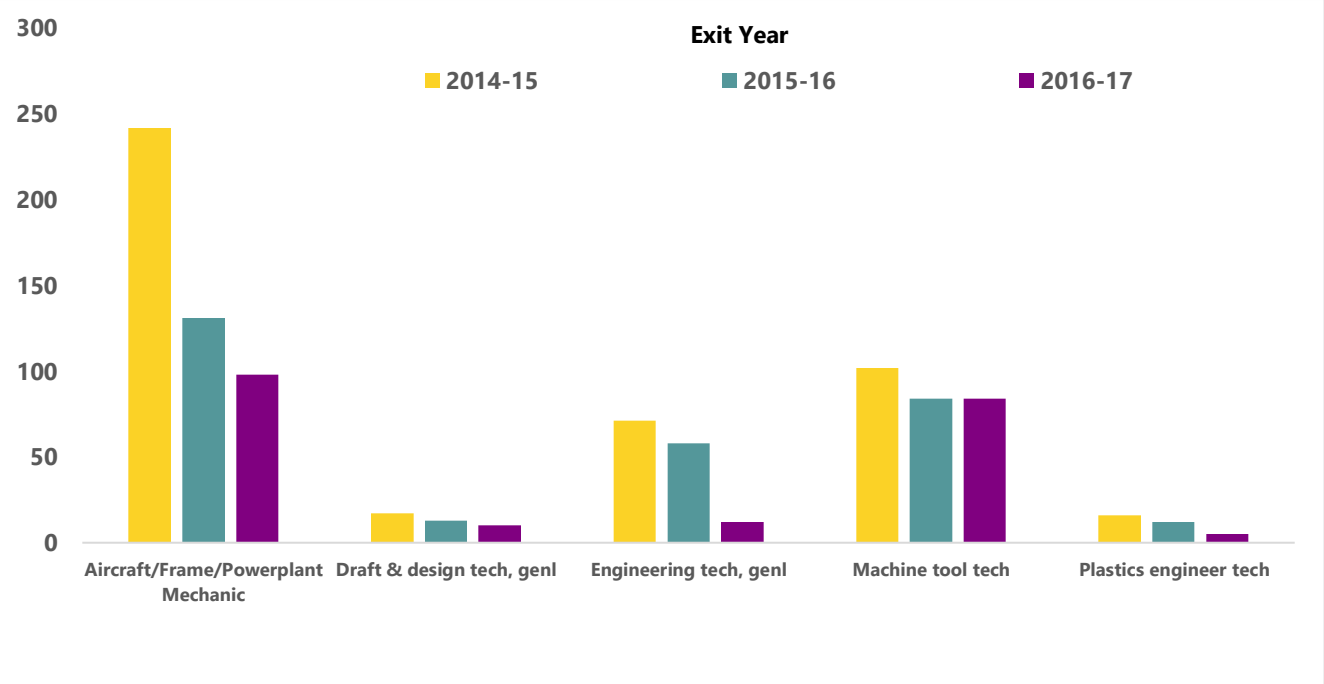
Employment Outcomes[7]

The Pipeline Committee report also discusses employment outcomes of those who exit the CTC system, defined as those who were not enrolled in the system for at least a year whether they completed a credential or not. Employment outcomes are measured three quarters after exit and categorized by whether the student's employer is in the aerospace industry or not (Appendix II). It's important to note that an employer's industry does not necessarily reflect the employee's job at a particular company or organization (e.g. a computer programmer at Starbucks Corporation would be classified under an accommodation and food service industry code).

The number of former students employed at aerospace industry employers has declined by more than half in the last three years, from a total of 448 exiting in 2014-15 to 209 exiting in 2016-17 (Figure 4). Meanwhile employment in non-aerospace-related industries is mixed. Total employment in non-aerospace industries increased sharply for those exiting in 2015-16 to 853 from 665 the prior year, but dropped down to 568 for students exiting in 2016-17. Overall, more students in these programs are employed in non-aerospace industries across all years.

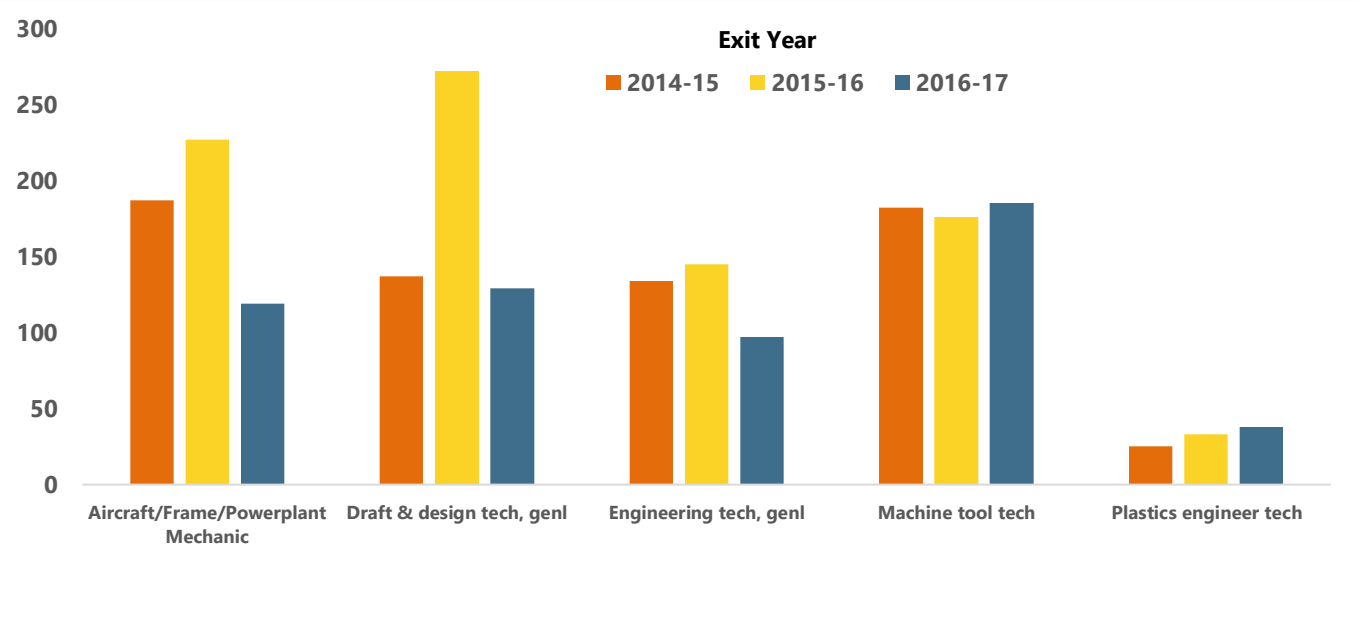
[7] Datapoints in which N<10 have been suppressed in all employment-related data.

Figure 15: Employment in aerospace industry



Source: State Board for Community and Technical Colleges

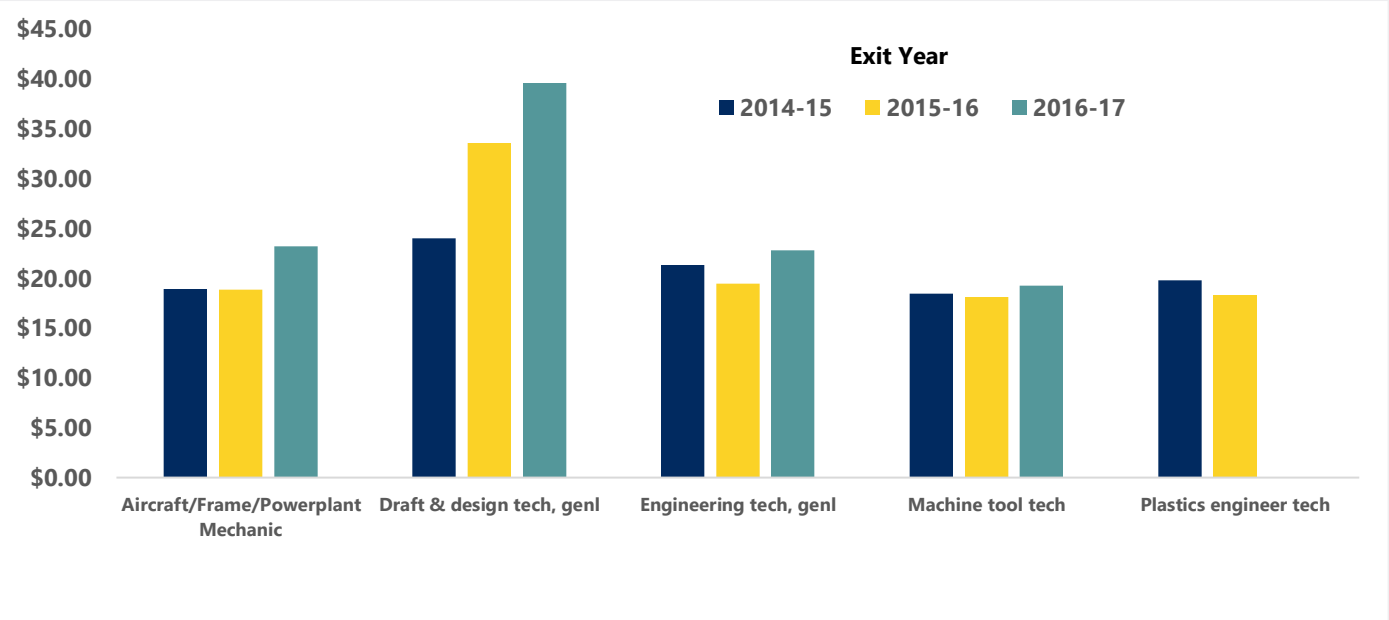
Figure 16: Employment in non-aerospace industries



Source: State Board for Community and Technical Colleges

Median wages among those employed in the aerospace industry, adjusted for inflation to the first quarter of 2018, saw modest improvements over the most recently available three years. Draft & design tech experienced an uptick in wages; however, the small N-size (as shown in Figure 4) for this program likely caused the increase.

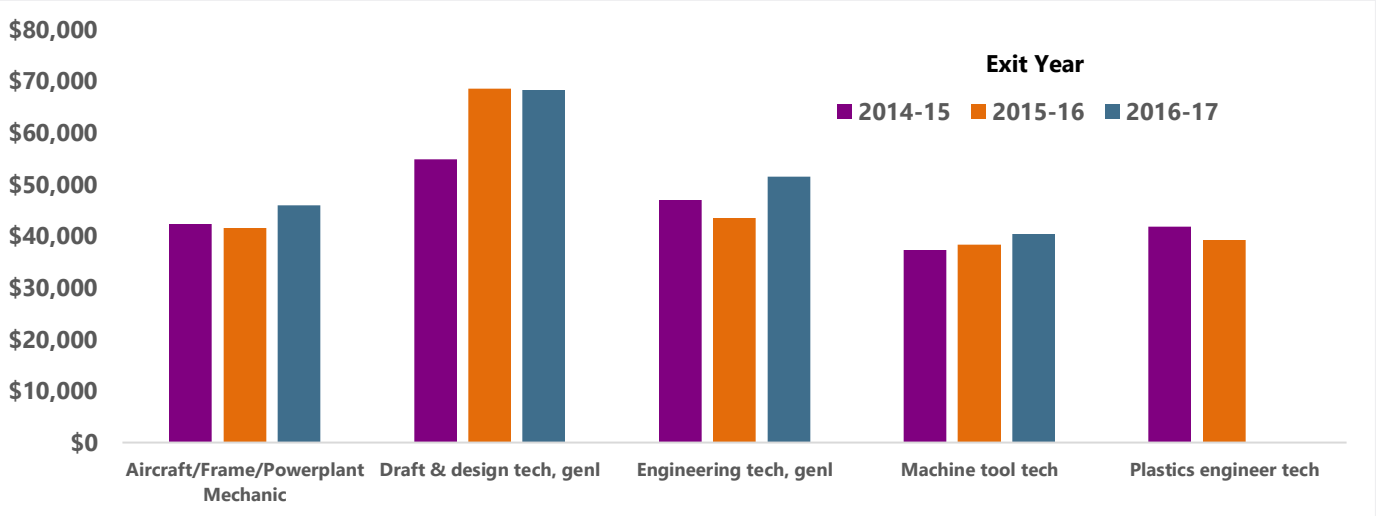
Figure 17: Median aerospace industry wages



Source: State Board for Community and Technical Colleges

Median Earnings tell a similar story in the aerospace industry, with slight improvement in most programs.

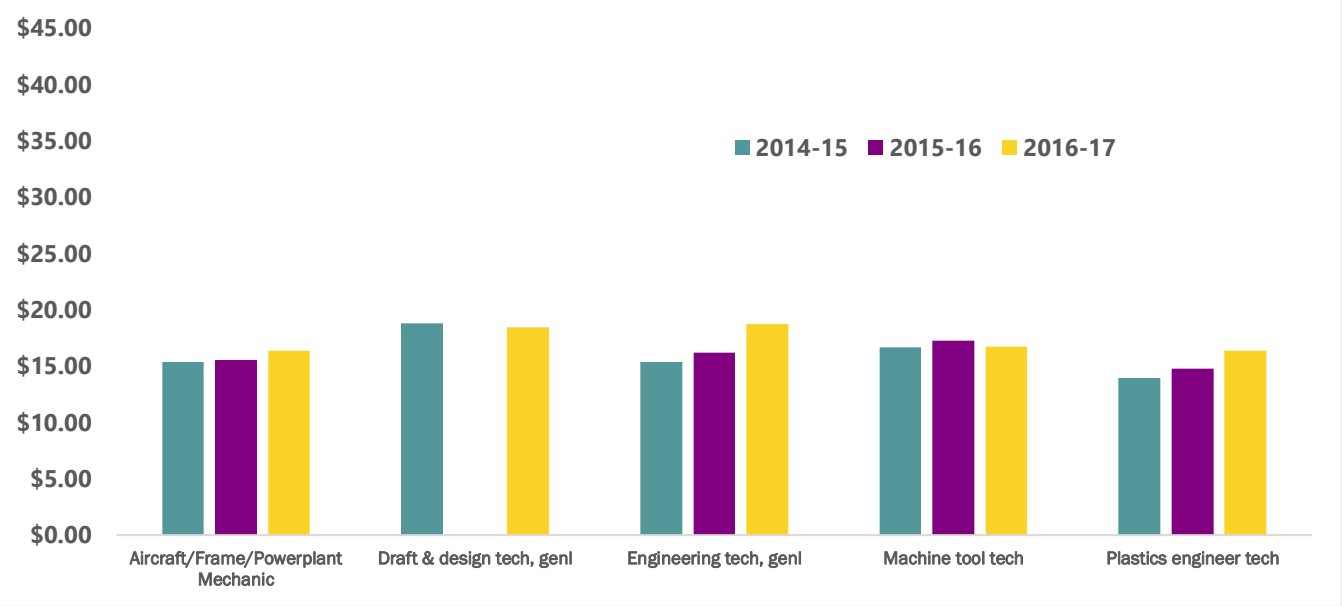
Figure 18: Median aerospace industry earnings



Source: State Board for Community and Technical Colleges

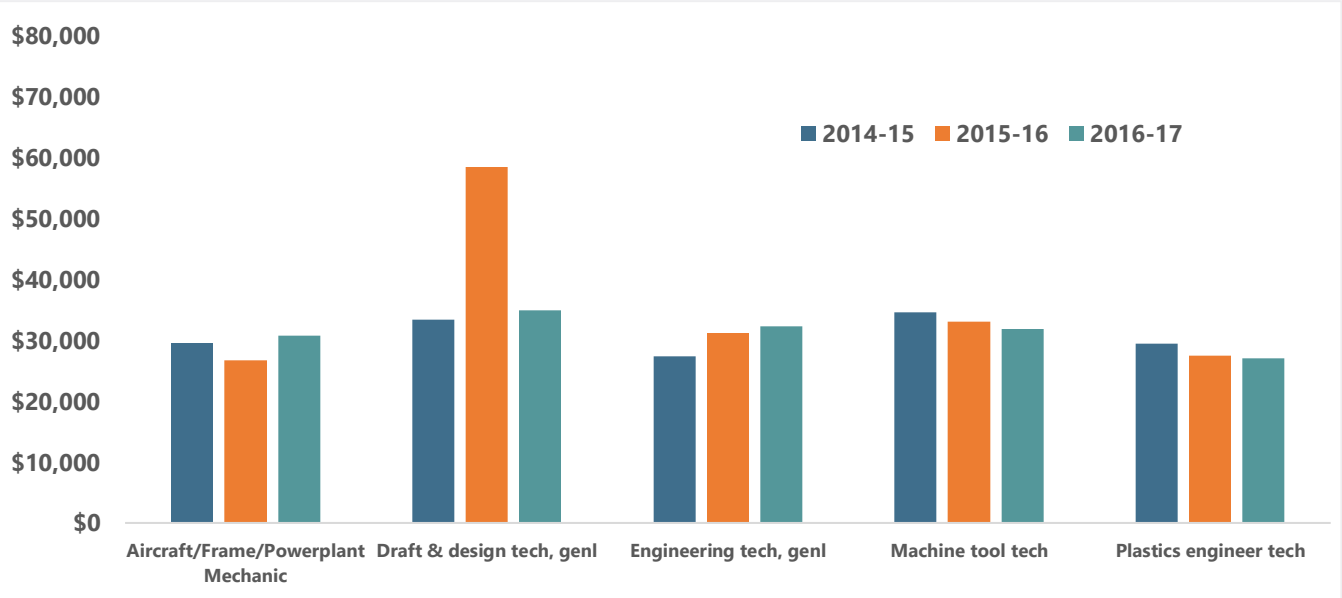
Meanwhile, wages and earnings among those in non-aerospace industries were mostly flat and declined in some cases.

Figure 19: Median non-aerospace industry wages



Source: State Board for Community and Technical Colleges

Figure 20: Median non-aerospace industry earnings



Source: State Board for Community and Technical Colleges

In general, students who exit one of these programs and gain employment in the aerospace industry enjoy higher earnings and wages compared with those in non-aerospace industries.

Figure 21: Median wages across all programs by industry

Year	2014-15	2015-16	2016-17
Aerospace Industry	$19.05	$18.73	$20.60
Non-Aerospace Industry	$16.08	$15.25	$17.37
Difference	$2.97	$3.48	$3.23

Source: State Board for Community and Technical Colleges

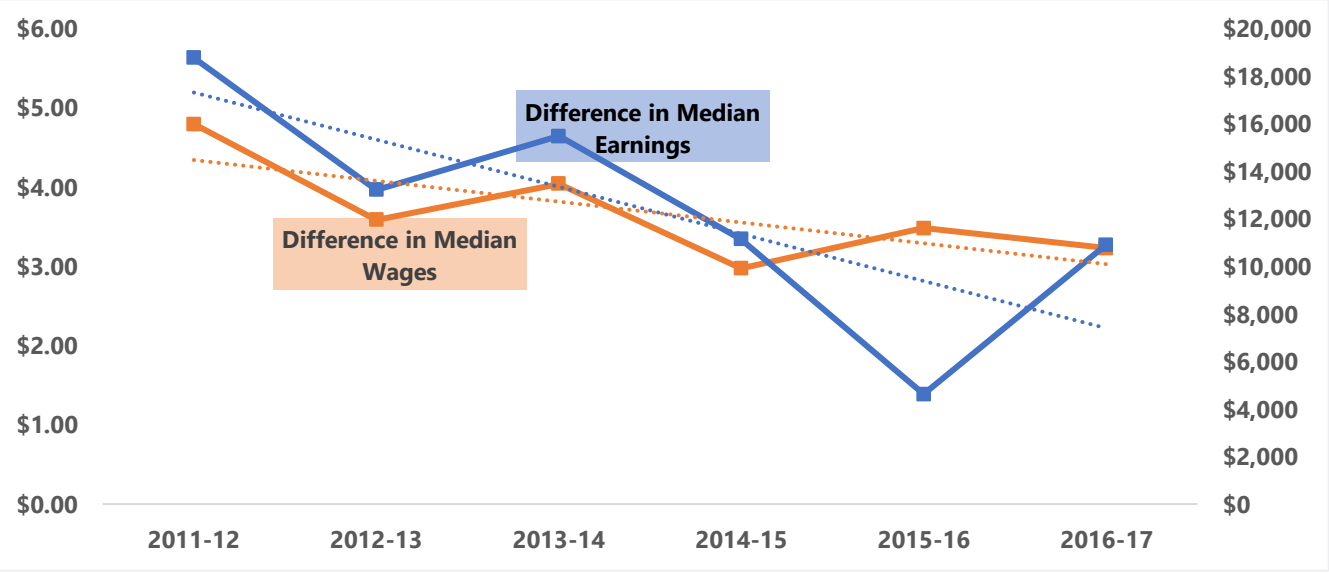
Figure 22: Median earnings across all programs by industry

Year	2014-15	2015-16	2016-17
Aerospace Industry	$42,332	$40,375	$42,991
Non-Aerospace Industry	$31,187	$35,749	$32,080
Difference	$11,145	$4,627	$10,910

Source: State Board for Community and Technical Colleges

Taking a broader view of the wage and earnings advantage experienced by those in the aerospace industry, however, points to a shrinking gap over the last six years (see Figure 10). For example, those employed in the aerospace industry who exited the CTC system in 2011-12 earned median wages nearly $5.00 higher than those in non-aerospace industries. For those who exited in 2016-17, the gap narrowed to just over $3.00. This may explain why employment in the aerospace industry among participants in these aerospace programs is not growing, as discussed earlier and illustrated in Figures 4 and 5.

Figure 23: The shrinking gap in wages between aerospace and non-aerospace industry wages and earnings



Source: State Board for Community and Technical Colleges

Washington Aerospace Training and Research Center[8]

The Washington Aerospace Training and Research Center (WATR) at Edmonds Community College opened in 2010 and provides short-term job skills training designed to prepare students "for high-paying jobs in the shortest possible amount of time."[9]

With the exception of 2015-16, the high-water mark year, annualized FTE enrollment at the WATR center since the implementation of the new coding has hovered around 100 FTE and headcounts of about 250 students over the last three years.

Figure 21: WATR Center FTE

Program	2015-16	2016-17	2017-18	2018-19
Aircraft elect fab & instl	15.6	8.6	13.3	19.6
Airframe mech & aircraft	86.8	38.6	44.4	49.3
Elect/electr & comm tech	8.6	4.3		
Engineering tech, genl	67.9	33.8		
Ind electronics tech			6.6	9.8
Occ safety & health tech	6.4	3.2	1.2	0.8
Quality control				3.0
Tool & die tech	17.0	15.2	44.9	19.7
Total	202.3	103.7	110.4	102.2

Source: State Board for Community and Technical Colleges

[8] WATR outcomes in this brief will vary from prior Pipeline Committee reports due to the methodology in distinguishing WATR students. The 2016 version of the report used course item number to identify WATR students, while this brief uses a fee-pay status code first implemented in academic year 2014-15. FEE_PAY_STATUS = 'WC'.

[9] https://washingtonaerospace.com/history.htm

Figure 22: WATR Center Headcounts

Program	2015-16	2016-17	2017-18	2018-19
Aircraft elect fab & instl	78.0	43.0	66.0	98.0
Airframe mech & aircraft	391.0	227.0	202.0	209.0
Elect/electr & comm tech	78.0	43.0		
Engineering tech, genl	366.0	238.0		
Ind electronics tech			66.0	98.0
Occ safety & health tech	63.0	32.0	12.0	8.0
Quality control				10.0
Tool & die tech	82.0	76.0	112.0	53.0
Total	438.0	255.0	260.0	247.0

Source: State Board for Community and Technical Colleges

WATR Center Employment Outcomes

Tracking employment outcomes for smaller programs, such as the WATR center, can prove challenging. SBCTC's method for measuring employment relies on a valid Social Security Number and measures employment based on Unemployment Insurance data, which won't include all employers (such as self-employed, out-of-state, and federal employers). Further, SBCTC's data view employment as a snapshot in time rather than longitudinally.

Employment outcomes based on this data show 152 students, who at some point since 2015-16 had enrolled in WATR center coursework, employed three quarters after exiting the CTC system in 2016-17. Median wages and earnings were higher for WATR participants employed in the aerospace industry, primarily due to higher compensation among students in the Tool & Die Tech program.

Figure 23: WATR Center employment outcomes for students exiting 2016-17

Program	Measure	Aerospace Industry	Non-Aerospace Industry
Airframe mech & aircraft	Count	18	45
	Median Earnings	$36,972	$30,805
	Median Wages	$16.29	$16.33
Computer programming	Count	<10	
	Median Earnings		
	Median Wages		
Engineering tech, genl	Count		<10
	Median Earnings		
	Median Wages		
Ind electronics tech	Count	<10	10
	Median Earnings		$39,631
	Median Wages		$17.17
Microcomputer apps, genl	Count	<10	
	Median Earnings		
	Median Wages		
Quality control	Count		<10
	Median Earnings		
	Median Wages		
Tool & die tech	Count	57	10
	Median Earnings	$57,302	$35,814
	Median Wages	$24.83	$17.70
All Programs	Count	84	68
	Median Earnings	$51,766	$32,802
	Median Wages	$23.57	$16.51

Source: State Board for Community and Technical Colleges

Appendix I. 1000 FTE programs tracked by SBCTC

College	Program Title
Bates	Mechanical Engineering Technology
Bates	Welding
Bellingham Tech	Mechatronics
Bellingham Tech	Machining Expansion
Bellingham Tech	Welding
Big Bend	AMT Program
Clark	Machine Technology
Clover Park	Avionics
Everett	Aircraft Mechanic (AMT) & Avionics
Everett	Engineering
Green River	Aero. Engineering
Lake Washington	Welding
Lake Washington	Engineering Transfer
Olympic	Engineering Technology
Peninsula	CNC Machining/Composites Technology
Renton	Mechatronics
Seattle North	Avionics/Electronics
Seattle North	Electronics
Seattle South	AMT Program
Tacoma	Engineering
Whatcom	Engineering Transfer
Green River	Mechatronics

Source: State Board for Community and Technical Colleges

Appendix II. Aerospace-related North American Industry Classification System (NAICS) Codes

NAICS Code	NAICS Title	NAICS Group
325211	Plastics Material and Resin Manufacturing	Manufacturing
332710	Machine Shops	Manufacturing
332813	Electroplating, Plating, Polishing, Anodizing, and Coloring	Manufacturing
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	Manufacturing
333512	Machine Tool (Metal Cutting Types) Manufacturing	Manufacturing
333514	Special Die and Tool, Die Set, Jig, and Fixture Manufacturing	Manufacturing
333517	Machine Tool Manufacturing	Manufacturing
333611	Turbine and Turbine Generator Set Units Manufacturing	Manufacturing
333612	Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing	Manufacturing
333613	Mechanical Power Transmission Equipment Manufacturing	Manufacturing
333618	Other Engine Equipment Manufacturing	Manufacturing
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	Manufacturing
334417	Electronic Connector Manufacturing	Manufacturing
334419	Other Electronic Component Manufacturing	Manufacturing
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	Manufacturing
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables	Manufacturing
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals	Manufacturing
334519	Other Measuring and Controlling Device Manufacturing	Manufacturing
335311	Power, Distribution, and Specialty Transformer Manufacturing	Manufacturing
335314	Relay and Industrial Control Manufacturing	Manufacturing
335921	Fiber Optic Cable Manufacturing	Manufacturing

NAICS Code	NAICS Title	NAICS Group
335991	Carbon and Graphite Product Manufacturing	Manufacturing
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	Manufacturing
336411	Aircraft Manufacturing	Manufacturing
336412	Aircraft Engine and Engine Parts Manufacturing	Manufacturing
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing	Manufacturing
336414	Guided Missile and Space Vehicle Manufacturing	Manufacturing
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	Manufacturing
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	Manufacturing
481111	Scheduled Passenger Air Transportation	Transportation and Warehousing
481112	Scheduled Freight Air Transportation	Transportation and Warehousing
481211	Nonscheduled Chartered Passenger Air Transportation	Transportation and Warehousing
481212	Nonscheduled Chartered Freight Air Transportation	Transportation and Warehousing
481219	Other Nonscheduled Air Transportation	Transportation and Warehousing
488111	Air Traffic Control	Transportation and Warehousing
488119	Other Airport Operations	Transportation and Warehousing
488190	Other Support Activities for Air Transportation	Transportation and Warehousing
611512	Flight Training	Educational Services

Source: Bureau of Labor Statistics

Appendix B -- Aerospace Industry Employment by North American Industry Classification System (NAICS)

Aerospace and Aerospace-related employment and wages
Washington, 2015 Annual Averages

6-digit NAICS	Industry description	Average Firms	Total 2018 wages paid	Average annual employment
325211	Plastics material and resin manufacturing	12	$ 28,202,996	721
332710	Machine shops	391.5	$ 270,450,681	4960
332813	Electroplating, anodizing, and coloring metal	31.5	$ 46,172,304	952
332999	Miscellaneous fabricated metal product manufacturing	76.5	$ 37,787,148	772
333514	Special tool, die, jig, and fixture manufacturing	17.5	$ 70,995,464	1113
333517	Machine tool manufacturing	15.75	$ 118,224,032	1228
333611	Turbine and turbine generator set units manufacturing	4	$ 6,329,620	78
333612	Speed changer, drive, and gear manufacturing	3	$ 4,275,603	117
333613	Mechanical power transmission equipment manufacturing	4.25	$ 3,883,096	62
333618	Other engine equipment manufacturing	5	$ 1,351,186	14
334417	Electronic connector manufacturing	6.5	$ 17,604,435	319
334418	Printed circuit assembly manufacturing	14	$ 39,251,225	903
334419	Other electronic component manufacturing	26.25	$ 154,028,344	2191
334511	Search, detection, and navigation instruments	24.75	$ 182,038,183	1858
334513	Industrial process variable instruments	47	$ 63,299,387	820
334515	Electricity and signal testing instruments	24.5	$ 209,069,677	1977
334519	Other measuring and controlling device manufacturing	26	$ 57,272,769	720
335311	Electric power and specialty transformer manufacturing	*	*	*
335314	Relay and industrial control manufacturing	*	*	*
335921	Fiber optic cable manufacturing	0	$ -	0
335991	Carbon and graphite product manufacturing	*	*	*
335999	Miscellaneous electrical equipment manufacturing	28.75	$ 67,568,343	997
336411	Aircraft manufacturing	24.5	$ 8,880,196,248	68416
336412	Aircraft engine and engine parts manufacturing	14	$ 20,130,939	295
336413	Other aircraft parts and equipment	127.75	$ 914,181,562	13464
336414	Guided missile and space vehicle manufacturing	*	*	*
336415	Space vehicle propulsion units and parts manufacturing	*	*	*
336419	Other guided missile and space vehicle parts	0	$ -	0
481111	Scheduled passenger air transportation	37	$ 1,323,484,766	14812
481112	Scheduled freight air transportation	12	$ 14,582,665	137
481211	Nonscheduled air passenger chartering	35	$ 24,058,021	279
481212	Nonscheduled air freight chartering	9.75	$ 5,106,369	63
481219	Other nonscheduled air transportation	12.25	$ 11,148,902	85
488111	Air traffic control	*	$ -	*
488119	Other airport operations	37	$ 112,945,107	3452
488190	Other support activities for air transportation	136.25	$ 202,096,132	2767
611512	Flight training	32.5	$ 16,150,486	403
927110	Space research and technology	1	$ 303,480	3
Total "Aerospace" Firms		206	$ 10,182,629,340	83,904
Total "Aerospace-related" Firms		1,406	$ 13,120,823,345	130,819

** Information not shown to avoid disclosure of data for individual employer.*

Source: Employment Security Department, Quarterly Census of Employment and Wages