Aerospace Manufacturing Skills

Supply, Demand, and Outcomes for Washington's Aerospace Training Programs

Annual Report – 2016

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This report and other aerospace-related information can be viewed at: www.wtb.wa.gov/aerospace.asp

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 a preliminary report in September of that year. The committee's inaugural report was distributed in December 2012, making this 2016 edition the fourth annual report. All of the reports were 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 2012-2014 reports included industry hiring needs, and employer satisfaction with aerospace program graduates derived from a survey with industry employers.

EXECUTIVE SUMMARY

Key Themes

Industry Outlook

- At the same time forecasters project moderate job declines, retirements promise openings. Boeing currently has an annual attrition rate of 4.5 percent and a backlog of job orders.

Pipeline Issues

- High anticipated retirement rates necessitate a stronger pipeline.
- While the state does not expect large net increases in aerospace employment, new jobs will likely require more education and be higher paying.

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

Summary of Findings
Washington saw slight decline in aerospace employment, wages still strong

- Washington state's core aerospace saw a very small decline in 2015, the most recent year data is available. However, when combined with related industries, net employment reached 136,192 workers.
- The state had the highest relative concentration of aerospace employment and earnings in the country, nearly 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 2015.
- Average annual earnings for those working in the aerospace field fell slightly in 2015, but at $108,539 remained more than twice the state average for all industries.
- In the most recent program year, 81 aerospace apprenticeship participants exited programs. Participants typically took over three and a half years (44.5 months) to complete training.
- A Net Impact Study conducted by the Workforce Board in 2016 found that the state's return on investment in aerospace training programs was $15 for every dollar invested. Until age 65, participants earned an additional $382,782 above what they typically would have earned without participation.[2]

Training accelerates in apprenticeships and at community & technical colleges

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

Key findings

- For the 2014-2015 program year, the most recent year data is available, 355 participants were served by the Aerospace Joint Apprenticeship Committee (AJAC). This is up from 303 enrolled as of December 2015.

- Overall, 2 percent more students attended the five community and technical college aerospace programs reviewed in this report, between 2011 and 2016. However, enrollments varied considerably by program, with some experiencing more than 300 percent growth during the five-year period and others shrinking by more than a third.

- In 2015-16, colleges enrolled 13,997 total students in the five aerospace programs. When adjusted to quantify full-time enrollment, this works out to 2,319 full-time

[2] The Workforce Board conducted a Net Impact Study in 2016 to assess aerospace training programs and their impact on employment and earnings among participants, along with their value to taxpayers, among other details. The study focused on aerospace training program participants vs. a control group with similar demographics, who did not participate in a program.

equivalents (FTEs). Figure 11 below shows enrollments (by college).

The community & technical programs have seen a softening in the overall enrollment in the programs highlighted for this report. A changing market outlook has impacted programs to varying degrees.

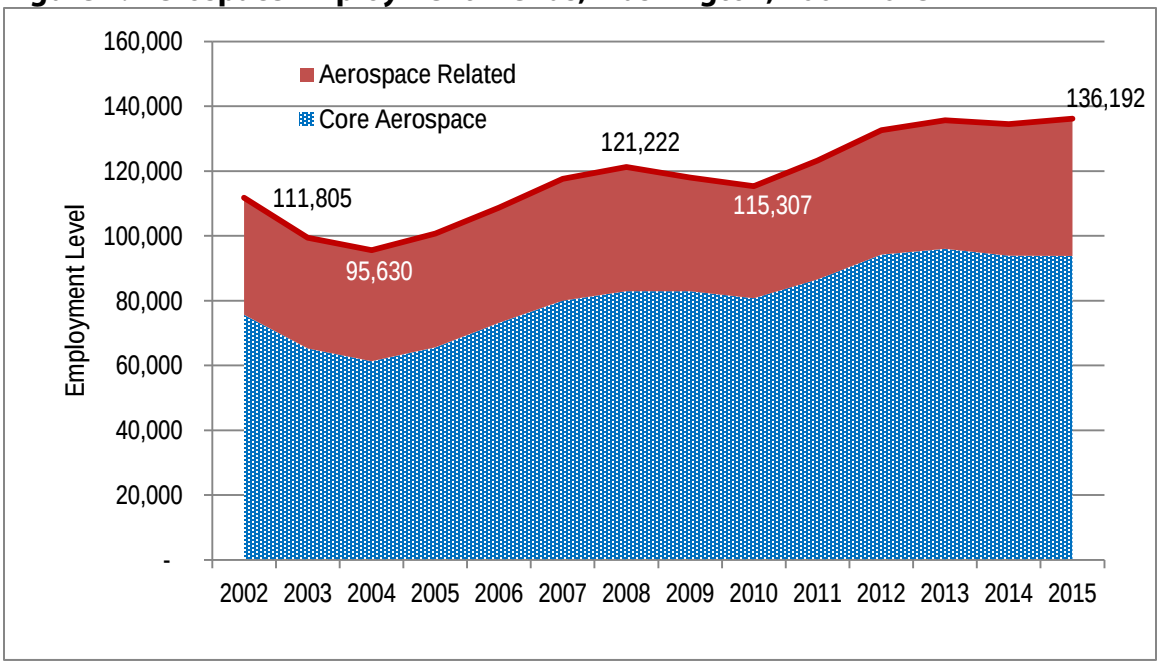
OVERVIEW OF WASHINGTON'S AEROSPACE INDUSTRY

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 1,361 firms, with 186 of these firms located in the core industry.

The core of Washington's aerospace industry is the "Aerospace Manufacturing and Parts" (NAICS 3364) industry, employing 93,815 in 2015.[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 136,000 Washingtonians in 2015.

Figure 1: Aerospace Employment Trends, Washington, 2002-2015



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

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

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.

Figure 2: Aerospace Core Industry Employment and Location Quotients, 2015, Washington and Other States

	Aerospace				Location Quotients			
	Total Employment		Total Wages		Total Employment		Total Wages	
Area	2005	2015	2005	2015	2005	2015	2005	2015
USA	**453,136**	**489,521**	**$32,949,172**	**$ 47,386,190**	**1.00**	**1.00**	**1.00**	1.00
Washington	65,616	93,816	$5,521,334	$10,051,308	7.07	8.76	8.24	9.06
Kansas	36,308	29,991	$2,249,560	$2,323,661	8.30	6.45	8.36	6.10
Connecticut	30,229	27,430	$2,316,941	$2,956,937	5.24	4.64	4.16	4.12
Arizona	26,569	24,718	$1,977,323	$2,485,481	3.08	2.69	3.38	3.11
Alabama	11,488	12,360	$ 679,391	$1,053,197	1.81	1.95	1.75	2.09
Missouri	15,452	16,778	$1,256,822	$1,824,693	1.68	1.76	2.10	2.28
Georgia	18,328	21,590	$1,173,046	$1,922,811	1.36	1.49	1.23	1.44
Utah	7,170	6,405	$444,262	$508,099	1.89	1.38	1.99	1.35
Oklahoma	3,677	7,013	$198,079	$ 532,982	0.77	1.33	0.74	1.24
California	72,690	76,048	$5,651,193	$7,740,827	1.38	1.32	1.31	1.20
Vermont	1,594	1,269	$97,378	$103,527	1.56	1.21	1.58	1.24
South Carolina	452	7,340	$27,790	$637,703	0.07	1.10	0.08	1.27
Texas	48,315	43,609	$3,475,876	$4,344,202	1.49	1.07	1.46	1.06

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

As seen in Figure 2, Washington's 2015 Employment LQ was 8.76—up from 7.07 in 2005. What this means is that the share of aerospace employment in Washington was nearly nine times larger than the aerospace share nationally. Not only is this the

highest LQ among states, but Washington's aerospace LQ was 36 percent higher than the next biggest state (Kansas). The wage location quotient (which shows the relative size of wages earned compared to all sectors) was even higher—9.06.

Occupational Composition

The majority of aerospace positions in Washington were concentrated in production (29.6 percent) or architecture and engineering (24.1 percent). Business/financial operations (15.9 percent) followed by computer/mathematical (10.3 percent) occupations round out the state's top aerospace occupational groups. Overall, these occupations account for approximately 80 percent of industry employment.

Figure 3: Aerospace Core Industry Occupational Composition, NAICS 3364, 2014 2nd Quarter, Washington State

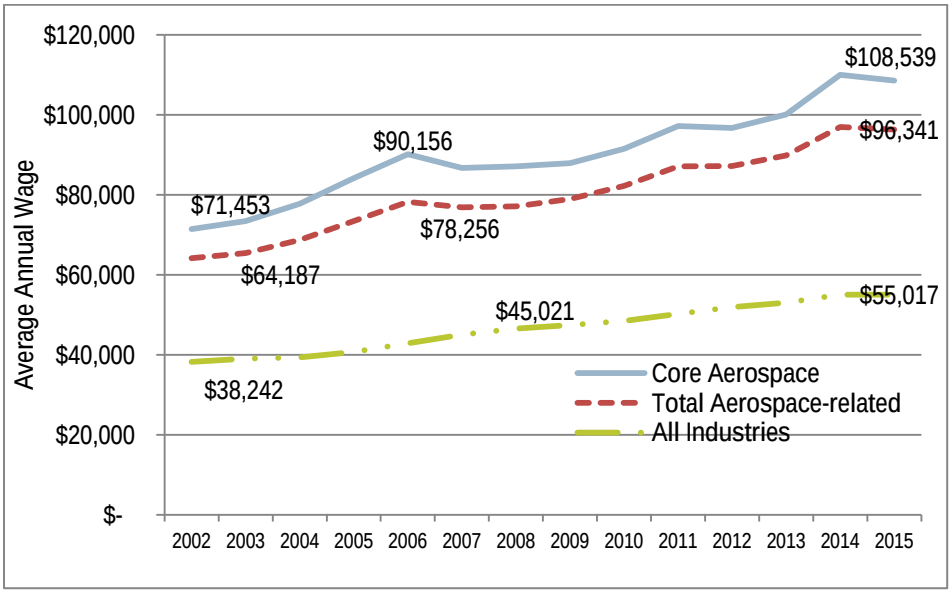
Major Occupation Group	% of Total Aerospace Employment	2014-2nd Quarter Employment
Production	29.6%	27,768
Architecture and Engineering	24.1%	22,650
Business and Financial Operations	15.9%	14,885
Computer and Mathematical	10.3%	9,654
Subtotal	**79.8%**	**74,957**
Installation, Maintenance, and Repair	6.5%	6,063
Office and Administrative Support	4.6%	4,290
Management	4.4%	4,140
Transportation and Material Moving	1.6%	1,529
All other major occupation groups	3.1%	2,930
Total	**100.0%**	**93,909**

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

Wages

Average annual wages earned by aerospace workers (see Figure 4) continue to significantly outpace the overall average wages of all Washington workers. Fifteen years ago, in 2002, average aerospace wages were 87 percent higher than the average wage across all industries. By 2015, aerospace wages were nearly double that of the average wage across all industries ($108,539 compared to $55,017).

Figure 4: Annual Wage Trends for Aerospace and All Industries 2001-2015, Washington

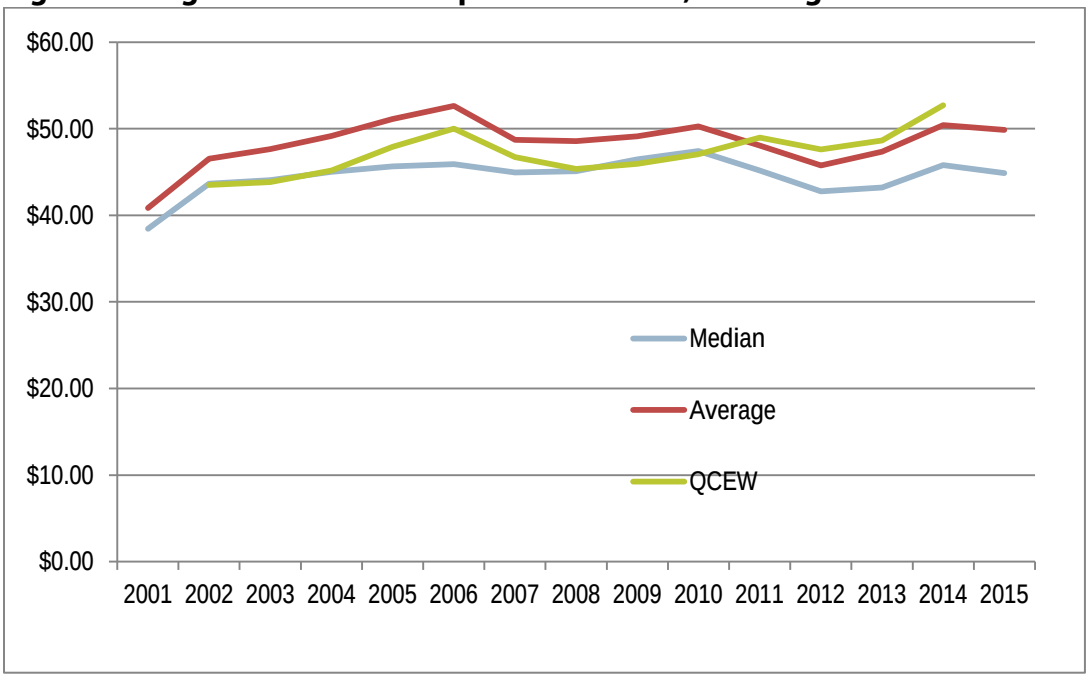


Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages

While aerospace pays much better on average than other industries, as seen in Figure 4, averages are susceptible to outliers and may mask substantial inequalities among different occupations within the same industry. The following chart (Figure 5) compares the average total wages (same as shown in Figure 4) to median hourly earnings. The median hourly earnings take into account actual hours worked and show a less positive trend since 2010 when compared to the Quarterly Census of Employment and Wages figure.

The implication of these two trends diverging is that it has taken more hours worked to see increasing wages. One caveat though is that we don't have hourly adjusted wage data for 2015, so it is possible there will be an uptick.

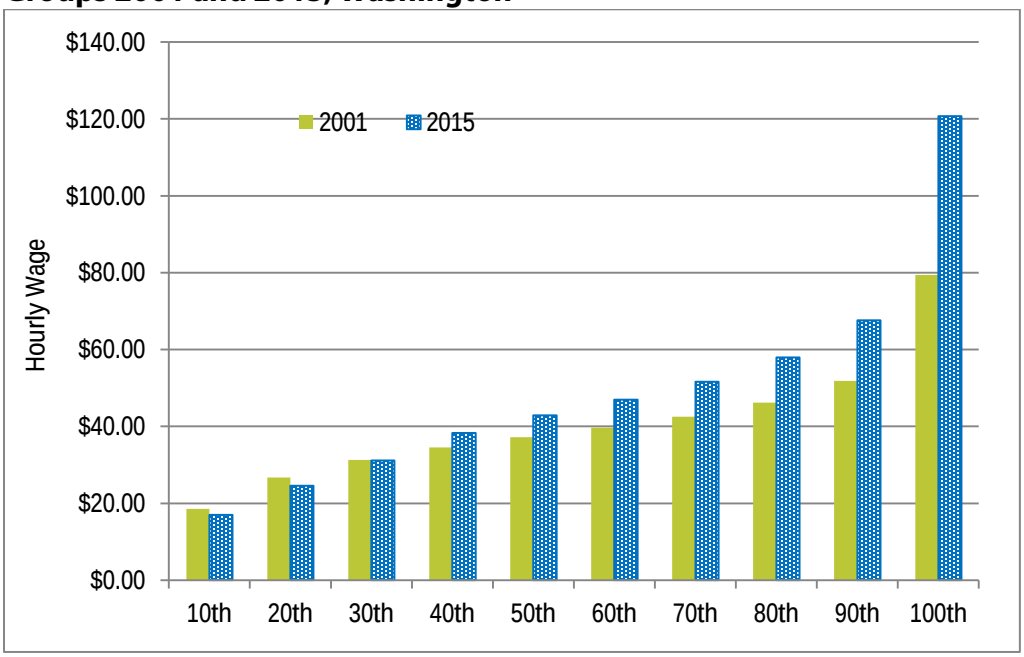
Figure 5: Wage Trends for Aerospace 2001-2015, Washington



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 three deciles saw real wages fall between 2001 and 2015, 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 2001 and 2015, Washington



Source: Washington's Employment Security Department

There is consensus that the core aerospace industry is likely to see declining net employment. At the same time it is a safe bet 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

The Washington State Economic and Revenue Forecast Council forecasts net job losses in the aerospace industry of about 3 percent annually out to 2021. Increasing productivity, restructuring, and a slowdown in sales are driving factors behind this.[4] Increasing productivity and restructuring are expected to spur these job losses, as well as global competition. The Employment Security Department is projecting a 1.6 percent annual average decline out to 2024.[5]

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. The Boeing Company reported the

[4] http://www.erfc.wa.gov/publications/documents/nov16pub.pdf
[5] https://esd.wa.gov/labormarketinfo/projections

company's current average attrition rate is 4.5 percent, and expects that level to be maintained or rise in the near future. Despite that, the company has a backlog of 5,700 planes to build and a market for 39,600 over the next 20 years, leading to a demand for skilled aerospace workers. The skilled positions in need are:

- Assembler
- Machinist
- Fabricator
- Sealer
- Tool Maker
- Advanced Machine Maintenance & Repair Technician
- Aircraft Test Technician
- Aviation Maintenance Technician
- Quality Inspector
- Material & Consumable Handler

Figure 7: Washington State Employment Projections, Aerospace and Selected Manufacturing Industries, 2014-24

Industry	Estimated employment			Average annual growth rate	
	2014	2019	2024	2014-2019	2019-2024
TOTAL NONFARM	3,076,400	3,363,800	3,586,400	1.8%	1.3%
MANUFACTURING	288,400	288,100	290,600	0.0%	0.2%
Durable Goods	209,600	206,900	208,000	-0.3%	0.1%
Wood Product Manufacturing	13,500	13,900	14,400	0.6%	0.7%
Nonmetallic Mineral Product Manufacturing	9,100	9,500	9,500	0.9%	0.0%
Primary Metal Manufacturing	5,800	4,600	4,500	-4.5%	-0.4%
Fabricated Metal Product Manufacturing	19,800	21,000	22,400	1.2%	1.3%
Machinery Manufacturing	15,900	17,000	18,300	1.3%	1.5%
Computer and Electronic Product Manufacturing	20,000	22,700	25,200	2.6%	2.1%
Electrical Equipment and Appliance Mfg	4,900	5,300	5,700	1.6%	1.5%
Aerospace Product and Parts Manufacturing	93,900	84,800	79,700	-2.0%	-1.2%
Other Transportation Equipment	9,600	10,000	9,500	0.8%	-1.0%

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 more 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 experience with college-credited classroom instruction. The following section analyzes aerospace apprenticeship dynamics, enrollments, and a snapshot of completers since the creation of the Aerospace Joint Apprenticeship Committee (AJAC) and for the program year 2014-2015.

AJAC works with the incumbent workforce, is employer driven by occupation and location, and is open to all employers in Washington. AJAC hires instructors from industry to ensure that training reflects current industry needs and technologies. AJAC partners with local community and technical colleges, employers, high schools and Skills Centers, as well as regional Workforce Development Councils, to provide pre-apprenticeship training 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 to provide youth apprenticeship in Washington's high schools. In addition to the wide range of benefits of adult apprenticeship, youth apprentices receive dual high school and college credits. After completing their training, apprentices can choose to remain in their current occupation or enter into one of five adult apprenticeship programs.

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.[6]

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

AJAC Apprenticeship Completions and Outcomes:

- A total of 455 apprentices participated during the 2014-15 program year.
- There were 355 active apprentices at the end of 2014-15 program year.
- 210+ partnering employer Training Agents.

Currently, AJAC maintains eight active apprenticeships. Of the participants in these apprenticeships, 81 percent are Machinist, Machinist (Aircraft Oriented) or Tool and Die Makers; 14 percent are Industrial Maintenance Technicians; 4 percent are Precision Metal Fabrication Technicians and 1 percent are Aircraft Maintenance Technicians (Airframe only).

- Within the eight occupations, participants take an average of nearly four years (46 months) to complete. (One apprenticeship requires a five-year commitment, four require a four-year commitment; two require a 36-month commitment; one requires an 18-month commitment).
- 18 percent average annual growth over the past three years in program enrollment.

Snapshot of Apprenticeship Completions and Outcomes

A total of 42 people completed an aerospace apprenticeship in program year 2014-15. Of that number, AJAC trained 36 individuals, and the Seattle Machinists Apprenticeship program and the IAM/Boeing program each trained three.

Figure 8: Snapshot of Aerospace Apprenticeship Program Completions Washington State, 2014-15

Program	Did Not Complete	Completer[7]
Aerospace JAC	79	36
IAM/Boeing JAC	1	3
Seattle Machinists Apprenticeship	1	3
Total All Programs	**81**	**42**

For All 2014-2015 Program Completers	
Median months to completion	44.5
Median annual wage (adjusted 2016 q1)	$69,235
Median quarterly hours	511

Source: Washington Department of Labor and Industries

[7] This is completers as defined by the Department of Labor and Industries for program year 2014-15. Apprenticeship programs may have different parameters and thus different numbers of completers than reported in this table.

Median annual wages for those who obtained full-time work was $69,235, (the lowest 25 percent earned $37,322 and the highest 25 percent earned $101,204). In 2014-15, apprenticeship completers clocked a median 511 hours per quarter, down a little from the median full-time 549 hours clocked a year prior.

The Net Impact of Aerospace Training Programs

Every four years the Workforce Board conducts net impact and cost-benefit analyses of workforce development programs in Washington state. This detailed study compares participants with non-participants from similar backgrounds to help determine whether a workforce program led to higher wages or employment, or whether those from similar demographic backgrounds would have achieved the same results without participating in a program. Washington is the only state to periodically conduct rigorous net impact evaluations of its workforce programs.

The net impact analysis was conducted by the W.E. Upjohn Institute for Employment Research (Upjohn), a national leader in evaluating training programs. To do the analysis, Upjohn studied program participants to see what results they achieved and compared these results with a control group. Individuals who participated in an apprenticeship program were compared to individuals who had similar demographic characteristics, but who did not participate in any of the programs included in the study. The comparison group members were selected from among those who registered only for assistance in finding jobs.

The most recent net impact analyses, published in December 2016, examined experiences of those who participated in a training program in 2010-11 and 2012-13. The short-term impact was from the Program Year 2012-13 and the long-term impact was from the Program Year 2010-11.

Figure 9: Net Impact of Aerospace Training Programs

Aerospace Training Programs	
Net Employment Rate Impact*	+15.4%
Net Hourly Wage Impact**	+$6.91
Net Hours Employed per Quarter Impact	+127.4
Average Annual Earnings Impact**	+$16,703

Source: Net Impacts and Benefit-Cost Estimates of the Workforce Development System in Washington State, December 2016

**Percentages listed are employment percentage points above those of the control group of non-participants.*
***Wages and earnings, expressed in first quarter 2016 dollars represent the average difference between Apprenticeship participants who got jobs and those in the control group who were employed.*

As shown in the table above, aerospace training program participants were employed at higher rates, earned more, and worked significantly more hours.

Participant and Public Benefits and Costs per Aerospace Trainee

The cost-benefit analysis estimates the value of the net impact on earnings, employee benefits, unemployment insurance benefits, and certain taxes. Program costs include both direct program costs and support payments borne by taxpayers and the tuition paid by participants, as well as the earnings participants would have otherwise received had they continued working instead of participating in training.

Benefits and costs are calculated for both the observed period of time and based upon a statistical model that estimated the benefits and costs out to age 65. To compare benefits and costs in terms of net present values, benefits and costs are discounted by 3 percent per year after a program ends and all figures are stated in 2016 1st Quarter dollars to control for inflation. The benefits and costs presented here are based on impacts estimated for apprentices leaving programs through 2013—three years before the analysis was conducted. This lag time gives researchers better insight on how participants fared once they left a program.

Figure 10: Net Impact Costs and Benefits of Aerospace Training Programs

Benefit/Cost	First 2.5 years		Lifetime (until 65)	
	Participant	Public	Participant	Public
Benefit				
Earnings	38,185	0	340,521	0
Fringe Benefits	15,274	0	136,208	0
Taxes	-9,546	9,946	-85,130	130,911
Transfers				
Unemployment Insurance benefits	-2,021	2,092	-3,912	4,368
Costs				
Forgone compensation	423	92	-423	92
Program costs	-4,482	-8,809	-4,482	-8,809
Benefits	41,891	12,038	387,688	135,279
Costs	-4,058	-8,717	-4,905	-8,717
Total (Net)	**$37,833**	**$3,321**	**$382,782**	**$126,561**

Source: Net Impacts and Benefit-Cost Estimates of the Workforce Development System in Washington State, December 2016
Inflation adjusted to 2016 1st Quarter Dollars

For each aerospace trainee, the public (taxpayer) cost is $8,809 over the length of their enrollment, and the participant cost is $4,482 in tuition. Net earnings lost during training was $423, but during the course of working life to age 65, the average trainee will gain about $340,098 in net earnings (net impact earnings plus earnings while in apprenticeship training) and about $136,208 in employee benefits. These are net gains compared to the earnings of similar individuals who did not participate in a program included in this study. Including program costs and the net impacts on taxes and unemployment insurance benefits, the total net benefit per participant is $382,782.

Projected benefits to participants
Projected participant net benefits to age 65 far outweigh public investment in apprenticeship training by a ratio of $43 to 1, or $382,782 to $8,809.

From the time of leaving training to age 65, the public is expected to gain about $126,561 per apprentice in net additional Social Security, Medicare, federal income, and state sales taxes. The estimated lifetime net benefit to taxpayers is $130,911 per participant.

Projected benefits to taxpayers
Projected taxpayer net benefits to age 65 outweigh public costs invested in apprenticeship training by a ratio of $15 to 1 or $135,279 to $8,809.

Community and Technical College Programs

Second Substitute House Bill 2156 sets guidance for the program evaluation to be conducted by the Workforce Board, working with the State Board for Community and Technical Colleges. The Aerospace and Advanced Materials Manufacturing Pipeline Advisory Committee recommended five programs be reviewed on an ongoing basis. They include:

- Engineering Technician
- Plastics Engineering Technician
- Drafting and Design Technician
- Aircraft/Frame/Powerplant Mechanic
- Machine Tool Technician

FTEs and Student Headcounts
As shown in Figure 11 below, the number of full-time equivalent (FTE) students served in the selected programs has gone up and average of 1 percent over the five-year period between 2011 and 2016.[8] Average growth among these five programs was higher in previous reports. But growth and declines among these programs varies considerably, with some experiencing more than 300 percent growth during the five-year period and others shrinking by more than a third. The high water mark for growth in the selected programs was the 2012-13 year. Enrollments have followed the

[8] A full-time equivalent is the number of students divided by the total number of credit hours for a full-time load in fall, winter, and spring quarters (45 credits).

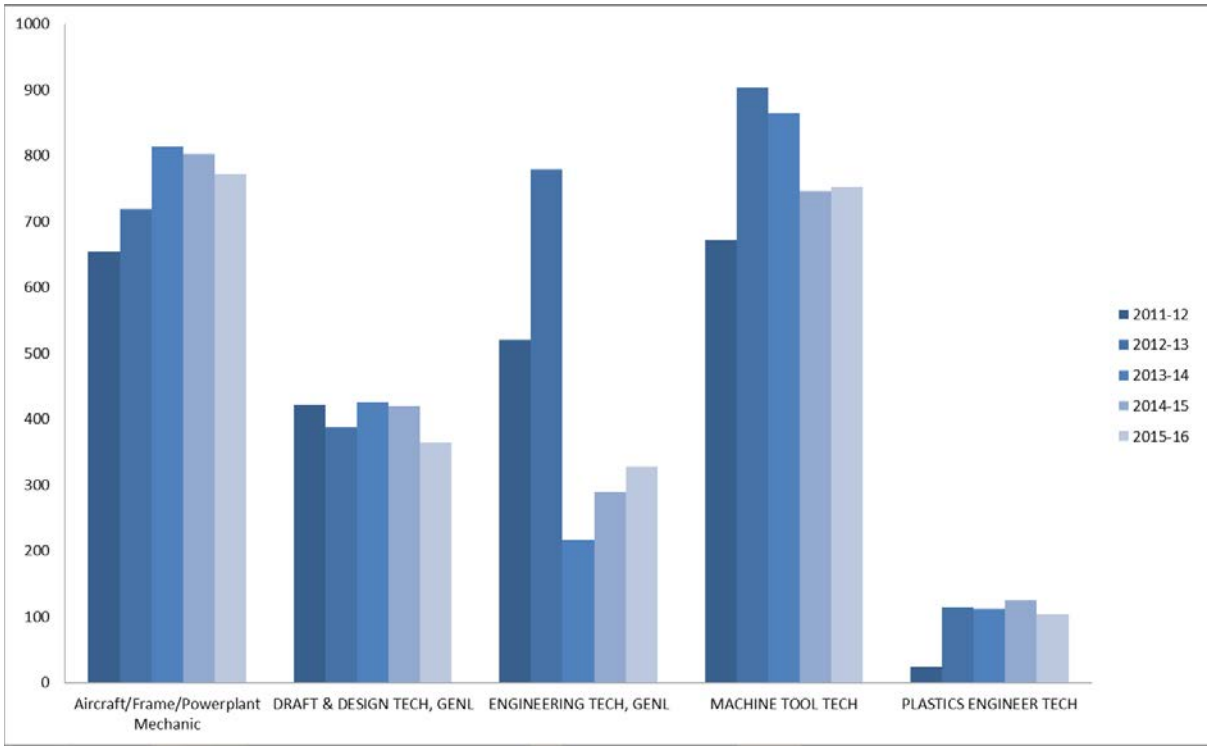
general trends in the industry. While there is still optimism for growth, there are programs that are experiencing a real reduction in student enrollments.

Figure 11: Community and Technical Colleges Select Aerospace Education and Training Program FTEs, 2011-16

Program	2011-12	2012-13	2013-14	2014-15	2015-16	5 Year Change
Aircraft/Frame/Powerplant Mechanic	654	719	814	802	772	18%
DRAFT & DESIGN TECH, GENL	423	388	426	419	364	-14%
ENGINEERING TECH, GENL	520	780	216	290	327	-37%
MACHINE TOOL TECH	671	903	865	746	752	12%
PLASTICS ENGINEER TECH	24	114	112	125	103	335%
Total FTES in Selected Programs	2291	2904	2433	2383	2319	1%

Source: The State Board for Community and Technical Colleges (SBCTC) Data Warehouse, January 2017

Figure 12: CTC Select Aerospace Education and Training Program FTEs, 2011-16



Source: State Board for Community and Technical Colleges

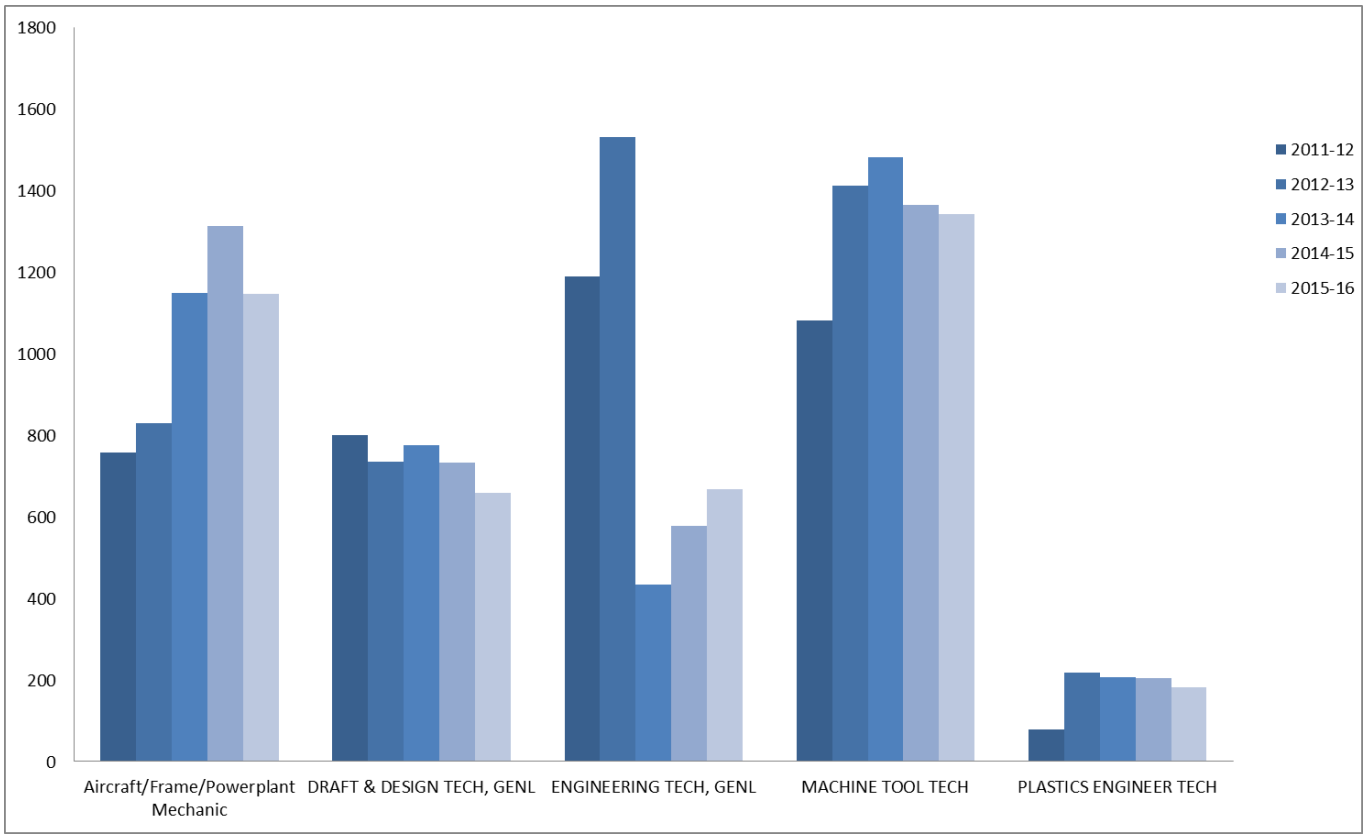
As shown in Figure 12 the number of students in the selected programs has increased by 1 percent over the most recent five year window. The trends in enrollment do reflect industry trends in production and hiring. FTEs and headcount trends are typically correlated, so the fall-off in student headcount for draft and design engineer and engineering tech follows the decline in full-time equivalent students previously shown. This represents multiple year declines in overall program enrollments for both of these programs.

Figure 13: Select Aerospace Education and Training Program Total Headcount, 2011-16

	2011-12	2012-13	2013-14	2014-15	2015-16	5 Year Change
Aircraft/Frame/Powerplant Mechanic	757	830	1149	1313	1147	52%
DRAFT & DESIGN TECH, GENL	799	735	775	733	658	-18%
ENGINEERING TECH, GENL	1190	1530	434	578	667	-44%
MACHINE TOOL TECH	1082	1412	1481	1364	1342	24%
PLASTICS ENGINEER TECH	79	219	206	205	183	132%
Total HC in Selected Programs	3907	4726	4045	4193	3997	2%

Source: The State Board for Community and Technical Colleges (SBCTC) Data Warehouse, Jan 2017

Figure 14: CTC Select Aerospace Education and Training Program Headcount, 2011-16



Source: State Board for Community and Technical Colleges

Engrossed House Bill 2088, which passed in November 2013, appropriated additional funding to the state's community and technical colleges to increase high-demand aerospace enrollments by an additional 1,000 full-time equivalent students. Through a competitive process, college proposals were reviewed by a 10-member review panel made up of industry, labor, education and government agencies. As result of the deliberations 21 colleges received funding for 35 programs. The funding became available July 1, 2014. There is some moderate overlap between the programs supported by this investment and the five programs categories that are reported on in other sections of this report. In 2015-16, colleges enrolled 5,182 headcount students for 3,272 full-time equivalents (FTEs). Figure 15 below shows enrollment at participating college by overall headcount and by FTEs.

Figure 15: CTC Headcount and FTE Engrossed House Bill 2088 High Demand Aerospace Enrollments

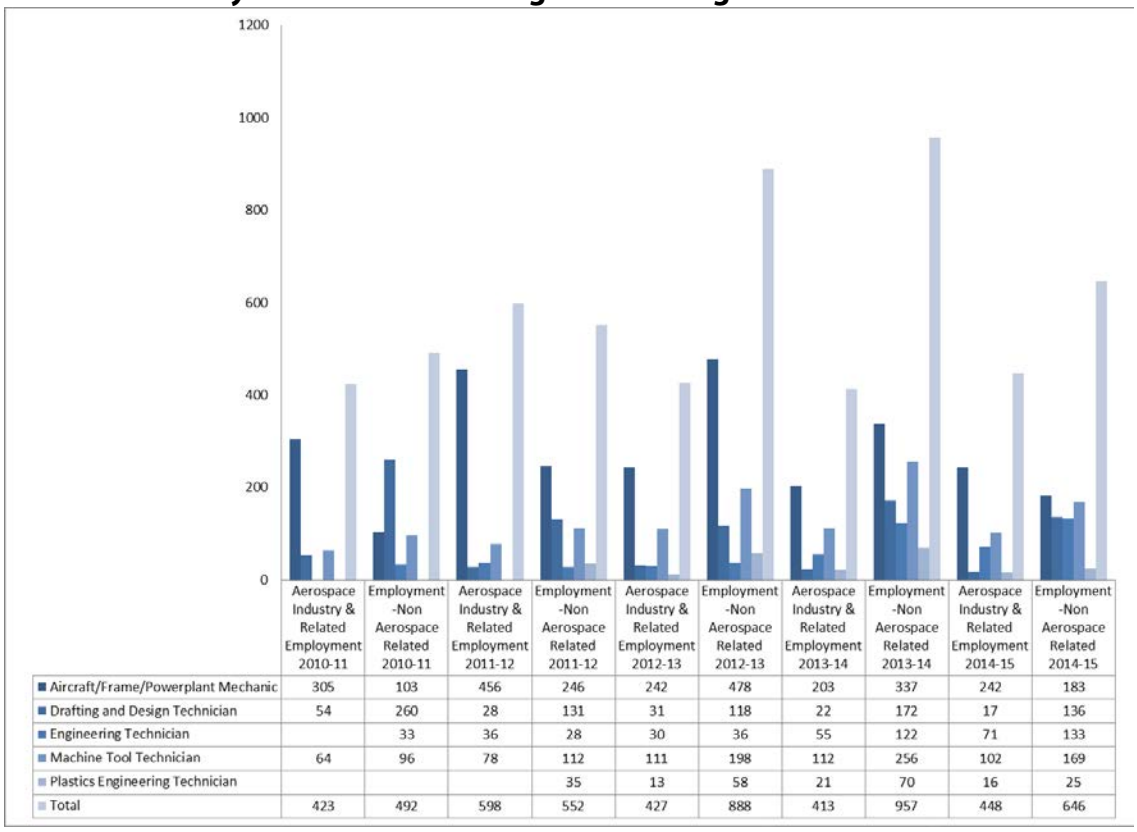
2015-16		
College	Headcount	FTE
Bates	115	111
Bellingham	204	158
Big Bend	54	55
Clark	109	63
Clover Park	236	157
Edmonds	874	466
Everett	935	502
Green River	281	180
Highline	467	223
Lake Washington	258	167
Olympic	187	90
Peninsula	33	24
Renton	52	52
Seattle North	165	72
Seattle South	268	211
Shoreline	180	214
Skagit Valley	99	46
South Puget Sound	26	19
Spokane	162	191
Tacoma	442	244
Wenatchee Valley	35	27
	5182	3272

Source: State Board for Community and Technical Colleges

Student Employment in the Year After Leaving College

Figure 16 below describes employment results for students in the year after leaving college in the five select programs. The definition of "leaver" encompasses more than one student category, including graduates who earned a degree or certificate, those who had at least one year of training and education, and those who left early and are considered non-completers. The total number of students employed each year is the sum of those employed in aerospace and non-aerospace industries. Students are measured for employment three calendar quarters (seven to nine months) after they leave college. The most recent cohort left college in 2014-15 and was typically measured in 2015-16. That year, a total of 1,094 students were employed after leaving college. This includes 448 students employed in aerospace-related industries and 646 employed in non-aerospace industries. The trends from the previous report show a very slight increase in the students in employed in aerospace-related industries and a decline in the number of students employed in non-aerospace industries. Overall there was a decline in total employment.

Figure 16: Employment in Aerospace and Non-Aerospace Industries for Leavers from Community and Technical College Select Programs



	Aerospace Industry & Related Employment 2010-11	Employment -Non Aerospace Related 2010-11	Aerospace Industry & Related Employment 2011-12	Employment -Non Aerospace Related 2011-12	Aerospace Industry & Related Employment 2012-13	Employment -Non Aerospace Related 2012-13	Aerospace Industry & Related Employment 2013-14	Employment -Non Aerospace Related 2013-14	Aerospace Industry & Related Employment 2014-15	Employment -Non Aerospace Related 2014-15
Aircraft/Frame/Powerplant Mechanic	305	103	456	246	242	478	203	337	242	183
Drafting and Design Technician	54	260	28	131	31	118	22	172	17	136
Engineering Technician		33	36	28	30	36	55	122	71	133
Machine Tool Technician	64	96	78	112	111	198	112	256	102	169
Plastics Engineering Technician				35	13	58	21	70	16	25
Total	423	492	598	552	427	888	413	957	448	646

Source: State Board for Community and Technical Colleges
**Note: Programs with fewer than 10 students have been redacted due to privacy.*

Figure 17 below describes within each select program area, by year, the percentage of leavers that went to work in aerospace-related industries. Some 41% of students leaving in 2014-15 were employed in aerospace-related industries. The remaining 59% of students who left in 2014-15 were employed in non-aerospace industries.

Leavers who *did not* go to work in the aerospace industry found employment in a wide variety of industries.

- 19% were employed in other manufacturing industries.
- 23 % were employed in business services.
- 19% were employed in retail trade.

These three industry sectors represent the highest density of employment for the 59% of students who left and were employed in non-aerospace industries. The remaining students were employed across a broad cross section of industries.

Figure 17: Percent Employed in Aerospace & Related Industries in the Year after Training

Select Programs	2011-12	2012-13	2013-14	2014-15	2015-16
Aircraft/Frame/Powerplant Mechanic	75%	65%	34%	38%	57%
Drafting and Design Technician	17%	18%	21%	11%	11%
Engineering Technician	0%	56%	45%	31%	35%
Machine Tool Technician	40%	41%	36%	30%	38%
Plastics Engineering Technician				23%	39%
Total Selected Programs	46%	52%	32%	30%	41%

Source: State Board for Community and Technical Colleges

**Note: Programs with fewer than 10 students have been redacted due to privacy.*

Figure 18 details hourly wages and annualized earnings for students leaving select programs in 2014-15. Results are shown separately for students employed in aerospace and non-aerospace industries. As a group, students who went to work in aerospace-related industries earned an estimated $40,700 annually based upon their earnings in the third quarter after college. Engineering Techs and Drafting and Design Techs who went to work in aerospace led all students in earnings. (See following chart.) Of note is the earlier data which shows that the enrollments in these programs have been falling. Overall earnings for students who went to work in aerospace were 36 percent higher than for students who went to work in non-aerospace industries.

Figure 18: Median Wage and Estimated Annual Earnings, 2014-15

Program Title	Non-Aerospace All Students Inflation Adjusted Wage	Non-Aerospace All Students Inflation Adjusted Earnings	Aerospace& Related Inflation Adjusted Wage	Aerospace & Related Inflation Adjusted Earnings	% Earnings Difference between to leavers Working in Aerospace & Non-Aerospace Employment
Aircraft/Frame/Powerplant Mechanic	$16.37	$32,100	$19.59	$45,600	42%
AIRFRAME MECH & AIRCRAFT	$14.34	$24,500	$17.70	$37,500	53%
Drafting and Design Technician	$18.47	$32,100	$23.11	$52,800	64%
Engineering Technician	$14.97	$26,300	$20.52	$45,100	71%
Machine Tool Technician	$16.53	$33,300	$17.77	$35,900	8%
Plastics Engineering Technician	$13.53	$28,400	$19.04	$40,200	42%
All Programs	$15.70	$30,000	$18.37	$40,700	36%

Source: State Board for Community and Technical Colleges

Washington Aerospace Training and Research (WATR) Center

The WATR Center at Edmonds Community College provides short-term skills training for aerospace and manufacturing jobs. Students start with a four-week core program and move on to specialized certificates such as assembly mechanic, electrical assembler, tooling, composites and quality assurance. For this report, FTEs and headcount for the last three years, 2013-14, 2014-15 and 2015-16 are shown for students enrolled in WATR Center courses based upon item numbers provided to SBCTC by the Center.

Figure 19: WATR Center Aerospace Program FTE, 2013-14 , 2014-15 and 2015-16

Program	2013-14	2014-15	2015-16
AIRCRAFT ELECT FAB & INSTL	17	26	10
AIRFRAME MECH & AIRCRAFT	71	181	128
ENGINEERING TECH, GENL	53	8	2
IND ELECTRONICS TECH			13
QUALITY CONTROL	2		11
TOOL & DIE TECH	33	47	34
TOTAL*	176	261	199

Source: State Board for Community and Technical Colleges based on course items identified by WATR Center

Figure 20: WATR Center Aerospace Headcount Enrollments, 2013-14, 2014-15 and 2015-16

Program	2013-14	2014-15	2015-16
AIRCRAFT ELECT FAB & INSTL	32	53	28
AIRFRAME MECH & AIRCRAFT	181	420	341
ENGINEERING TECH, GENL	118	15	5
IND ELECTRONICS TECH			33
QUALITY CONTROL	*		24
TOOL & DIE TECH	59	74	84
TOTAL*	397	562	515

Source: SBCTC, 2013-14, 2014-15 based on academic year and quarter, course items and sections identified by college. 2015-16 based on course fee pay status

**Note: Programs with fewer than 10 students have been redacted due to privacy, but are included in the total*

WATR Center Post-Training Employment and Earnings

Some 340 WATR Center students were evaluated after leaving training in 2014-15 to see where they went to work and how much they earned. In the year after training 55%, or 188 students, were employed in aerospace industries. Overall, these leavers had estimated annual earnings of nearly $43,200. The remaining 152 WATR Center students found non-aerospace related employment and had estimated earnings of $23,800.

Figure 21: Wages and Earnings for Students Leaving College in 2014-15 and Employed in 2015-16 in Aerospace & Non-Aerospace Related Industries

Program Title	Students Employment-Non-Aerospace Related	All Students Inflation Adjusted Wage	All Students Inflation Adjusted Earnings*	Students Employed in Aerospace and Related	Aerospace & Related Inflation Adjusted Wage	Aerospace & Related Inflation Adjusted Earnings*
AIRFRAME MECH & AIRCRAFT	91	$13.88	$23,900	105	$17.41	$37,800
ENGINEERING TECH, GENL	28	$14.42	$24,600	25	$25.17	$52,500
QUALITY CONTROL				<10		
TOOL & DIE TECH	33	$13.68	$21,500	58	$26.61	$58,800
All Employed	152	$13.91	$23,800	188	$18.83	$43,200

Source: State Board for Community and Technical Colleges- And Washington Wage Records

*Earnings are an annual estimate

Appendix A

Aerospace Pipeline Advisory Committee

Industry Representatives

- Eric Hahn, Vice President/Organization Development, General Plastics
- Melissa Garner, The Boeing Company
- John Theisen, President and CEO, ORION
- Jackie Davis, Regional Sales Manager, AMI Metals Inc.
- Bahman Hadi, Cascade Engineering Services
- Tom Doughty, Vice President of Administration, Janicki Industries
- Ben Hempstead, Engineer-Mechanical Lead, Electroimpact
- Kelly Maloney, Director, Aerospace Future Alliance
- Tim Morgan, CEO, TTF Aerospace, LLC

Education Representatives

- David Beyer, President, Everett Community College
- Larry Cluphf, Director, Washington Aerospace Training & Research Center
- Ron Langrell , President, Bates Technical College
- Lynn Strickland, Executive Director, Aerospace Joint Apprenticeship Program

Labor Representatives

- Chelsea Orvella, Legislative Director, SPEEA, IFPTE 2001
- Ron Harrell, Staff Assistant, IAM&AW District Lodge 160

Ex-Officio Members

- John Thornquist, Director, Office of Aerospace, Governor's Aerospace Sector Lead
- Mary Kaye Bredeson, Director, Center of Excellence for Aerospace & Advanced Materials Manufacturing
- Staff as assigned, Career and Technical Education, Office of the Superintendent of Public Instruction
- Marty Brown, Executive Director, WA State Board for Community & Technical Colleges
- Marcia Garrett, Director of Regional Relations, Washington State University

- Bill Keough, Director of Program Operations, Supply Chain Transportation and Logistics Master's Program, University of Washington

Committee Staff

- Nancy Dick, Director-Workforce Education, WA State Board for Community & Technical Colleges
- Kendra Hodgson, Policy Associate, WA State Board for Community & Technical Colleges
- David Prince, Policy Research Associate, WA State Board for Community & Technical Colleges
- Dave Wallace, Research Director, WA Workforce Training & Education Coordinating Board

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

Aerospace and Aerospace-related employment and wages
Washington state
2015 Annual Averages
Employment Security Department, Quarterly Census of Employment and Wages

NAICS Code	Industry Description	2015 Firm Counts	2015 Annual Average Employment	2015 2015 total wages
325211	Plastics material and resin manufacturing	10	627	$40,935,118
332710	Machine Shops	453	4985	$243,709,441
332813	Electroplating, anodizing, and coloring	37	1021	$43,120,222
332999	Miscellaneous fabricated metal product manufacturing	73	806	$35,396,382
333512	Machine Tool Manufacturing	0	0	$ -
333514	Special Die and Tool Manufacturing	19	901	$52,387,957
333517	Machine tool manufacturing	12	1201	$114,590,530
333611	Turbine and turbine generator set units	5	99	$6,901,336
333612	Speed changer, drive, and gear manufacturing	2	145	$9,644,559
333613	Mechanical power transmission equipment	4	83	$4,452,278
333618	Other engine equipment manufacturing	5	18	$1,397,934
334417	Electronic Connector Manufacturing	8	288	$14,885,387
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	16	921	$35,954,607
334419	Other Electronic Component Manufacturing	28	2648	$164,405,290
334511	Search, Detection, Navigation, Guidance, and Nautical System Manuf.	28	1795	$172,032,874
334513	Instruments and Related Products Manufacturing	42	800	$53,225,746
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals	24	2086	$213,964,434
334519	Other Measuring and Controlling Device Manufacturing	28	733	$54,576,887
335311	Power, Distribution, and Specialty Transformer Manufacturing	5	239	$20,753,976
335314	Relay and Industrial Control Manufacturing	16	2452	$159,243,653
335921	Fiber Optic Cable Manufacturing		0	
335991	Carbon and Graphite Product Manufacturing	3	14	$731,088
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	30	1151	$77,080,195
336411	Aircraft Manufacturing	46	79873	$9,127,926,509

336412	Aircraft Engine and and Engine Parts Manufacturing	6	94	$5,413,878
336413	Other Aircraft Parts and Auciliary Equipment Manuf.	141	12922	$812,705,666
336414	Guided Missile and Space Vehicle Manufacturing	1	371	$50,242,715
336415	Guided Missle and Space Vehicle Propulsion Manuf.	2	555	$55,179,965
336419	Other Guided Missile and Space Vehicle Parts Manuf.		0	
481111	Scheduled passenger air transportation	57	11898	$987,288,784
481112	Scheduled freight air transportation	11	130	$12,156,477
481211	Nonscheduled air passenger chartering	45	220	$16,921,240
481212	Nonscheduled air freight chartering	10	94	$8,003,216
481219	Other nonscheduled air transportation	10	61	$6,455,761
488111	Air traffic control	15	477	$57,414,116
488119	Other airport operations	51	3644	$175,764,664
488190	Other support activities for air transport	148	2339	$134,046,271
611512	Flight Training	39	501	$20,753,582
927000	Space Research and Technology	0	0	$131,160,607
	Total "Aerospace" (shaded codes above)	196	93,815	10,182,629,340
	Total "Aerospace and Aero-space related" (all NAICS codes listed above)	1,430	136,12	13,120,823,345

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