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Virginia's Aviation and Aerospace State of the Workforce: 2011

Technical Report

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[**Abstract:** A supply of skilled workers to aviation and aerospace in Virginia is critical to continued growth in the Commonwealth because it connects products and people to the marketplace. In 2010, the Virginia Department of Aviation commissioned a benchmarking analysis of the skills and occupations that support aviation and aerospace in the state. The state of the workforce report shows that worker availability and industry demand for skilled labor varies between the regions in the state. Aviation workers support 66 airports throughout Virginia's regions; aerospace is more concentrated from the central part of the state eastward to the coastal regions. Based on industry forecasts, Virginia's aviation and aerospace industry will need at least 12,283[1] more workers over the next 10 years with each job supporting an additional 1.12 jobs elsewhere in Virginia. Potential shortages include mechanics, maintenance workers, pilots, and engineering occupations. The major issues facing this industry are its aging workforce and its relatively high threshold of required high-technology skills. Moreover, its highly regulated environment leaves fewer resources for upskilling the existing workers.]

[1] This study considers only employment directly related to the aviation and aerospace industry. It does not include aviation-dependent businesses or the workforce from industries that supply goods to the aviation and aerospace industry. For further clarification on the industries included in an aviation-dependent businesses study, please see Appendix 1 in the accompanying Appendix document.

1. Executive Summary

Human capital is a regional capacity issue. It is vital to address because the competitiveness of a region's workforce drives living standards for communities and profitability for businesses. However, the regional issue of human capital is typically not addressed with the rigor that firms apply to streamlining processes that create their services or product lines. Profitable firms meet customer demand by maximizing efficiencies in their pipeline of starting materials, reducing waste within their operations, and leveraging capital across product lines. These business principles also apply to managing the workforce pipeline in both industries and regions. In order to build workforce strategies that streamline the process and allocate scarce resources, the baseline and future occupational needs of industries and regions must be identified. This *Virginia's Aviation and Aerospace*[2] *State of the Workforce: 2011* report evaluates the regional human capital issues for an industry that is integral to the states' continued growth.

The key workforce issues facing aviation and aerospace are its aging workers, a shortage of skilled workers, and increasing regulations, particularly for public's safe flying.

One of the immediate needs in aviation and aerospace is to close the gap with the aging workforce by focusing on aligning the pipeline with demand occupations based on industry and occupation forecasts. Aviation and aerospace occupations run the full gamut of skill requirements. On average, they pay better than many other industry sectors in the state. The higher wages are reflected in the overall skills competencies of the workers. Of keen interest on the aviation side of this industry is the skills required around safety for the traveling public. As with most occupations, however, the skill required by aviation and aerospace workers continues to increase.

Regions can better align their organic mix of workers to the needs of local businesses by first tracking key workforce indicators that follow market trends and then implementing response strategies across the worker pipeline. Mapping demand occupations to meet real-time needs by employers helps regions become flexible and responsive.

The key workforce metrics that came from this study that are suggested as indicators for aviation and aerospace workforce planning are:

- employment projections by region and industry,
- skill threshold demand by region,[3] and
- demand occupations by region and industry.

The relative impact from these workforce indicators, when taken together, is the gradual lifting of the skills needed to meet future business growth, including strengthening the knowledge of workers around safe travel practices and closing the retiring worker gap with skilled labor.

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[2] There is no nationally accepted standard definition of the aviation and aerospace industry. The definition used in this study, which is in Section 3.4, combines some of the industries that made up the definitions of the two economic impact studies conducted for DOAV in 2010, one for the aerospace industry and the other for the aviation industry.
[3] The regions are identified in the Section 3.3 of this report.

Virginia's aviation and aerospace pipeline strategies should address expected shortages for mechanics, maintenance workers, pilots, and engineers in both the short and long term.

A statewide strategic plan is needed to address pipeline strategies for informing and engaging the skills needed by aviation and aerospace for future workers that are now being educated, incumbent workers, and those that are currently not in the workforce. The strategic plan should also align Virginia's aviation and aerospace workforce with the target markets Virginia's economic developers are seeking, and these plans should be customized at the regional level to meet local employment demand. *[For more detail, see pages 68 – 69.]*

Key Findings

The aviation and aerospace industry is relatively small in terms of employment but is critical to the national economy.

The aviation and aerospace industry directly employed over 600,000 U.S. workers in 2007, or less than 1% of total employment, according to the Aerospace Industries Association. However, it contributed $97 billion in export sales during the same year, or about 6% of total exports. More than 600 million passengers relied on U.S. commercial air transportation in 2007 and more than 40% of the value of U.S. freight was transported by air.[4]

Virginia is home to a world-class aviation and aerospace industry.

The civilian aviation and aerospace industry employed 29,694 workers in Virginia as of the 2nd quarter of 2010. From 2000 through 2009 employment in the industry declined an average 0.4% per year—a slightly better performance than in the nation. The industry contributed $2.0 billion in 2009 to the Virginia economy based on total wages and salaries. Virginia's competitiveness in aviation and aerospace is partially attributed to its proximity to the national capital. Many federal agencies have installations in Virginia—including space research and technology, a component of the aviation and aerospace industry. Top employers include United Air Lines, Raytheon Company, the National Aeronautics and Space Administration (including the Langley Research Center and the Wallops Flight Facility), Orbital Sciences Corporation, and US Airways. *[For more detail, see pages 34 – 39.]*

The aviation and aerospace industry supports an additional 33,257 jobs in the Commonwealth.

The aviation and aerospace industry supports employment in other industries in Virginia due to its supply chain and the purchasing power of its workers. The total employment multiplier for the industry in 2009 was 1.12, indicating that each job in aviation and aerospace supported 1.12 additional jobs elsewhere in Virginia. The employment multiplier for this industry is higher than some other major industries. For example, the employment multiplier is 0.27 for the retail industry, 0.54 for health care, and 0.72 for construction. However, this study considers only employment directly related to the aviation and aerospace industry. It does not include aviation-dependent businesses or the workforce from industries that supply goods to the aviation and aerospace industry.

[4] "A Special Report: Launching the 21st Century American Workshop," December 2008, Aerospace Industries Association.

For further clarification on the industries included in an aviation-dependent businesses study, please see Appendix 1 in the accompanying Appendix document.

The aviation and aerospace industry creates additional value to the Commonwealth through sales. Based on a 2009 estimate,[5] the total output from air transportation was $3.7 billion, or 0.6% of total state output. Output from the aerospace industry was $7.6 billion in 2009.[6] *[For more detail, see pages 36 – 40.]*

Virginia's aviation and aerospace industries pay above-average wages.

Average wages in Virginia's aviation and aerospace industry are above average compared to other industries. In 2009, the average wage for aviation and aerospace workers was $65,579 per year or 38% higher than the state average wage of $47,672. In 2009, four sub-industries within aviation and aerospace averaged over $100,000 in employee earnings: air traffic control; guided missile and space vehicle manufacturing; satellite telecommunications; and search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing. *[For more detail, see pages 39 – 41.]*

Virginia's aviation and aerospace industry is expected to need at least 12,283 new workers over the next ten years.

Virginia's aviation and aerospace industry is expected to expand by 1,885 jobs over the next ten years. The expected job increase in the aviation and aerospace workforce includes a projected increase of 720 jobs in scheduled passenger air transportation and an increase of 489 jobs in other airport operations. Aside from net growth, aviation and aerospace firms will need additional workers to replace[7] retirees and individuals who go into new occupations. From this perspective, an additional 10,398 workers will be needed in the aviation and aerospace industry over the next ten years, increasing the total workforce need to 12,283 new workers. *[For more detail, see page 44.]*

Ninety-four percent of Virginia's aviation and aerospace employment is located within its eleven metropolitan statistical areas.

In 2009, the Northern Virginia metropolitan statistical area (MSA) accounted for more than two thirds (68%) of all Virginia aviation and aerospace employment with 20,360 jobs. Hampton Roads accounted for 15% of the state's aviation and aerospace employment in 2009. Currently, rural areas in the state account for about 14% of aerospace employment. *[For more detail, see pages 45 – 46.]*

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[5] IMPLAN Pro was used to create this estimate. *IMPLAN Professional* is an economic impact assessment modeling system developed by the Minnesota IMPLAN Group that is widely used by economists to build economic models that estimate the impacts of economic changes in local economies.
[6] "Virginia's Aerospace Industry," revised January 2011, Chmura Economics & Analytics, page 2.
[7] Replacements are estimated based on information from the U.S. Bureau of Labor Statistics which should be considered a "minimum measure of replacement needs."

Baseline employment in Virginia is expected to expand 1.3% annually over the next ten years, creating competing demands for a highly-skilled workforce.

From the second quarter of 2010, the Commonwealth is projected to add 472,505 jobs over the next ten years, driven by growth in professional and business services (+186,276 jobs) and education and health services (+183,334 jobs). Manufacturing, in contrast, is expected to shed 25,733 jobs. Also during this period, both median age and average educational attainment are both projected to increase for this supply of workers. The supply of workers may have a difficult time keeping up with demand in fast-growing occupation groups such as healthcare practitioners, computer and mathematical, and architecture and engineering. *[For more detail, see pages 51 – 52.]*

The productivity of Virginia's aviation and aerospace industry is much higher than the average productivity of all industries combined.

In the past two decades, the average sales per aviation and aerospace employee more than doubled, from $92,456 in 1990 to $197,144 in 2009. The average amount of sales per employee for the average industry in Virginia was $116,105 in 2009, about 63% of the average sales per employee in aviation and aerospace industries. *[For more detail, see page 62.]*

Per the business survey, aviation and aerospace respondents expect job growth consistent with a fast recovery of recession job losses.

The overall expectation for aviation and aerospace businesses was 2.9% employment growth over the coming year and 1.4% annual average growth over the coming three years. This expectation is consistent with the industries' quick recouping of job losses incurred during the recession, and resuming the long-term growth projection assumption of 0.6% per year. *[For more detail, see page 74.]*

Among Virginia's aviation and aerospace employers, a wide variety of occupations have critical workforce issues.

Respondents to the business survey reported specific occupations

- For which there were insufficient qualified applicants for job openings,
- Where pending retirements were critical,
- That lacked training support (technical occupations),
- That were difficult to retain, and
- Among the most impactful to business success.

Taken together, the results show that there are a wide variety of occupations critical to the success of aviation and aerospace businesses in Virginia. The occupations most frequently mentioned as being associated with workforce issues were mechanics, maintenance workers, pilots, and engineers. *[For more detail, see page 69.]*

Aviation and aerospace occupation demand in the Commonwealth is neither uniform by industry nor by region.

Occupation demand among aviation industries is led by service occupations such as ticket agents and flight attendants, but also includes more technology-driven jobs such as pilots, aircraft mechanics, and service technicians. The Northern Virginia metro area accounts for more than 80% of employment in some of the leading aviation occupations but lesser amounts in some occupations such as aircraft mechanics and service technicians (69%) and commercial pilots (39%). About half of the aerospace occupations in Virginia are STEM-related;[8] with many of the top occupations being engineers. About half the aerospace employment in the state is in the Northern Virginia metro area, and approximately one quarter is found in the Hampton Roads MSA. However, the latter region has greater demand for the top engineering occupations due to the NASA Langley Research Center. *[For more detail, see pages 92 – 96.]*

Aviation maintenance training capacity is about average in Virginia, yet improvement may still be needed.

Aviation maintenance occupations include aircraft mechanics and service technicians; avionics technicians; and aircraft structure, surfaces, rigging, and systems assemblers. For these occupations, postsecondary training programs in Virginia grant awards per demand[9] at about the same pace as in the nation. The Commonwealth also benefits from hundreds of aviation-qualified military exits (individuals leaving the military) annually with these skills. Nevertheless, considering that the supply of these occupations was an issue for many respondents in the business survey, ways to bolster the supply chain need to be examined. *[For more detail, see pages 97 – 106.]*

The aviation and aerospace industries have a shared demand for maintenance workers. These occupations also have common education and training backgrounds.

The three occupations with the most in common, and most specific to the aviation and aerospace industry are also the three aviation maintenance occupations that share a common classification instructional program (CIP). In terms of critical and shared occupations and skills, the next most-shared labor resources for aviation and aerospace markets are aerospace engineers and technicians. Finally, critical to both aviation and aerospace are transportation inspectors and commercial pilots. *[For more detail, see pages 69 – 70.]*

Military exits with pilot skills in the Commonwealth outnumber postsecondary graduates.

From October 2009 through September 2010, 179 military exits entered civilian life in Virginia with aircraft pilot and flight engineer skills. By comparison, in the 2008-2009 academic year in Virginia, 26 pilot-related postsecondary awards were granted, a rate of training that is only 38% of the nation's rate. In the business

[8] Technical occupations related to science, technology, engineering, and mathematics are known as STEM occupations. Workers in such occupations use science and math to solve problems. There is no universally accepted definition for these occupations. This report uses the definition developed by Barroilhet and Udalova which includes 176 occupations and can be found here: www.stemequitypipeline.org/_documents/FINAL_LIST_OF_STEM.xls.

[9] Awards per demand refers to the "training capacity;" see Section 9 for the formal definition.

survey, pilots were mentioned as critical occupations by both aviation respondents and related industry businesses; though among respondents who said pending retirements among skilled occupations was a critical workforce issue for their organization, none mentioned pilots, specifically, as an occupation with pending retirements being a critical issue. *[For more detail, see page 100.]*

Engineer postsecondary training output in Virginia is mixed depending on the field of engineering.

The Commonwealth's postsecondary training institutions have above-average training capacity for aerospace, industrial, and materials engineers with below-average capacity for electrical and electronic and mechanical engineers—based on 2008-2009 awards data. The link between training output and occupation supply, however, is complicated by the fact that many of these awards are granted to individuals who will work outside the state after graduation. Engineers were frequently cited as occupations associated with workforce issues in the business survey, especially aerospace engineers and electronics or electrical engineers, suggesting that despite some of the positive awards data, improvement in the supply of these workers is still needed. *[For more detail, see pages 103 – 104.]*

Skills analyses show significant differences in knowledge attributes required in aviation and aerospace occupations compared to occupations overall in the nation.

Customer and personal service is the knowledge attribute[10] that is most needed at a high-skill level among aviation occupations, followed by public safety and security and mechanical skills. In contrast, the overall occupation mix in the nation requires the top three knowledge attributes of customer and personal service, clerical, and administration and management. Aerospace occupation requirements add further variation, leaning more heavily on STEM-related skills. Three of the top four knowledge attributes needed most frequently at a high-skill level among aerospace occupations are mathematics, computers and electronics, and engineering and technology. *[For more detail, see pages 107 – 110.]*

A best practice to model workforce development planning utilized multiple primary and secondary data sources, including industry and subject matter experts.

The Virginia Department of Aviation (DOAV) in the Commonwealth commissioned a labor market study and Chmura applied a business process for mapping the demand occupations needed by aviation and aerospace employers today and in the future. As shown in the diagram below, the approach uses primary (surveys and focus groups) data along with secondary data and forecasts obtained from JobsEQ®.[11] This approach allows workforce planners to overlay planned industry expansions that are not yet in the state's industry mix onto the forecast that is based on the current industry mix for a more accurate assessment of workforce needs for Virginia's aviation and aerospace industries. The combination of real time and secondary data provides the confidence practitioners need to bridge the gaps between historical data trends with projected trajectories based on business expansions.

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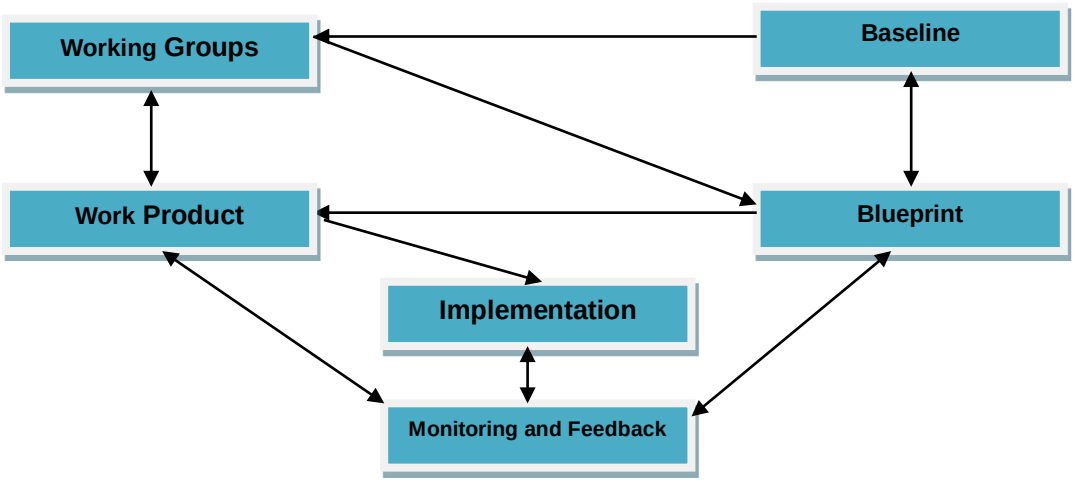
[10] Knowledge attributes for occupations are defined by the Occupational Information Network: http://www.onetonline.org/.

[11] JobsEQ® is copyright © 2011, Chmura Economics & Analytics. All Rights Reserved. JobsEQ is protected by U.S. Patent 7,480,659 and patents pending. For more information see http://www.chmuraecon.com/software_jobseq.aspx.

Phases for Workforce Planning



The phases in the workforce project are shown in the blue boxes in the workflow presented above.

- Phase one delivered a baseline of the secondary data for the aviation and aerospace industry, which provided the 'as is' workforce profiles that were supplemented with surveys, interviews, and focus group events.
- Phase two identified key players from both the supply and demand side of the labor equation. The working group members, who are thought leaders from multiple industries throughout the nation, came together and discussed common needs for workforce planning.
- Phase three brought the data from the baseline together with the inputs from the thought leaders (suppliers and consumers of labor) to create a 'blue print' analysis for the 'should be' workforce. The 'should be' workforce is an array of demand occupations that embody overlapping skills and competencies. If the key workforce indicators were corrected and accounted for, the Commonwealth's aviation and aerospace would be closer to being in a desired 'steady state' for human capital.
- Phase four was the creation of the final 'work product' which is embodied in this report. The work product describes the workforce model and best practices. It was shared with a group of reviewers along with a scoping document for their particular comments.
- Phases five and six represented the implementation of the model, monitoring, and a feedback loop for refreshing the data sets on an ongoing basis. The ongoing synthesis of secondary data and primary research from both industry experts and subject matter experts can help position strategies throughout the aviation and aerospace organizations. *[For more detail, see pages 15 and 22 – 24.]*

The BusinessEQ® portal allows the DOAV to adjust forecasting data for events, such as firm expansions that change the types of occupations in the current forecast.

The industry and occupation forecasts underlying the aviation and aerospace workforce planning efforts need to be updated in a real-time manner to anticipate changes in the workforce due to changes in the types of firms in the region. This capability allows the Commonwealth to modify strategic responses to changes in the workforce landscape. To this end, BusinessEQ delivered this functionality to DOAV staff to input validated events into the JobsEQ system to produce updated projections based on events like firm expansions, contractions, and relocations of firms. *[For more detail, see page 23.]*

As the landscape of the economy and the workforce change over time, the model is easily adaptable to include macroeconomic and workforce changes that occur as the baseline data change. The model is a "pull strategy" that is powered by JobsEQ®, a leading information technology source for developing human capital policy in the state and the nation. The combination of primary data from BusinessEQ brings the lags in the historical secondary data (JobsEQ) forward based on real-time data. Further, the secondary data outputs from JobsEQ include estimates that are revised as the data are refreshed on an ongoing basis.

Recommendations

Better alignment between workforce supply and employer needs for talent development is highly recommended. Policy alignment to maximize regional effectiveness points to systemic change in Virginia's approach to workforce planning.

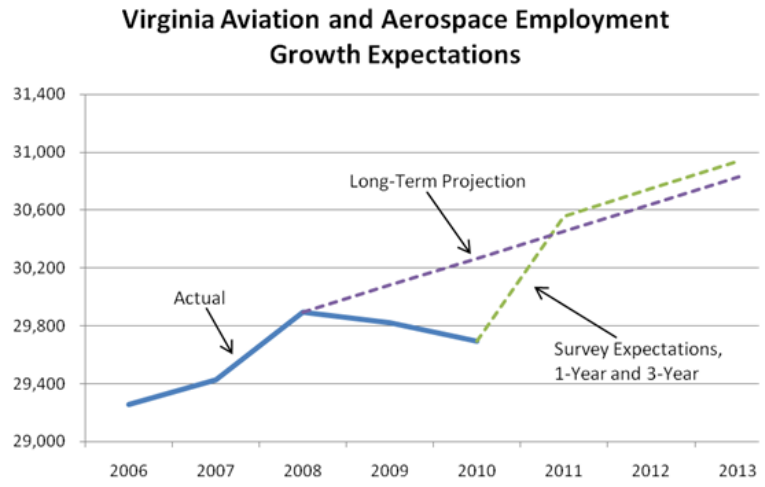
To improve the supply of skilled workers into the workforce network, Virginia's policies need to be coordinated, comprehensive, and congruent. STEM initiatives have made their way to the center of the policy agenda for most states. States with a competitive advantage in aviation and aerospace are facing a skills crisis due to structural changes within the supply chain of workers for aerospace and aviation jobs. These structural changes are due to an aging workforce, the need to upskill workers due to new technologies such as those predicted from the NextGen initiative, a non-integrated supply-chain, and a waning interest in STEM careers. STEM policies need to be supported by replacing the cracks in the P-20 pipeline--as long as the pipeline continues to lose students to less-skilled disciplines, STEM will not address the many issues facing aviation and aerospace. Too many students today back away from STEM majors because they lack the math and problem-solving skills embodied in STEM disciplines. These cracks in the talent pipeline underpin competitiveness and increase underemployment.

Workforce strategic plans should focus on regional goals.

The policies most directly tied to the need for skilled workers for the next several years grew out of the work of the Jobs Commission, the Higher Education Commission, and the Innovation Funding Bill. In order to position the workforce needs at the center of Virginia's current policy platform, this state of the workforce report recommends that the language of these policies be considered as part of the overall need for an integrated strategic plan for Virginia's regional aviation and aerospace workforce development. Skill requirements vary by region because industries located in each region varies.

Industries in addition to Virginia's aviation and aerospace industry should identify potential workforce gaps by supplementing secondary labor data with primary data.

The chart below illustrates how primary data (surveys) track with the long-term industry projections (actual are the secondary data from JobsEQ) preceding and trailing the latest recession (2007—2009). Industry projections set a trajectory so that educators and training providers can reduce the gaps between the supply of workers and the demand for their skills in Virginia's aviation and aerospace industry.



Source: JobsEQ Suite (includes survey data input into BusinessEQ).

2. Introduction

Virginia's aviation and aerospace industry has been a contributor to the growth in the national space and aviation industry as early as 1917.[12] Virginia's strategic location on the Atlantic Coast and proximity to the nation's capital were contributing factors to the development of several prominent aviation and aerospace installations in the state. For example, NASA's Langley Research Center, the National Institute of Aerospace, and the Wallops Flight Facility are east-coast facilities within a 170 mile radius of the District of Columbia and 190 miles of the state capital in Richmond. In fact, two of the major airports serving the Washington D.C. metropolitan area—Dulles International and Reagan National—are located in Northern Virginia.

As part of the continual assessment of aviation and aerospace on the Virginia economy, the Virginia Department of Aviation (DOAV) has conducted major studies to understand the impact from the aviation and aerospace industry on the economy. It commissioned two major economic impact studies in 2010—*Economic Impacts of the Aerospace Industry in Virginia*, and *Economic Impacts of the Aviation Industry in Virginia*. Taken together, both of these studies support the view that the aviation and aerospace industries are important to the state's economic growth.

Since the current and future vigor of the aviation and aerospace industry in Virginia depends, in part, on its ability to maintain and sustain a pipeline of workers that meet the industry's needs for talent, the DOAV wanted to further understand its economic footprint from the human capital perspective. To this end, the Performance Management Group (PMG) of Virginia Commonwealth University (VCU) contracted Chmura Economics & Analytics (Chmura) on behalf of the DOAV to conduct a workforce study of the aviation and aerospace industry in Virginia. This study, *The Virginia Aviation and Aerospace Workforce Report: 2011,* is the blueprint to both benchmark and forecast the 'as is' workforce to the 'should be' workforce through 2020. In addition to providing a baseline for the workforce in the current industry mix (the "as is" workforce), it provides the gaps between the supply and demand forces shaping the workforce mix, such as new trends and technologies that have been deployed to the aviation and aerospace industry.

This report assesses how best to recruit, train, retrain, and retain an adequate number of people with the appropriate skills for the industry's jobs of the short, mid, and long-term future—the "should be" workforce. Geographically, this study provides a workforce analysis of the aviation and aerospace industry in Virginia as an aggregate, as well as in the state's 11 metropolitan statistical areas (MSAs), its 21 Planning District Commissions (PDC), and its 15 Workforce Investment Areas (WIAs).[13]

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[12] The nation's first civilian laboratory on flight was located in Hampton, Virginia. Source: http://www.nasa.gov/centers/langley/about/history.html, accessed December 20, 2010.
[13] The regional definitions are in Section 3.

3. Methodology

This section explains Chmura's approach to data collection, surveys, and its analytical evaluation of the workforce in Virginia's aviation and aerospace industry. Aside from the research needed to identify workforce issues is the application of the findings to effectively reduce the current and expected gaps in skills for the aviation and aerospace industry. From this perspective, a best practices approach was used, in which practices in other industries in Virginia and other states were reviewed to identify parallel methods to identify and reduce gaps.

3.1. Best Practices

Human capital development resides in a continuum between education and employability. Students enter into lifelong learning as early as preschool. Workers move in and out of learning phases as they adapt to changes in the demand for their skills. Employers' needs for human capital change as they find more productive ways to deliver products and solutions to the marketplace. Anticipating the changes in workforce skills development in response to changes in macroeconomic conditions is central to regional workforce development planning. Part of the anticipation comes from having a reliable template from which to model change. In the case of human capital, the capacity for creating a world-class workforce is impacted by the flexibility of the overall workforce system. At the core of a workforce development model is a data management system that coordinates and integrates the required data across the education, training, and employer spectrum.

The Virginia Aviation and Aerospace Workforce Report: 2011 was designed to help Virginia's aviation and aerospace industry adopt regional core relationships between the suppliers of talent and the employers that need workers. Understanding the very fluid nature of workforce development for this industry sector against a set of common best practices was accomplished in a model that integrated information from focus groups with industry experts (the Working Smarter Alliance), business surveys, and discussions with subject matter experts along with labor market data (JobsEQ®). The role of the aviation and aerospace alliance was to provide the collective best practices from industry leaders from both within and external to the Commonwealth.

The alliance leadership along with primary (focus groups/surveys) and secondary data (JobsEQ) provided an interactive approach toward capturing the current state of workforce development planning. The outcomes provided the foundation for mapping human capital capacity impacts in the short, medium, and long-term forecasts for labor in these industries. A central theme toward achieving the goals for the workforce study rests in the adoption of reliable and credible workforce indicators for monitoring and measuring change. The baseline data provide the key trends for both historical performance and the workforce trajectories for the future labor trends in aviation and aerospace.

3.2. Working Smarter Alliance

The Virginia Aviation and Aerospace Workforce Report: 2011 includes input from a wide range of business and community leaders currently engaged in aviation and aerospace workforce development. In addition to business

surveys and discussions with subject matter experts, a consortium was established to guide and review the results and analysis of the report:[14]

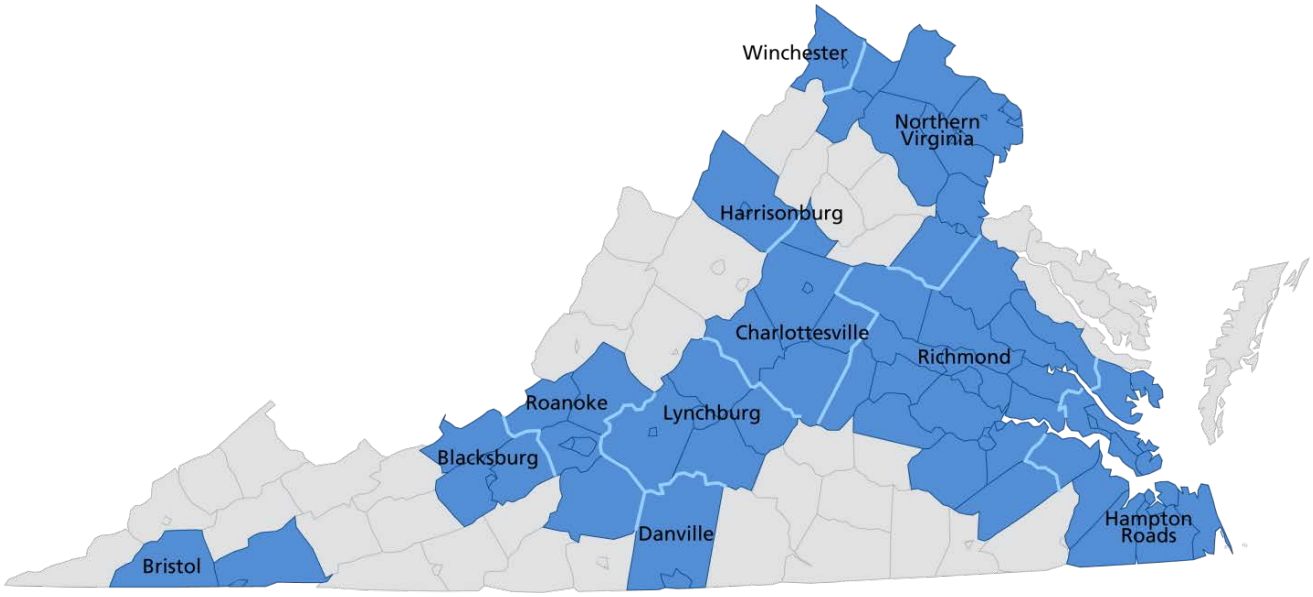
Working Smarter Alliance – The Working Smarter Alliance (working groups) met for a one-day workshop on March 9, 2011. The agenda included an overview of the project's goals and timeline, a review of the national economy, and break-out sessions (working groups). The objectives for this event were to (1) engage thought leaders and subject-matter experts into the development of the regional work product (the best practice model prototype) and (2) to collect primary research around the needs for the supply of demand occupations and talent to aviation and aerospace in the future.

- The members of the working groups represented:
    - The Virginia Lieutenant Governor's Office
    - The Virginia Department of Aviation
    - ACT, Inc.
    - The MathScience Innovation Center
    - Virginia Tech
    - NASA Langley Research Center
    - Virginia Community College System
    - National Association of Manufacturers
    - Virginia Space Grant Consortium
    - Virginia's Center for Innovative Technology
    - The Office of the Virginia Secretary of Education

3.3. Defining the Study Region

The aviation and aerospace workforce was analyzed for Virginia as an aggregate labor market, as well as regional labor sheds for each of Virginia's eleven metropolitan statistical areas, 21 planning district commissions, and 15 workforce investment areas. Detailed data for each MSA, PDC, and WIA are included in appendices 4 through 6.

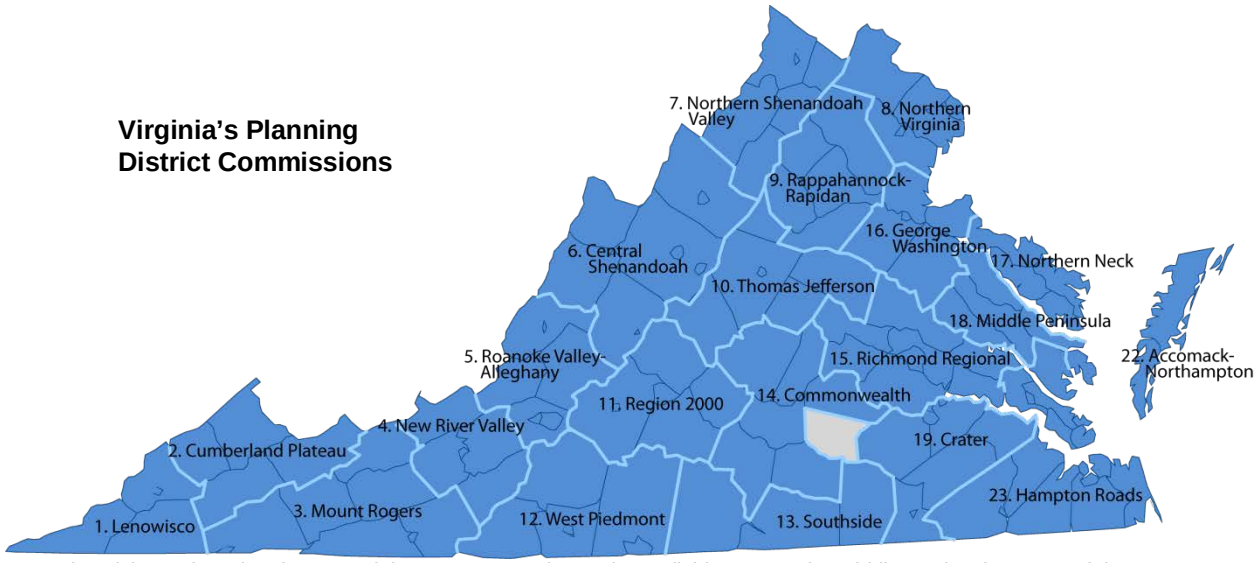
[14] A project portal was provided for the consortium and working groups to receive additional feedback after the initial meeting.



Virginia's MSAs are shown in the table below as defined by the U.S. Office of Management and Budget (OMB).

Virginia Metropolitan Statistical Area (MSA) Definitions				
MSA	**Localities**			
Blacksburg	Giles	Montgomery	Pulaski	Radford
Bristol	Scott	Washington	Bristol	
Charlottesville	Albemarle	Fluvanna	Greene	Nelson
	Charlottesville			
Danville	Pittsylvania	Danville		
Harrisonburg	Rockingham	Harrisonburg		
Hampton Roads	Gloucester	Isle Of Wight	James City	Mathews
	Surry	York	Chesapeake	Hampton
	Newport News	Norfolk	Poquoson	Portsmouth
	Suffolk	Virginia Beach	Williamsburg	
Lynchburg	Amherst	Appomattox	Bedford	Campbell
	Bedford	Lynchburg		
Northern Virginia	Arlington	Clarke	Fairfax	Fauquier
	Loudoun	Prince William	Spotsylvania	Stafford
	Warren	Alexandria	Fairfax	Falls Church
	Fredericksburg	Manassas	Manassas Park	
Richmond	Amelia	Caroline	Charles City	Chesterfield
	Cumberland	Dinwiddie	Goochland	Hanover
	Henrico	King And Queen	King William	Louisa
	New Kent	Powhatan	Prince George	Sussex
	Colonial Heights	Hopewell	Petersburg	Richmond
Roanoke	Botetourt	Craig	Franklin County	Roanoke
	Roanoke	Salem		
Winchester	Frederick	Winchester		
Source: U.S. Census; Note: cities are shown in blue.				

Virginia contains 21 planning district commissions (PDCs), shown in the table below, that represent local government associations that foster intergovernmental cooperation by involving local elected and appointed officials as well as citizens to discuss common needs and establish solutions to regional issues.[15]



Note: The Richmond Regional PDC and the Crater PDC share Chesterfield County. The Middle Peninsula PDC and the Hampton Roads PDC share Gloucester County. The Crater PDC and the Hampton Roads PDC share Surry County. The Roanoke Valley PDC and the West Piedmont PDC share Franklin County.

Virginia Planning District Commission (PDC) Definitions				
PDC Number and Name	Localities			
1-LENOWISCO	Lee	Norton	Scott	Wise
2-Cumberland Plateau	Buchanan	Dickenson	Russell	Tazewell
	Bland	Bristol	Carroll	Galax
3-Mount Rogers	Grayson	Smyth	Washington	Wythe
	Floyd	Giles	Montgomery	Pulaski
4-New River Valley	Radford			
	Alleghany	Botetourt	Covington	Craig
5-Roanoke Valley	Roanoke	Roanoke	Salem	Franklin
	Augusta	Bath	Buena Vista city	Harrisonburg city
	Highland	Lexington	Rockbridge	Rockingham
6-Central Shenandoah	Staunton	Waynesboro		
	Clarke	Frederick	Page	Shenandoah
7-Northern Shenandoah Valley	Warren	Winchester		
	Alexandria	Arlington	Fairfax city	Fairfax
	Falls Church	Loudoun	Manassas	Manassas Park
8-Northern Virginia	Prince William			

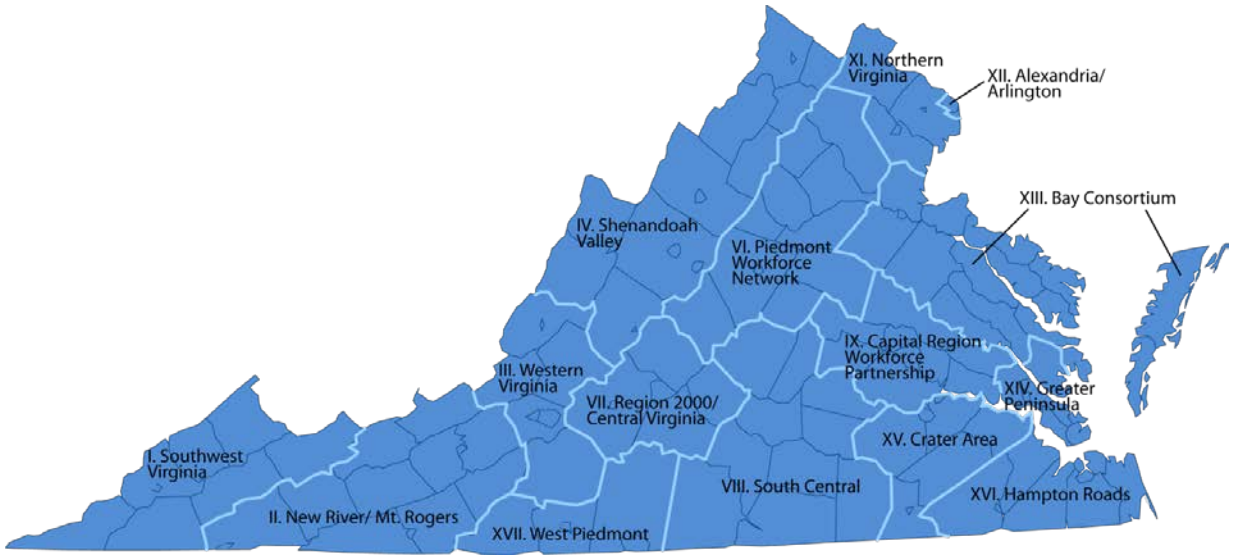
[15] Source: http://www.dhcd.virginia.gov/CommissiononLocalGovernment/pages/PDC.htm. Accessed December 18, 2010.

Virginia Planning District Commission (PDC) Definitions				
PDC Number and Name	Localities			
	Culpeper	Fauquier	Madison	Orange
9-Rappahannock-Rapidan	Rappahannock			
	Albemarle	Charlottesville	Fluvanna	Greene
10-Thomas Jefferson	Louisa	Nelson		
	Amherst	Appomattox	Bedford	Bedford
11-Region 2000	Campbell	Lynchburg		
	Danville city	Franklin	Henry	Martinsville
12-West Piedmont	Patrick	Pittsylvania		
13-Southside	Brunswick	Halifax	Mecklenburg	
	Amelia	Buckingham	Charlotte	Cumberland
14-Commonwealth Regional Council	Lunenburg	Prince Edward		Hanover
	Henrico	New Kent	Powhatan	Richmond
	Caroline	Fredericksburg	King George	Spotsylvania
16-George Washington Regional	Stafford			
17-Northern Neck	Lancaster	Northumberland	Richmond	Westmoreland
	Essex	Gloucester	King and Queen	King William
18-Middle Peninsula	Mathews	Middlesex		
	Colonial Heights city	Dinwiddie	Emporia	Greensville
	Hopewell	Petersburg	Prince George	Surry
19-Crater	Sussex	Chesterfield	Charles City	
22-Accomack-Northampton	Accomack	Northampton		
	Chesapeake	Franklin city	Hampton city	Isle of Wight
	James City	Newport News	Norfolk	Poquoson
	Portsmouth	Southampton	Suffolk	Virginia Beach
23-Hampton Roads	Williamsburg	York	Gloucester	Surry

Source: Virginia Association of Planning District Commissions
Note: The Richmond Regional PDC and the Crater PDC share Chesterfield County. The Middle Peninsula PDC and the Hampton Roads PDC share Gloucester County. The Crater PDC and the Hampton Roads PDC share Surry County. The Roanoke Valley PDC and the West Piedmont PDC share Franklin County

Note: cities are shown in blue.

Virginia contains 15 workforce investment areas (WIAs) as shown in the map below, that are created to increase the employment, retention, earnings and occupations skills of participants, resulting in an improved workforce.[16]



3.4. Definition of the Aviation and Aerospace Industry

The federal government classifies firms into industries for statistical purposes based on the process by the product or service created. The system is called the North American Industry Classification System (NAICS). Oftentimes, however, there is an interest in tracking industries that cross over more than one NAICS sector. High-technology industries are one such example. Since the aviation and aerospace industry spans several NAICS codes, defining the components of the industry is required before beginning the workforce analysis.

There is no nationally accepted standard definition of the aviation and aerospace industry. The definition used in this study combines some of the industries that made up the definitions of the two economic impact studies conducted for DOAV in 2010, one for the aerospace industry[17] and the other for the aviation industry.[18] The full industry definitions for both of these studies are provided in Appendix 4: 2010 Aviation and Aerospace Industry Definitions in Virginia.

Industry lists from the two studies were carefully reviewed to reach the list in the table below and was adopted as the definition for the aviation and aerospace industry used in this workforce study. All nine of the industries in the previous aerospace study are included in this study. Three additional industries unique to the aviation industry

[16] Source: http://myfuture.vccs.edu/WorkforceServices/VirginiaWorkforceNetwork/tabid/693/Default.aspx, accessed on December 20, 2010.

[17] *Virginia's Aerospace Industry: An Economic Impact Analysis* prepared by Chmura Economics & Analytics in collaboration with Virginia Commonwealth University's Performance Management Group for Randall Burdette, Director, Virginia Department of Aviation, November 2010.

[18] The aviation economic impact is expected to be completed in June 2011.

were added (air transportation, airport operations, and other support activities for air transportation) to create an aviation and aerospace industry that included twelve industries.[19]

Definition of the Aviation and Aerospace Industry			
NAICS	Description	Sector	Percent of Total Employment
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	Manufacturing	11.4
336411	Aircraft Manufacturing	Manufacturing	1.7
336412	Aircraft Engine and Engine Parts Manufacturing	Manufacturing	0.2
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing	Manufacturing	2.8
336414	Guided Missile and Space Vehicle Manufacturing	Manufacturing	>5.0
336415	Guided Missile and Space Vehicle Propulsion Units	Manufacturing	>0.5
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment	Manufacturing	0.0
481	Air Transportation	Transportation	47.3
48811	Airport Operations	Transportation	14.2
48819	Other Support Activities for Air Transportation	Transportation	7.6
517410	Satellite Telecommunications	Information	1.4
611512	Flight Training	Education	0.7
927110	Space Research and Technology	Public Administration	>7.0
Source: Chmura Economics & Analytics			

As shown in the last column of the table above, air transportation (NAICS 481) makes up 47.3% of all aviation and aerospace jobs and is at the 3-digit NAICS level with diverse industry sub-sectors such as scheduled and non-scheduled air transportation, which vary in the type of skills required for employees. For that reason, the more detailed NAICS industries are analyzed in the remainder of this report.

The expanded definition of aviation and aerospace shown in the table below contains 18 industries. However, detailed sub-industry data shown in the tables in the remainder of this study contain information on only 17 industries because Virginia does not contain any firms identifying themselves as manufacturing "other guided missiles and space vehicle parts and auxiliary equipment (NAICS 336419). Airport operations (NAICS 48811) is also included in the remainder of this report at the level of its two 6-digit NAICS industries: air traffic control and other airport operations.[20]

[19] The aviation study included visitor spending sectors such as ground transportation, restaurants, and hotels, which are not included in the aviation and aerospace industry study used in this report.

[20] Note that NAICS 926120, regulation and administration of transportation programs, is not included in the definition. This industry includes the Federal Aviation Administration, the Transportation Security Administration, and Virginia Department of Aviation, and the Metropolitan Washington Airports Authority. However, more than half of the employment in this industry in Virginia is devoted to non-aviation organizations such as the Virginia Department of Motor Vehicles and the Coast Guard. Thus this industry was omitted from the formal definition so as to not introduce a large faction of activity unrelated to aviation and aerospace.

Detailed NAICS definitions for the 18 aviation and aerospace industries are found in Appendix 7 of the Appendix document.

Expanded Definition of the Aviation and Aerospace Industry		
NAICS	Description	Sector
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument 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 Units	Manufacturing
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment	Manufacturing
481	Air Transportation (including 5 6-digit NAICS sub-industry)	Transportation
481111	*Scheduled Passenger Air Transportation*	
481112	*Scheduled Freight Air Transportation*	
481211	*Nonscheduled Air Passenger Chartering*	
481212	*Nonscheduled Air freight Chartering*	
481219	*Other Nonscheduled Air Transportation*	
48811	Airport Operations (including 2 6-digit NAICS sub-industry)	Transportation
488111	*Air Traffic Control*	
488119	*Other Airport Operations*	
48812	Other Support Activities for Air Transportation	Transportation
517410	Satellite Telecommunications	Information
611512	Flight Training	Education
927110	Space Research and Technology	Public Administration
Source: Chmura Economics & Analytics		

3.5. Data Collection Method

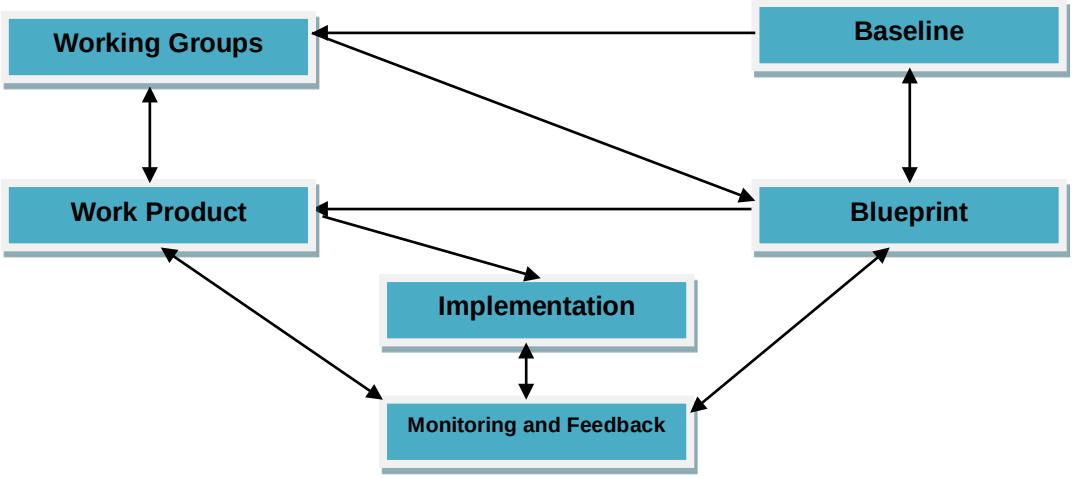
Chmura used a blend of secondary and primary data sources for this analysis. Secondary data provided baseline information regarding the "as is" nature of the region's economy, which underpins workforce and education capacity. The secondary data sources are mainly:

- Virginia quarterly census of employment and wages (QCEW) data
- Chmura's proprietary JobsEQ® database
- NETS database that provides employment and sales for 8-digit standard industrial classification (SIC) industries based on Dun & Bradstreet data
- U.S. Bureau of Labor Statistic skills categories based on education requirements
- National Center for Education Statistics, which identifies the curriculum taught in Virginia and the number of graduates by education level

Primary data augmented secondary data with insights into issues and challenges unique to Virginia's aviation and aerospace industry with a focus on new trends and technologies. The primary data were surveys and subject matter expert interviews. Business surveys were conducted with businesses in the aviation and aerospace industry to understand their employment needs from the short, mid, and long-term perspective. Expert interviews were conducted with industry leaders, education leaders, and community leaders. Interviews with education experts focused on the initiatives in the region's education communities and their future plans for changes in

human capital education, while interviews with industry experts focus on the demand trends in the industry and related-skills competencies. The survey instrument and responses by employers were used to supplement forecasts for labor and to identify new trends in the industry.[21]

Phases in Regional Workforce Planning (The Business Process)



The baseline analysis was developed using JobsEQ outputs. Starting with the baseline in the upper right corner, the aviation aerospace industries were analyzed for their current mix of industries and occupations. The baseline provided a 'snap shot' of the regions' capacity for human capital development.[22] The secondary data from JobsEQ have lagging data. To augment the lags in these datasets, the baseline and forecasts were adjusted with primary data from both the Working Smarter Alliance (focus group and thought leaders) and with an industry-wide survey of the businesses in the aviation and aerospace industry.

The methodology included a blueprint design for the 'should be' workforce to gain a closer alignment between the education and skills in demand by employers and the capacity of the current talent pipeline to meet that demand. The blueprint design expanded the baseline analysis to allow for economic development impacts in the aviation and aerospace industry. The goal for this project is to better inform job seekers and training providers/educators with the best information about occupations that will be in demand in the aviation and aerospace.

The blending of public and primary data was selected because it addressed the short-term regional-specific needs as defined by businesses and firms[23] with the longer-term forecasts for labor based on such macroeconomic factors as national growth, international competitiveness, productivity, and demographics. Because a continued rationalization for the supply of skills is needed, this approach was first differentiated into a conceptual model and then compared and contrasted to existing best practices from around the nation.

Publically available employment data can lag between three and six months. To adjust the lags in workforce indicators with the current voice of the customer, Chmura and Performance Management Group (PMG) engaged thought leaders and subject matter experts through focus group events and surveys. The lagging data were also

[21] Completed questionnaires, survey summaries, and interview summaries were provided in the appendices of this report.
[22] The baseline analysis was developed in the fourth quarter of 2010 using JobsEQ®.
[23] BusinessEQ is the proprietary software created by Chmura to collect business-specific forecasts on an ongoing basis.

updated with the validated needs from economic developers (announcements of firms expanding into the state) and firm expansion plans.

The outcomes from this approach helped create strategies for workforce development practitioners throughout the aviation and aerospace industry. As the landscape of the economy and the workforce change over time, the model is easily adaptable to include macroeconomic and workforce changes that occur as the baseline data change. The model is a "pull strategy" and is powered by JobsEQ®, a leading information technology source for developing human capital policy in the state and the nation.

3.6. Analysis Methodology

Analysis of the current and future workforce depended on the labor supply and demand projections that provided the 'pull' strategies for potential policy applications. In Virginia's aviation and aerospace industry, labor demand comes from the organic expansion and contraction of industries. These changes occur in response to demographic shifts, retirements, and turnovers in the workplace. Several factors drive the future demand of occupations in an industry. The first is the national and state economic and demographic trends. For example, manufacturing employment in the nation continues to decline as firms move offshore or become more efficient. In contrast, surging high-tech product sales has increased the demand for U.S. workers in high-tech industries.

Innovation and government policies also drive workforce growth. Emerging technologies alter the demand for particular occupations based on product obsolescence and the introduction of new products and services. The increase in security at airports and the creation of new products to ensure safety is an example of this trend in aviation. Both the aviation and aerospace industry are also impacted by changes in the national defense budget. Many Virginia firms serve the U.S. Department of Defense including Orbital, Northrop Grumman, and Raytheon.

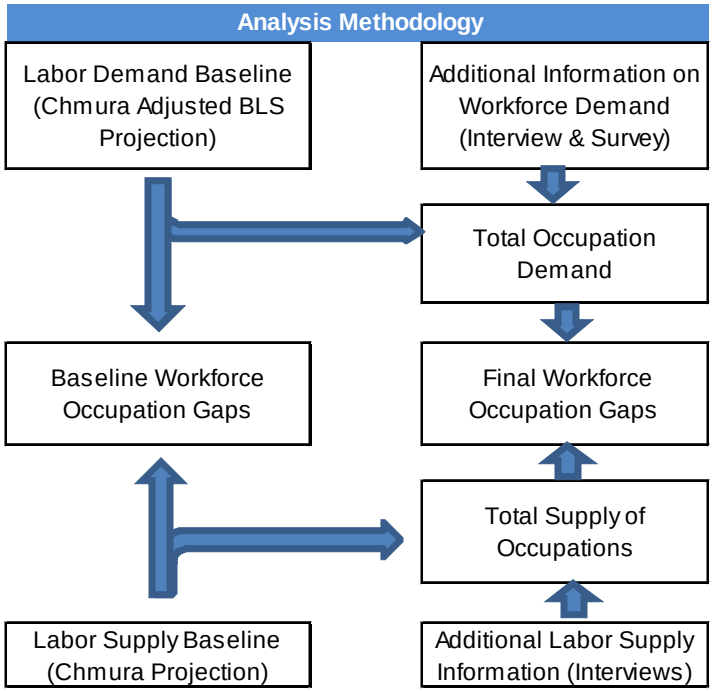
The Next Generation Air Transportation System (NextGen), which is expected to be implemented between 2012 and 2025, is likely to cause significant changes in workforce needs over the need decade.[24] The Federal Aviation Administration (FAA) is leading this transformation of the National Airspace System (NAS). According to the FAA:

> At its most basic level, NextGen represents an evolution from a ground-based system of air traffic control to a satellite-based system of air traffic management. This evolution is vital to meeting future demand, and to avoiding gridlock in the sky and at our nation's airports.
>
> NextGen will open America's skies to continued growth and increased safety while reducing aviation's environmental impact.
>
> We will realize these goals through the development of aviation-specific applications for existing, widely-used technologies, such as the Global Positioning System (GPS) and technological innovation in areas such as weather forecasting, data networking and digital communications. Hand in hand with state-of-the-art technology will be new airport infrastructure and new procedures, including the shift of certain decision-making responsibility from the ground to the cockpit.

[24] http://www.faa.gov/about/initiatives/nextgen/media/NGIP_3-2010.pdf, accessed January 21, 2011.

> When fully implemented, NextGen will allow more aircraft to safely fly closer together on more direct routes, reducing delays and providing unprecedented benefits for the environment and the economy through reductions in carbon emissions, fuel consumption and noise.[25]

The *Aviation and Aerospace Workforce Study: 2011* estimates labor demand using the national ten-year employment projection prepared by the U.S. Bureau of Labor Statistics as the starting point (see schematic below).[26] Chmura adjusted the national forecasts for the regional industry mix, regional employment growth expectations, along with the inclusion of the primary data gleaned from the industry expert interviews and the business survey instrument. To estimate labor supply, Chmura first derived a baseline forecast based on the regional population growth trends and a variety of demographic factors including educational attainment. Finally, comparing labor demand and supply enabled Chmura to identify workforce shortages and surpluses and to frame strategies to address those issues.



[25] http://www.faa.gov/nextgen/why_nextgen_matters/what/, accessed January 21, 2011.
[26] Source: Employment Projections: 2008-2018, U.S. Department of Labor. This study can be found at: http://www.bls.gov/news.release/ecopro.toc.htm.

4. Economic and Industry Baseline

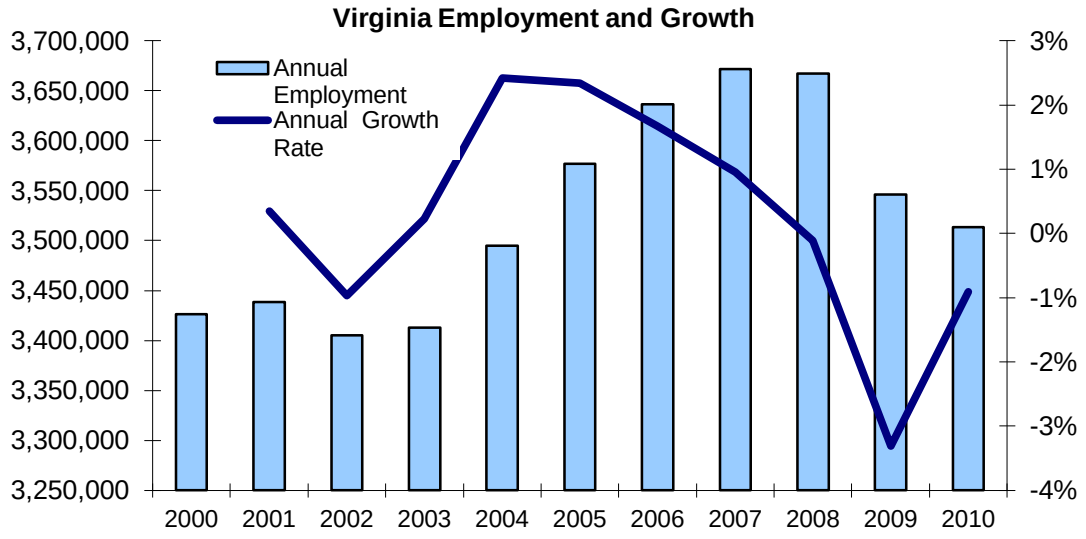
The baseline growth of the Virginia and U.S. economies are analyzed along with the aggregated aviation and aerospace industry in the Commonwealth to provide a context for future growth. All industries, including aviation and aerospace, are affected to some degree by the national business cycle. For that reason, the national environment is reviewed alongside that of Virginia. To the degree that industries, such as aviation, are driven by local demand, the relative health of the state will also impact industry growth. Section 4.1 discusses the overall employment, wages, and industry mix in Virginia: the regional definitions include the MSAs, the PDCs, and the WIAs in Virginia relative to the performance of the national economy; Section 4.2 provides more detail on the aviation and aerospace industry in Virginia.

As noted in Section 3.3, the aviation and aerospace industry is made up of a diverse set of industries. County-level data for the aggregate of each region are obtained from the U.S. Department of Labor quarterly census of employment and wages (QCEW). The latest data available at the level of detail needed are through the second quarter of 2010.

4.1. Virginia's Overall Economy

4.1.1. Overall Employment and Wages

Virginia's economy has grown faster than the nation's economy over the past few decades thereby providing ample opportunities for its residents and attracting workers from outside the state. Employment in Virginia grew 0.4% per year from 2000 through 2009—a faster pace than the 0.1% decline per year in the nation. In 2009, total wage and salary employment in Virginia amounted to 3.5 million.[27]



Source: Chmura Economics & Analytics, 2010 employment data reflect the first two quarters. 2010 growth rates compared average employment of first two quarters with average employment of 2009.

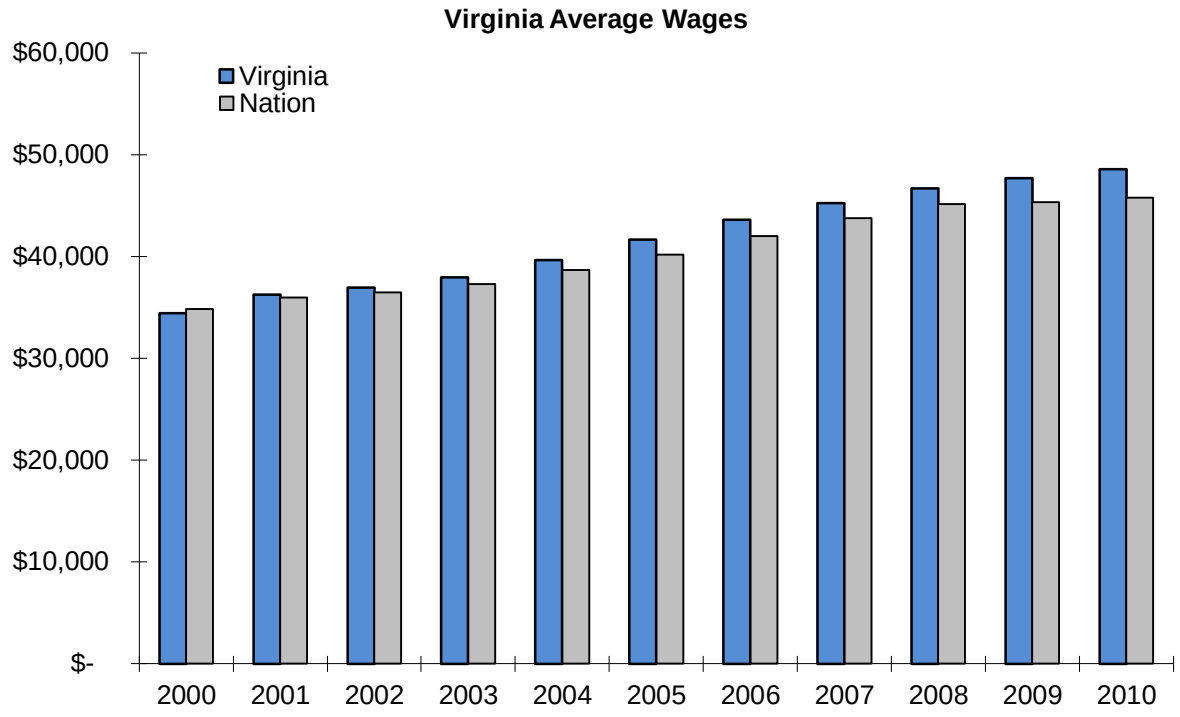
[27] The next section will estimate the size of proprietary employment in Virginia and its aviation and aerospace industries.

Even though Virginia grew at a faster pace than the nation since 2000, it was affected by the national recession that started in December 2007. Total employment dropped 0.1% in 2008 compared with a 0.4% decline in the nation before declining another 3.3% in 2009 compared with the 4.6% drop in the nation. For the seven years before the recession, Virginia employment expanded an average 1.0% per year.

Although the national recession officially ended in June 2009, the labor market remains weak in both the state and the nation. Employment fell by over 5,000 jobs in Virginia since the recession ended and through the second quarter of 2010. However, it grew by a modest 15,000 over the first two quarters of 2010. Trends in the nation have been similar with U.S. employment in June 2010 at lower levels than when the recession ended, but up 315,000 from January through June 2010. Even if employment in the nation were to grow at an average monthly rate of 200,000 (similar to growth during recent times of expansion), it would take until 2013 to regain the net loss of 8.5 million jobs that occurred during the recession. Based on the current pace of growth in Virginia, employment is likely to reach its pre-recession level in 2012.

Average wages reflect a number of factors, including cost of living and industry mix. In general, relatively higher and faster growing wages often point to a more productive and educated workforce whose skills are in demand. In fact, 33.2% of the population, aged 25 and older in Virginia, hold at least a bachelor's degree compared with 27.4% in the nation based on the American Community Survey, 2006-2008.

As shown in the chart below, average wages in Virginia have been higher than the national average since 2001. In 2009, the latest full year of data, the average wage was $47,672 for Virginia, compared with the national average of $45,333. Wages in Virginia have been growing an average 3.7% per year in nominal terms from 2000 to 2009 compared with 3.0% in the nation, which reflects the impact of slower growth from the severe recession that impaired the economy in 2008 and 2009. Prior to the recession, from 2004 to 2006, wages grew 4.8% a year in Virginia compared with 4.2% in the nation.



Source: Chmura Economics & Analytics, 2010 data reflect the first two quarters

High levels of unemployment and labor surpluses are likely to exist in Virginia for at least another year because of the recession, especially in industries that were hit hard such as construction, manufacturing, and banking. Even so, the unemployment rate in Virginia is generally lower than that of the nation because of its more highly educated workforce and diverse industry base. Based on the latest data available, the unemployment rate in Virginia was 6.8% in November 2010 compared with 9.8% in the nation.

Even during times of expansion, some firms will continue to shed jobs for a variety of reasons, such as declining sales from an obsolete product or productivity efficiencies. Changes in the demand for employees result in some workers becoming displaced while the need for workers in other industries grows. As noted later in this report, skills of the displaced workers are not always transferable to the requirements of expanding firms.

4.1.2. Major Industry Sectors

All industries in Virginia are classified into the following twelve major sectors:

- natural resources
- construction
- education and health
- financial activities
- government
- leisure
- other services[28]
- manufacturing
- professional and business services (PBS)
- trade
- transportation, warehousing, and utilities (TWU)

Industrial diversity buffers regions experiencing job losses when entire industries such as textiles are in decline. The percentage of a region's jobs provided by major industry sectors indicates the potential employment loss associated with secular decline or shocks to that industry. On the positive side, regions whose employment mix favors fast-growing industries experience strong employment growth.

Virginia possesses a favorable industry mix with education and health as the largest component, accounting for 21.7% of its workforce in 2009. This is followed by professional and business services (PBS), making up 18.5% of the state workforce. These two sectors have shown strong growth over the last decade and are expected to continue to grow at a sharp pace. Health and education are also more recession-proof than other sectors (such as manufacturing or construction) and has a steady demand for labor even during recessions. Moreover, occupations in these two sectors (education and health and PBS) are likely to be skilled occupations that require postsecondary education. Put another way, jobs in these sectors are high-paying and highly-skilled jobs coveted by all regions. The leisure and trade sectors round out the top four industry sectors in Virginia. The leisure sector also experienced employment growth in the past decade despite the recession while trade contracted slightly.

[28] This sector includes firms such as those such as beauty salons and photographers.

Major Sectors and Growth	Virginia					National (2009)	
	Industry Mix (2000)	Industry Mix (2009)	Employ-ment (2009)	Annual Employ-ment Growth (2000-2009)	Average Annual Wages (2009)	Industry Mix	Annual Average Wages
Construction	6.5%	5.7%	201,163	-1.1%	$45,305	4.8%	$49,167
Education and Health	17.6%	21.7%	770,653	2.8%	$41,932	23.3%	$43,219
Financial Activities	5.2%	5.0%	176,739	0.0%	$61,820	6.0%	$69,835
Government	6.2%	6.6%	235,602	1.2%	$66,961	5.8%	$53,923
Information	3.6%	2.4%	86,564	-3.8%	$73,990	2.3%	$69,146
Leisure	9.1%	10.2%	360,522	1.6%	$17,336	10.5%	$19,252
Manufacturing	10.7%	7.0%	246,880	-4.3%	$50,032	9.2%	$54,921
Natural Resources	0.7%	0.6%	20,141	-1.5%	$40,796	1.4%	$47,415
Other Services	3.7%	3.7%	131,857	0.5%	$36,506	3.6%	$29,627
Professional Business Services	16.8%	18.5%	656,676	1.5%	$72,759	13.0%	$58,313
Trade	15.5%	14.6%	518,817	-0.2%	$34,031	15.7%	$35,932
Transportation, Warehousing, and Utility	4.6%	4.0%	140,199	-1.2%	$49,015	4.6%	$49,576
Total	100.0%	100.0%	3,545,812	0.4%	$45,672	100.0%	$45,549
Source: Chmura Economics & Analytics							

Similar to the nation, manufacturing employment in the Commonwealth has been in long-term decline. From 2000 through 2009, manufacturing employment in Virginia contracted 4.3% per year on average, similar to the 4.2% annual decline in the nation. The information industry and several others also declined in Virginia in the past decade. The workforce implications from these contractions manifest a surplus of workers, particularly in the manufacturing and construction sectors. This situation creates structural unemployment, which means that some of the jobs lost may not be refilled even when job creation picks up. Not all of the unemployed workers have skills that are transferable to occupations in demand. Preparing displaced workers for jobs that are in demand will remain a challenge for workforce professionals and policy makers for years to come.

4.1.3. Location Quotients

The competitiveness of industries in a region affects whether the net flow of workers and firms will keep pace with the rest of the country. The measure provided in this section, the location quotient, assesses the competitive advantage of industries within Virginia relative to the nation. Specifically, a location quotient[29] of 1.25 or higher

[29] The location quotient measures the degree to which an industry is concentrated in a region relative to the nation. It is the ratio of the share of industry employment in the region to the same industry's share of employment in the nation.

indicates that the region possesses a competitive advantage in that industry. A location quotient larger than 1.00 indicates the region has a greater concentration of employment in the industry relative to the nation. However, regions can possess a competitive advantage in growing or declining industries. A high location quotient in a declining industry is bad news for a region—it indicates that the industry will be a drag on the region's overall employment growth.

The following table shows the top 14 industries (measured at the 3-digit NAICS level) in Virginia that possessed a competitive advantage in the second quarter of 2010. In total, these competitive industries employ 21% of all workers in Virginia.

Competitiveness of 3-digit NAICS-Level Industries in Virginia, 2010-Q2			
Industry Competitiveness 2010-Q2	Location Quotient	Employ-ment	Average Annual Wages
Space Research and Technology	>4.00	>2,000	>$100,000
National Security and International Affairs	>3.50	>50,000	>$90,000
Monetary Authorities-Central Bank	>3.00	>1,000	>$85,000
Funds, Trusts, and Other Financial Vehicles	>2.00	>5,000	>$50,000
Administration of Economic Programs	2.10	39,218	$75,409
Professional, Scientific, and Technical Services	1.86	387,402	$89,064
Museums, Historical Sites, and Similar Institutions	1.75	9,356	$30,332
Admini. of Housing Programs, Urban Planning, Community Development	1.61	4,391	$50,091
Data Processing, Hosting and Related Services	1.60	10,896	$81,212
Heavy and Civil Engineering Construction	1.58	39,054	$47,864
Justice, Public Order, and Safety Activities	1.46	77,021	$57,071
Management of Companies and Enterprises	1.46	74,469	$98,557
Wood Product Manufacturing	1.42	13,074	$32,832
Beverage and Tobacco Product Manufacturing	1.42	6,983	$66,717
Source: JobsEQ®			

The location quotient for space research and technology in Virginia was higher than any other industry in the state with a value greater than 4.0.[30] It also possessed the highest average annual average wage of the competitively-advantaged industries, paying more than $100,000 in the second quarter of 2010 on an annualized basis. The second-largest competitively-advantaged industry in Virginia is national security and international affairs, with a location quotient greater than 3.5, followed by monetary authorities (central banks). Virginia's competitiveness in these industries is likely attributed to the proximity of the state to nation's capital. As a result of this relationship,

$$LQ = \frac{\text{Employment in industry i in area j} \big/ \text{Total employment in area j}}{\text{Total U.S. employment in industry i} \big/ \text{Total U.S. employment}}$$

[30] Due to the disclosure policies of the U.S. Department of Labor, the exact value of the location quotient, employment, and wages cannot be displayed if the 3-digit NAICS is made up of less than three firms or if one firm employs 80% or more of the total employment.

many federal agencies have installations in Virginia—including space research and technology, a component of the aviation and aerospace industry.

Based on the number of people employed, Virginia's greatest competitive advantage is in professional, scientific, and technical services. This industry employed 387,402 workers with an average annualized wage of $89,064 in the second quarter of 2010. It is made up of firms that provide services such as legal, accounting, architectural and engineering, interior and graphic design, computer system design, management, consulting, and scientific research and development. Other competitive advantage industries employing a large number of workers in Virginia include justice and safety (77,021 workers), and management of enterprises and companies (74,469 workers).[31]

In summary, the competitiveness of Virginia industries lies in government and high-tech sectors such professional and technical services. The federal government sector generally is stable, which has helped the Commonwealth weather the recent recession. The high-tech industry enjoyed strong growth in the past and will need to be leveraged to develop regional strengths in emerging industries. Only two of Virginia's competitive industries are in manufacturing (wood products and beverage and tobacco products).

4.1.4. MSA Employment and Wage Summary

Eighty-eight percent of Virginia's employment is located in its eleven metropolitan statistical areas. Based on 2009 employment, the largest metro area in Virginia is Northern Virginia. With 1.2 million wage and salaried jobs, it accounted for 35% of all Virginia employment in 2009. The Hampton Roads and Richmond metro areas ranked second and the third, accounting for 20% and 16% of state employment. There is a significant drop in terms of employment beyond the top three MSAs. Among the other metro areas, only the Roanoke MSA employed more than 100,000 people in 2009.

Virginia Metropolitan Statistical Area Employment and Wage Summary				
	Annual Employment 2009	Annual Wages 2009	Annual Employment Growth Rate (2000-09)	Annual Wage Growth Rate (2000-09)
Blacksburg	62,218	$35,169	-0.5%	3.0%
Bristol	36,621	$32,683	-0.3%	3.4%
Charlottesville	93,742	$42,331	0.9%	3.8%
Danville	37,789	$30,595	-2.0%	2.2%
Hampton Roads	706,331	$39,313	0.3%	3.8%
Harrisonburg	57,871	$34,654	0.6%	3.2%

[31] According to the U.S. Census, "management of companies and enterprises" includes "three main types of establishments: (1) those that hold the securities of (or other equity interests in) companies and enterprises; (2) those (except government establishments) that administer, oversee, and manage other establishments of the company or enterprise but do not hold the securities of these establishments; and (3) those that both administer, oversee, and manage other establishments of the company or enterprise and hold the securities of (or other equity interests in) these establishments. Those establishments that administer, oversee, and manage normally undertake the strategic or organizational planning and decision making role of the company or enterprise." Source: http://www.census.gov/cgi-bin/sssd/naics/naicsrch?code=551&search=2007 NAICS Search, accessed December 27, 2010.

Virginia Metropolitan Statistical Area Employment and Wage Summary				
	Annual Employment 2009	Annual Wages 2009	Annual Employment Growth Rate (2000-09)	Annual Wage Growth Rate (2000-09)
Lynchburg	98,759	$35,301	-0.4%	2.8%
Northern Virginia	1,235,226	$62,879	1.2%	3.7%
Richmond	579,582	$44,883	0.2%	3.2%
Roanoke	149,502	$37,588	-0.3%	3.1%
Winchester	48,057	$38,390	0.7%	3.4%
State Total	3,545,812	$47,672	0.4%	3.3%
Source: Chmura Economics & Analytics				

Northern Virginia is not only the largest MSA in Virginia; it also grew the fastest in the past decade. From 2000 to 2009, employment in the region grew at an average rate of 1.2% per year. By comparison, the Hampton Roads and Richmond MSAs expanded 0.3% and 0.2% per year. The variation in growth by region can be attributable to the industry mix of the regions. Northern Virginia has a high concentration of the relatively fast-expanding high-tech industries. It has also attracted relocations of several major corporate headquarters such as Northrop Grumman because of its access to the D.C. economy and because of its highly-educated workforce.

Outside of the top three MSAs, Charlottesville, Harrisonburg, and Winchester achieved better-than-average employment growth while Danville, Blacksburg, Lynchburg, Roanoke, and Bristol experienced nearly a decade of employment declines spanning 2000 to 2009. The three fastest-growing MSAs are located outside the Northern Virginia MSA and have enjoyed a spillover benefit from the faster-growing Northern Virginia MSA as some jobs and residents from Northern Virginia choose the outlying metro areas in search of a lower cost of living. On the other hand, the metro areas with employment declines are all located in the southern and southwest areas in the state. These rural regions have a higher percentage of employment in traditional industries such as textile and furniture manufacturing, which have been losing jobs due to out-sourcing and the recession.[32]

In terms of wages, the Northern Virginia MSA had the highest average wages in 2009 at $62,879 per year. It is also one of the metro areas with the fastest pace of wage growth. Outside Northern Virginia, the average wages of all other MSAs were lower than the state average in 2009. Only Charlottesville and Richmond reported average wages higher than $40,000 per year. The lowest wages in 2009 ($30,595) were in Danville, which is also the region with the slowest job growth. The wage data imply that the industry structure strongly affects the level and growth rates of the average wages in each MSA.

4.1.5. PDC Employment and Wage Summary

The summary employment and wage data for Virginia's planning district commissions (PDCs) tell a similar story to those for Virginia's MSAs. Based on 2009 employment, the largest PDC in Virginia is Northern Virginia. With 1.1 million jobs, it accounted for 31% of all employment in the Commonwealth. The Hampton Roads PDC and Richmond Regional PDC employed 20% and 14% of the state total. There is a significant drop in terms of employment after the top three PDCs. However, Roanoke Valley, Central Shenandoah, Crater, George Washington, and Thomas Jefferson PDCs all employed more than 100,000 people in 2009. The smallest PDCs,

[32] Please see Appendix 5 of the Appendix document for more details of industry mix and location quotients for each MSA.

in terms of employment, were Accomack-Northampton, Northern Neck, Middle Peninsula, Commonwealth Regional Council, Southside, and LENOWISCO—all with employment lower than 30,000 in 2009.

Virginia Planning District Commission Employment and Wage Summary	Annual Employment 2009	Annual Wages 2009	Annual Employment Growth Rate	Annual Wage Growth Rate
Accomack-Northhampton,	18,720	$30,513	-0.3%	4.4%
Central Shenandoah	119,996	$33,473	0.1%	2.8%
Central Virginia	98,921	$35,266	-0.5%	2.9%
Commonwealth Regional Council	26,612	$29,211	-0.3%	3.1%
Crater	183,153	$39,514	0.3%	3.1%
Cumberland Plateau	35,831	$33,665	0.1%	3.9%
George Washington Regional Commission	104,403	$40,506	2.3%	4.2%
Hampton Roads	713,836	$39,195	0.3%	3.8%
LENOWISCO	29,474	$33,145	1.2%	3.3%
Lord Fairfax	82,734	$35,136	0.2%	3.4%
Middle Peninsula	23,232	$29,889	0.4%	3.6%
Mount Rogers	71,649	$30,733	-1.1%	3.1%
New River Valley	65,056	$34,738	-0.4%	3.0%
Northern Neck	14,273	$28,794	0.7%	3.2%
Northern Virginia	1,115,799	$65,482	1.1%	3.7%
Rappahannock-Rapidan	48,236	$36,519	1.4%	3.7%
Richmond Regional	503,729	$46,007	0.2%	3.2%
Roanoke Valley	157,690	$37,416	-0.5%	3.1%
Southside	29,154	$29,547	-1.5%	3.2%
Thomas Jefferson	101,275	$42,413	1.0%	3.8%
West Piedmont	81,040	$29,149	-2.2%	2.1%
State Total	3,545,812	$47,672	0.4%	3.3%
Note: Some Counties belong to multiple PDCs, so PDC total will be greater than state total				
Source: Chmura Economics & Analytics				

Many of the PDCs that achieved the fastest employment growth in the past decade are located in the northern part of the state. Employment in the George Washington Regional PDC grew at 2.3% per year from 2000 to 2009, the fastest among all the PDCs, followed by Rappahannock-Rapidan, Northern Virginia, and Thomas Jefferson. The LENOWISO PDC in southwest Virginia also achieved 1.2% employment growth, thanks to a rebound in the coal mining industry in the middle of the decade.

On the other hand, many PDCs in Virginia suffered employment loss from 2000 to 2009. The West Piedmont PDC had the most severe employment decline with an annual average loss of 2.2% per year. The next two

largest losses occurred in the Southside and Mount Rogers PDCs with heavy reliance on manufacturing contributing to those losses.[33]

In terms of wages, the Northern Virginia PDC had the highest average wages in 2009, at $65,482 per year. The average wages of all the other PDCs were lower than the state average. Only George Washington, Richmond, and Thomas Jefferson PDCs reported average wages higher than $40,000 per year. The lowest wages were in West Piedmont, Commonwealth Regional Council, Northern Neck, and Southside, where average wages were below $30,000 in 2009.

4.2. Aviation and Aerospace Industry Profiles

4.2.1. National Ranking

As shown in the table below, Virginia ranked 11th in the nation in terms of aviation and aerospace employment in 2009 and increased to 10th in 2010 based on a four-quarter average ending with the second quarter of each year. In the second quarter of 2010, Virginia employed 29,822 people in aviation and aerospace—behind Kansas with 33,039 workers. California ranked first in the country with 175,141 workers in aviation and aerospace during the same period followed by Texas at 149,954 and Florida at 79,451 workers. Between 2009 and 2010, the aviation and aerospace industry performed relatively well in the Commonwealth during a time when the recession was impacting the industry and especially passenger air travel. With a scant increase in employment, Virginia experienced the only gain in employment among the 25 largest aviation and aerospace employer states.

Some of Virginia's recent economic development successes in the aviation and aerospace industry are not fully accounted for in the table below. The most notable is the Rolls Royce engine manufacturing facility located in Prince George County—part of the Richmond metro area. The facility may ultimately employ 500 workers, depending on market conditions.[34] At the writing of this study, the construction of the first Rolls Royce building has been completed and hiring has begun for the initial phase of disc manufacturing.

Based on the Virginia Economic Development Partnership's (VEDP) announcements of employment creation and capital investment that was cross referenced to QCEW firm-specific data, additional expansion announcements that are not fully accounted for in the table below include:

- Cobham Composite Products announced in 2009 that it would add 198 employees in Suffolk and invest $13.2 million (NAICS 336413: Other Aircraft Parts and Auxiliary Equipment Manufacturing)
- NextGen Aeronautics announced in 2008 that it would add 20 employees in Danville (NAICS 336411: Aircraft Manufacturing)

[33] Please see Appendix 5 of the Appendix document for more details of industry mix and location quotients for each PDC as well as WIA data.
[34] Source: http://www.rolls-royce.com/investors/news/2009/090827_construction_virginia.jsp, accessed December 20, 2010.

State Rankings by Employment for the Aviation-Aerospace Industry, Top 25*						
	2009 Q2**		2010 Q2**		2009 Q2-2010 Q2	
	Employment	Rank	Employment	Rank	Percent	Number of Jobs
California	185,137	1	175,141	1	-5.4	-9,996
Texas	153,577	2	149,954	2	-2.4	-3,623
Florida	82,164	3	79,451	3	-3.3	-2,713
Georgia	63,188	4	66,178	4	4.7	2,990
New York	60,109	5	56,600	5	-5.8	-3,509
Arizona	45,489	8	43,306	7	-4.8	-2,183
Illinois	45,329	7	44,109	6	-2.7	-1,220
Kansas	44,740	6	33,039	9	-26.2	-11,701
Ohio	36,074	9	33,928	8	-6.0	-2,147
New Jersey	30,583	10	29,389	11	-3.9	-1,194
Virginia	29,809	11	29,822	10	0.0	14
Washington	28,825	12	27,136	12	-5.9	-1,689
Pennsylvania	26,763	13	26,695	13	-0.3	-68
Michigan	22,702	14	21,050	14	-7.3	-1,652
Maryland	22,348	16	18,814	20	-15.8	-3,535
North Carolina	22,147	15	20,588	15	-7.0	-1,559
Colorado	21,171	17	19,756	17	-6.7	-1,415
Connecticut	21,135	20	19,405	19	-8.2	-1,730
Minnesota	20,990	19	19,446	18	-7.4	-1,544
Massachusetts	20,853	18	19,969	16	-4.2	-883
Oklahoma	18,175	23	17,329	22	-4.7	-846
Alabama	17,696	21	17,624	21	-0.4	-72
Indiana	17,528	22	16,980	23	-3.1	-548
Missouri	11,763	24	10,534	25	-10.4	-1,229
Utah	11,081	25	10,546	24	-4.8	-535
Sources: Chmura Economics & Analytics and U.S. Bureau of Labor Statistics						
*Employment by state is understated in most states because employment for 6-digit NAICS are not disclosed when there are less than 3 firms in the classification in the state or one firm accounts for 80% or more of employment in that particular NAICS code.						
**Data represent an average of four quarters ending with the second quarter.						

4.2.2. Firm-Specific Employers in Virginia

In the second quarter of 2010, 394 aviation and aerospace firms were located in Virginia. On average, they employed 75 people per firm in the second quarter of 2010. Based on the Small Business Administration definition in which small businesses employ less than 500 workers, all but 13 of the aerospace aviation industry firms in Virginia are classified as small. As shown in the table below, United Airlines is the largest aviation and aerospace employer in the state with more than 5,000 workers and is followed by Raytheon (greater than 2,000 workers) and NASA (greater than 2,000 workers).

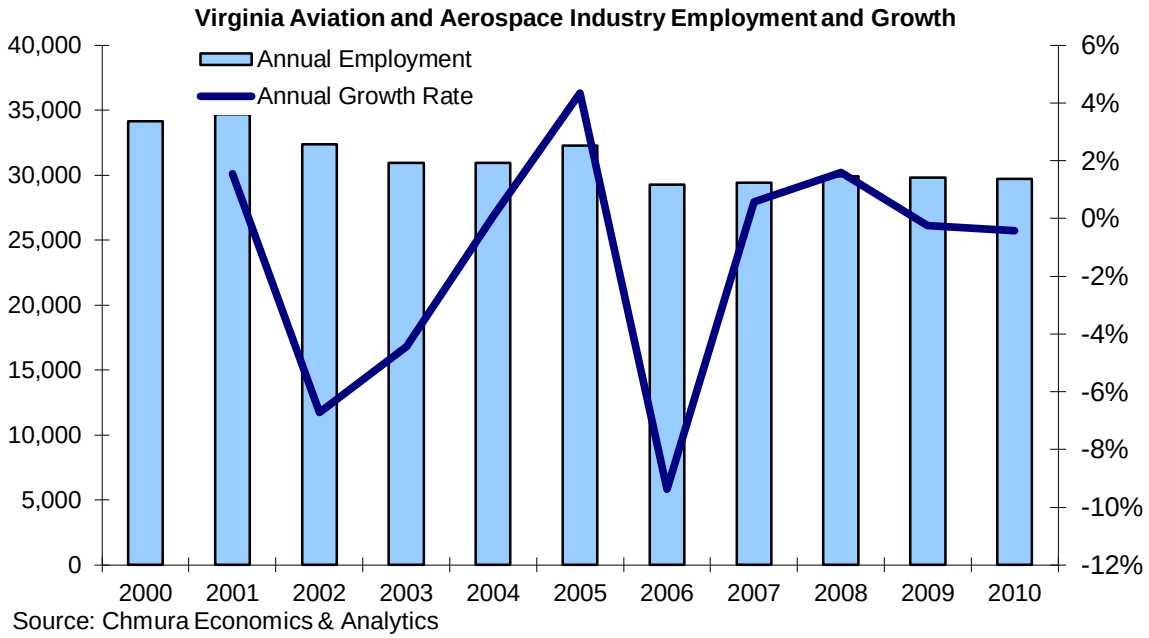
Top 20 Aviation and Aerospace Employers in Virginia, 2nd Quarter 2010		
Rank	Firm	Employment
1	United Airlines Inc.	>5,000
2	Raytheon Company	>2,000
3	National Aeronautics and Space Administration	>2,000
4	Orbital Sciences Corporation	>1,500
5	US Airways.	>1,500
6	US Airways Express	>1,000
7	Federal Aviation Administration	>1,000
8	American Airlines, Inc.	>900
9	Northrop Grumman Corp.	>800
10	Air Service Corp.	>600
11	Piedmont Airlines, Inc.	>600
12	Delta Air Lines, Inc.	>500
13	General Dynamics Armament	>500
14	DynCorp International, LLC	>400
15	Hunt Leigh USA Corp	>300
16	Dynamic Aviation Group, Inc.	>300
17	Swissport USA, Inc.	>300
18	Trans World Express	>300
19	Aerojet General Corp	>300
20	Piedmont Hawthorne Aviation, LLC	>200
Sources: Chmura Economics & Analytics and Virginia Employment Commission		

4.2.3. Overall Aviation and Aerospace Employment and Wages

In 2009, almost 30,000 people were employed in Virginia's aviation and aerospace industry or 0.8% of Virginia's workforce. This is similar to the nation where 1.0% of workers or 1.3 million people worked in the aviation and aerospace industry in 2009. The aviation and aerospace industry supports employment in other industries in Virginia due to its supply chain and the purchasing power of its workers. The total employment multiplier for the industry in 2009 was 1.12, indicating that each job in aviation and aerospace supported 1.12 additional jobs elsewhere in Virginia. The employment multiplier for this industry is higher than some other major industries. For example, the employment multiplier is 0.27 for the retail industry, 0.54 for health care, and 0.72 for construction.

The aviation and aerospace industry creates additional value to the Commonwealth through sales. Based on a 2009 estimate,[35] the total output from air transportation was $3.7 billion, or 0.6% of total state output. Output from the aerospace industry was $7.6 billion in 2009.[36]

Since 2000, employment in Virginia's aviation and aerospace industry has contracted. Employment in the industry fell 1.5% per year from 2000 to 2009 during a time when total employment expanded 0.4% per year.

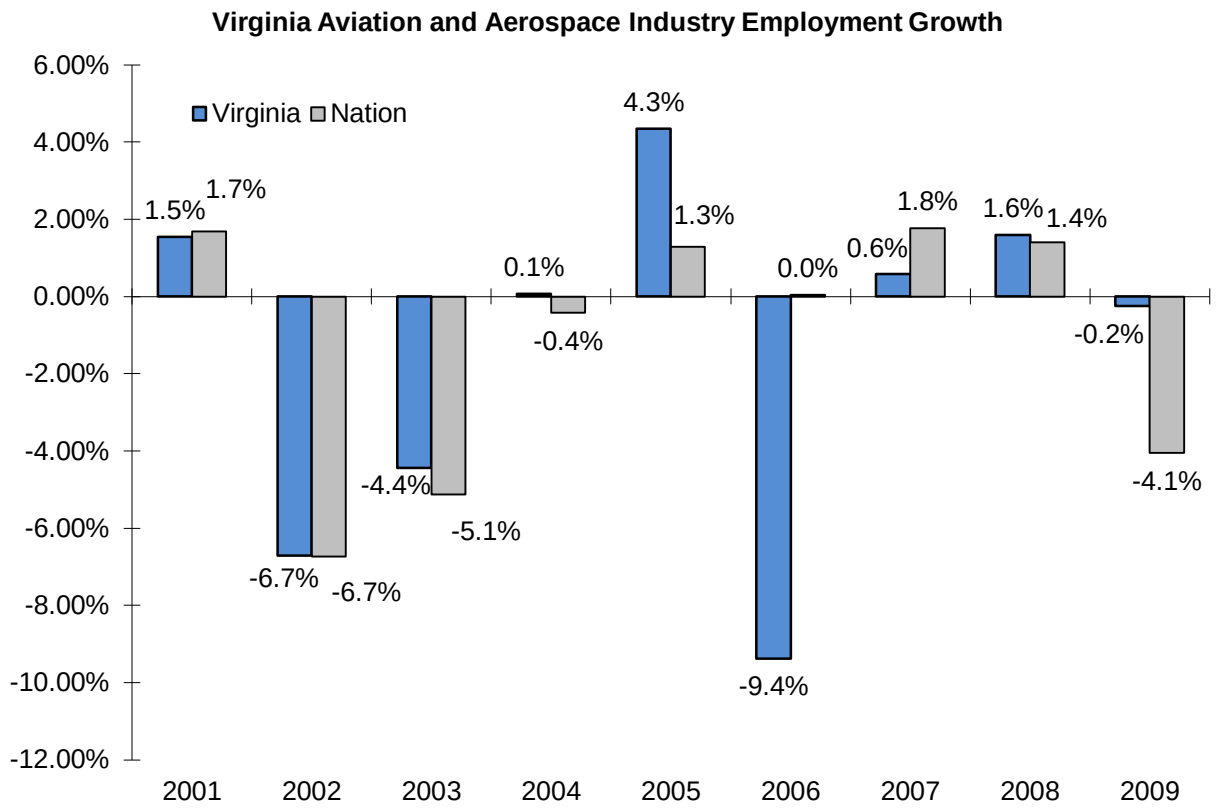


Source: Chmura Economics & Analytics

National employment in the aviation and aerospace industry fell 1.2% per year since 2000. As shown in the chart below, large employment contractions in the aviation and aerospace industry occurred in 2002, 2003, and 2006.

[35] IMPLAN Pro was used to create this estimate. *IMPLAN Professional* is an economic impact assessment modeling system developed by the Minnesota IMPLAN Group that is widely used by economists to build economic models that estimate the impacts of economic changes in local economies.

[36] "Virginia's Aerospace Industry," revised January 2011, Chmura Economics & Analytics, page 2.



Source: Chmura Economics & Analytics

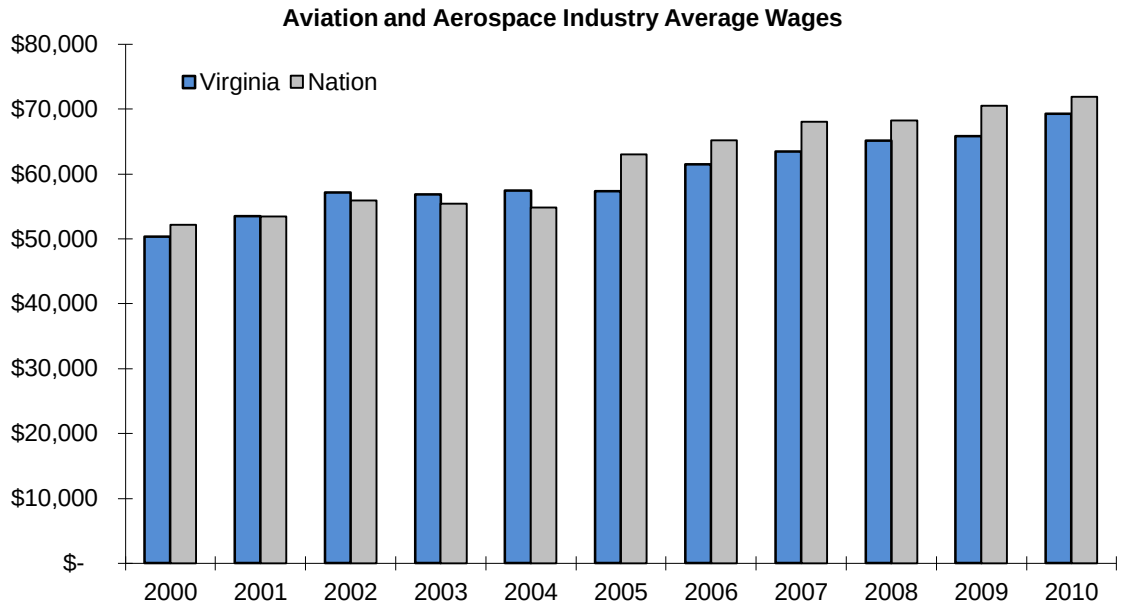
The small size of the industry tends to create sharp percentage swings in employment relative to the nation. The 2002 and 2003 employment contractions occurred in both the state and nation due largely to the sharp drop in the scheduled passenger air transportation sub-industry after the 9/11 terrorist attacks. In Virginia, employment in the scheduled passenger air transportation sub-industry fell 7.0% from 18,115 in 2001 to 16,846 in 2002 and slipped another 3.7% to 16,222 in 2003. Nationally, employment in the same sub-industry fell 8.7% from 553,689 in 2001 to 505,333 in 2002 and dropped another 6.5% to 472,247 in 2003.

The sharp 9.4% contraction in Virginia employment in 2006 was mainly the result of one low-cost carrier, Independence Air, going out of business. Independence Air employed about 2,600 people when it went bankrupt in January 2006 with its main headquarters in the Washington Dulles International Airport.[37] Unlike the 9/11-related cutbacks, this decline did not occur for the national sub-industry.

On the positive side, aviation and aerospace employment in Virginia grew much faster than in the nation in 2005 because of an increase in the other airport operations sub-industries, whose employment jumped from 2,242 in 2004 to 3,086 in 2005. Also, the scant decline of 0.03% in 2009 in the Commonwealth relative to the 4.0% drop in the nation was due to a decline of about 30,000 jobs in the national scheduled passenger air transportation sub-industry compared with a loss of only 200 in Virginia for sub-sector over the same period.

[37] Source: http://www.msnbc.msn.com/id/10729047/, accessed on December 23, 2010.

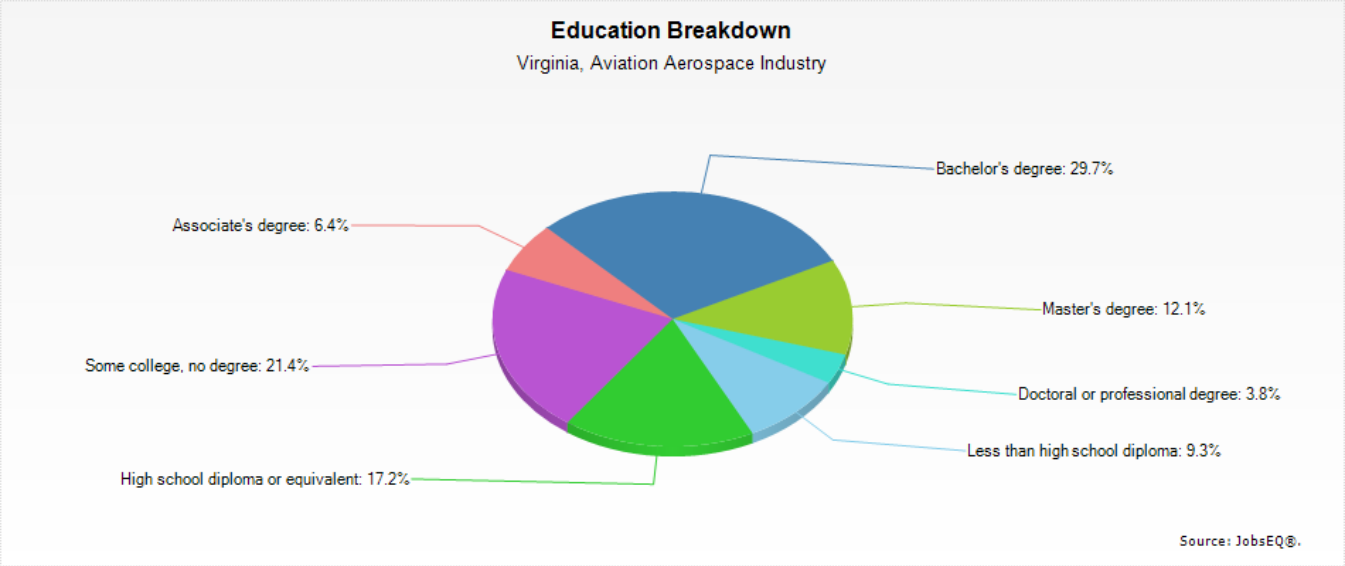
Average wages in the Virginia aviation and aerospace industry are higher than the state average. In 2009, the average wage for aviation and aerospace workers was $65,579 per year or 38% higher than the state average of $47,672. Wages in Virginia's aviation and aerospace industry have been expanding an average 3.0% per year in nominal terms from 2000 to 2009, similar to the national rate of 3.4% per year.



Source: Chmura Economics & Analytics, 2010 data reflect the first two quarters

The relatively higher wages in the aviation and aerospace industry is due, in part, to its highly-skilled workforce. As shown in the chart below, 47.6% of the aviation and aerospace workers in Virginia are in occupations that typically require a bachelor's degree or higher. By comparison, 33.4% of the residents in Virginia and 27.5% of U.S. residents ages 25 years and older holds a bachelor's degree or higher. In fact, 75% of the occupations in the aviation and aerospace industry typically require some level of college education.

Despite the skew toward a highly-educated workforce, opportunities are available for lower skilled workers as well. Almost 9% of the occupations in the aerospace aviation industry typically use workers with less than a high school diploma and another 16.5% have a high school diploma or equivalent.



4.2.4. Industry Mix

Among Virginia's aviation and aerospace sub-industries, the largest employer in 2009 (measured at the 6-digit NAICS level) is scheduled airline transportation, accounting for 42.6% of Virginia's aviation and aerospace workforce. This is followed by search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing; and other airport operations, which make up 11.4% and 10.5% of the aviation and aerospace workforce, respectively.

Nine of the aviation and aerospace sub-industries added employment from 2000 through 2009 for a total of 3,585 jobs. Other non-scheduled air transportation[38] expanded the fastest from 2000 to 2009—at a 46.5% annual average growth rate as shown in the chart below. However, since it started with less than 20 workers in 2000, even after rapid growth, it still only accounted for over 1% of the employment in the industry by 2009. In fact, the majority of the growth came from one firm that began in 2003 and continued to grow over the decade.

Two industries added at least 600 workers each from 2000 through 2009 and expanded more than 7% per year in the past decade. These were guided missile and space vehicle manufacturing and other support activities for air transportation.

The employment growth in guided missile and space vehicle manufacturing was mainly due to one firm. In contrast, there were 54 firms classified as other support activities for air transportation in Virginia at the beginning of the decade that grew to 80 firms by the second quarter of 2010. Four of the firms employed more than 200 workers with the largest firm employing over 450 people in the second quarter of 2010.

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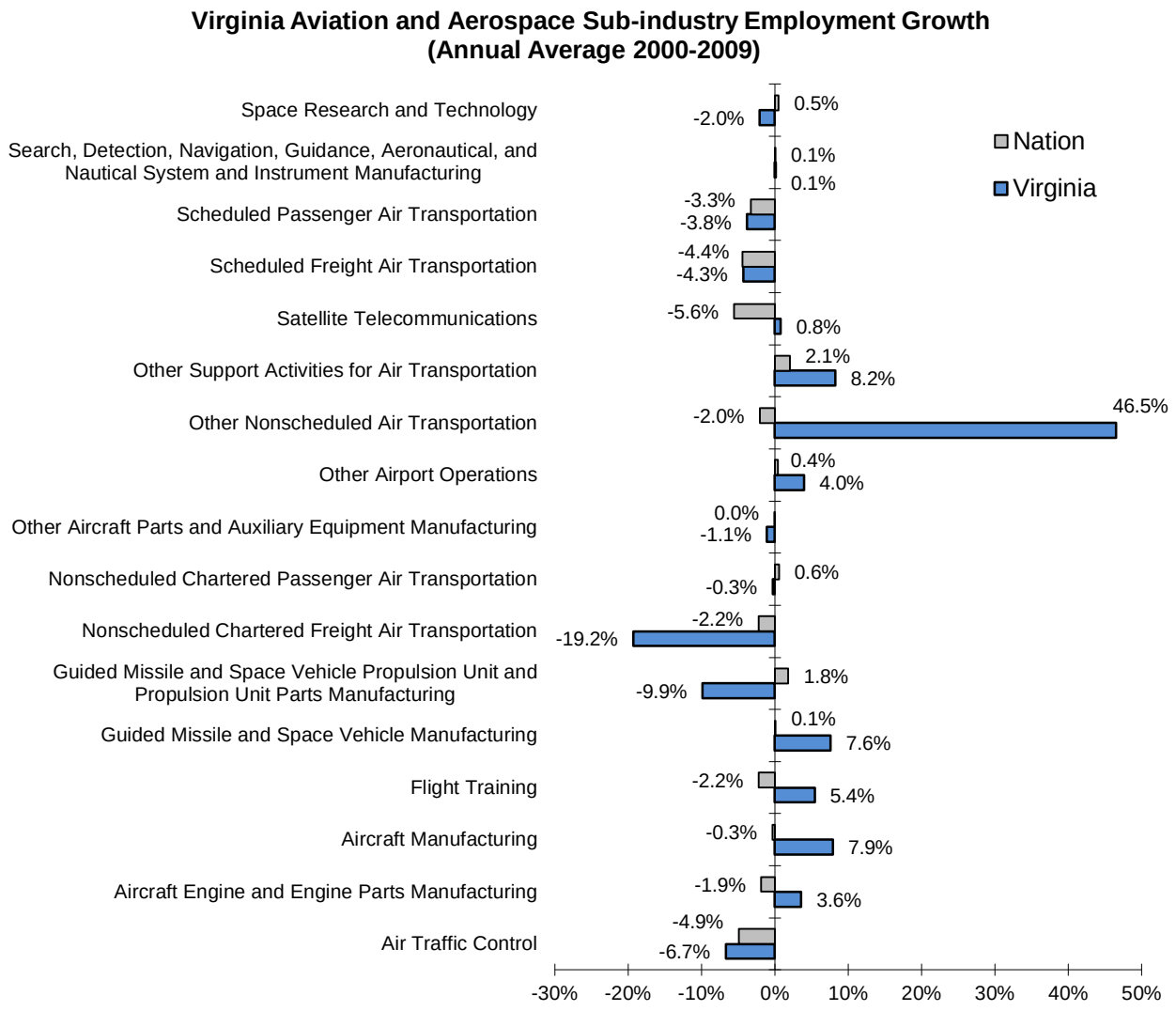
[38] According to the U.S. Census Bureau, this industry is made up of "establishments primarily engaged in providing air transportation with no regular routes and regular schedules (except nonscheduled chartered passenger and/or cargo air transportation). These establishments provide a variety of specialty air transportation or flying services based on individual customer needs using general purpose aircraft." Source: http://www.census.gov/cgi-bin/sssd/naics/naicsrch, accessed January 27, 2011.

Aviation and Aerospace Sub-industries						National (2009)	
	Industry Mix (2009)	Employment (2009)	Virginia Annual Employment Growth (2000-2009)	Jobs Created (2000-2009)	Average Annual Wages (2009)	Industry Mix	Annual Average Wages
Air Traffic Control	>3.0%	>1,000	-6.7%	<-900	>$120,000	1.9%	$78,686
Aircraft Engine and Engine Parts Manufacturing	0.2%	45	3.6%	12	$77,859	6.0%	$76,869
Aircraft Manufacturing	1.7%	496	7.9%	246	$74,505	17.4%	$85,808
Flight Training	0.7%	218	5.4%	82	$36,298	1.2%	$39,523
Guided Missile and Space Vehicle Manufacturing	>5.0%	>1,500	7.6%	>700	>$110,000	4.1%	$105,062
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	>0.5%	>100	-9.9%	<-200	>$70,000	1.1%	$80,267
Nonscheduled Chartered Freight Air Transportation	0.4%	114	-19.2%	-666	$76,289	0.6%	$64,504
Nonscheduled Chartered Passenger Air Transportation	1.3%	383	-0.3%	-11	$56,420	2.4%	$64,504
Other Aircraft Parts and Auxiliary Equipment Manufacturing	2.8%	828	-1.1%	-85	$53,148	7.2%	$81,522
Other Airport Operations	10.5%	3,145	4.0%	932	$25,926	6.3%	$49,090
Other Nonscheduled Air Transportation	>1.0%	>300	46.5%	>300	>$60,000	0.3%	$64,504
Other Support Activities for Air Transportation	7.6%	2,253	8.2%	1,148	$62,316	6.7%	$49,090
Satellite Telecommunications	1.4%	428	0.8%	30	$140,930	1.0%	$82,329
Scheduled Freight Air Transportation	1.8%	525	-4.3%	-256	$40,549	0.8%	$54,287
Scheduled Passenger Air Transportation	42.6%	12,706	-3.8%	-5,307	$50,744	30.0%	$55,797
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	11.4%	3,393	0.1%	36	$104,334	11.1%	$93,640
Space Research and Technology	>7.0%	>2,000	-2.0%	<-400	>$90,000	1.4%	$106,957
Total	100.0%	29,824	-1.5%	-4,337	$65,579	100.0%	$71,350
Source: Chmura Economics & Analytics							

From 2000 through 2009, eight of the state's aviation and aerospace sub-industries contracted for a total loss of 7,922 positions. The largest employment loss occurred in scheduled passenger air transportation (over 5,000 jobs lost), nonscheduled chartered freight air transportation (over 600 jobs lost) and space research and technology (greater than 400 jobs lost). However, even these industries were relatively small. A relocation or expansion of a single firm significantly changes the industry growth rates at that level.



Source: Chmura Economics & Analytics

Virginia's aviation and aerospace sub-industries generally pay higher wages than the state average. Four industries within aviation and aerospace averaged over $100,000 for 2009 wages: air traffic control; guided missile and space vehicle manufacturing; satellite telecommunications; and search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing. Other airport operation, flight training, and scheduled freight air transportation pays less than $40,000 per year and were the only three aviation and aerospace sub-industries with average wages below the state average.

4.2.5. Industry Competitiveness

The following table shows location quotients of the aviation and aerospace sub-industries in Virginia, based on data from the second quarter of 2010.

Other nonscheduled air transportation is Virginia's most competitive aerospace and aviation sub industry with a location quotient over 5.0. The concentration of employment that provides specialty aircraft transportation or flight services on nonscheduled routes is driven by one firm in the western part of the state. The second greatest competitive advantage of the state is in space research and technology, with a location quotient over 4.0. As

noted earlier, the Commonwealth benefits from its proximity to the nation's capital. Langley Air Force Base is a significant contributor in this sub industry. Competitive advantages are also apparent in Virginia's guided missile and space vehicle manufacturing, air traffic control, and satellite telecommunications. Some of the competitive sub-industries within Virginia's aviation and aerospace industry, such as satellite telecommunication and air traffic control, possessed some of the highest wages, with average annual wages well over $100,000.

Industry Competitiveness 2010-Q2			
Industry Competitiveness 2010Q2	Location Quotient	Employment	Average Annual Wages
Other Nonscheduled Air Transportation	>5.0	>400	>$60,000
Space Research and Technology	>4.0	>2,000	>$100,000
Air Traffic Control	>1.6	>1,000	>$120,000
Satellite Telecommunications	1.48	480	$149,134
Scheduled Freight Air Transportation	1.44	419	$42,715
Other Airport Operations	1.28	3,057	$25,703
Scheduled Passenger Air Transportation	1.13	12,449	$52,043
Guided Missile and Space Vehicle Manufacturing	1.07	1,616	$115,811
Other Support Activities for Air Transportation	0.98	2,500	$62,159
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	>0.80	>300	>$80,000
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	0.78	3,214	$105,257
Nonscheduled Chartered Freight Air Transportation	0.65	133	$82,991
Flight Training	0.49	216	$40,487
Nonscheduled Chartered Passenger Air Transportation	0.43	367	$55,636
Other Aircraft Parts and Auxiliary Equipment Manufacturing	0.28	745	$52,298
Aircraft Manufacturing	0.08	501	$75,294
Aircraft Engine and Engine Parts Manufacturing	0.02	50	$82,429
Source: JobsEQ			

On the other end of the spectrum, sub-industries with the lowest location quotients were aircraft engine and engine parts manufacturing, aircraft manufacturing, and other aircraft parts and auxiliary equipment manufacturing. With the addition and continued expansion of the Rolls Royce jet engine factory in Prince George County that will eventually employ 500 workers, the location quotient for aircraft engine manufacturing is expected to increase significantly.

4.2.6. Industry Employment Forecast

Employment is expected to grow in nine of the sixteen aviation and aerospace sub-industries in Virginia for a net gain of 1,885 over the entire 10 years from the second quarter of 2010 to the second quarter of 2020. The Virginia aviation and aerospace firms are expected to expand by over 2,000 jobs during that period, but the seven

contracting industries are expected to shed over 200 jobs. This forecast reflects the state's current industry mix and does not take into account economic development successes such as Rolls Royce.[39]

Employment Forecast for Aviation and Aerospace Sub-industries					
	Four Quarters Ending with 2010q2			Projected Change in Employment 2010q2-2020q2	
Industry	Employment	Avg. Annual Wages	Location Quotient	Total Employment	Avg. Annual Percent
Air Traffic Control	>1000	>$120,000	>1.5	>100	1.5%
Aircraft Engine and Engine Parts Manufacturing	48	$82,429	0.0	-1	-0.2%
Aircraft Manufacturing	489	$75,294	0.1	-10	-0.2%
Flight Training	219	$40,487	0.5	54	2.2%
Guided Missile and Space Vehicle Manufacturing	>1,000	>$110,000	1.0	-30	-0.2%
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	>200	>$80,000	>0.6	<0	-0.2%
Nonscheduled Chartered Freight Air Transportation	122	$82,991	0.6	7	0.6%
Nonscheduled Chartered Passenger Air Transportation	377	$55,636	0.4	22	0.6%
Other Aircraft Parts and Auxiliary Equipment Manufacturing	>800	>$50,000	>0.3	<-10	-0.2%
Other Airport Operations	3,073	$25,703	1.3	489	1.5%
Other Nonscheduled Air Transportation	>300	>60,000	>4.0	>20	0.6%
Other Support Activities for Air Transportation	2,356	$62,159	0.9	375	1.5%
Satellite Telecommunications	455	$149,134	1.3	-48	-1.1%
Scheduled Freight Air Transportation	462	$42,715	1.6	27	0.6%
Scheduled Passenger Air Transportation	12,480	$52,043	1.1	720	0.6%
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	3,317	$105,257	0.8	-111	-0.3%
Space Research and Technology	>2000	>$100,000	>4.0	>200	0.9%
Aviation and Aerospace	29,638	$67,950	0.8	1,885	0.6%
Total All Industries	3,525,414	$48,781	1.0	479,173	1.3%
Source: JobsEQ					

Aside from net growth, aviation and aerospace firms will need additional workers to replace[40] retirees and individuals who go into new occupations. From this perspective, an additional 10,399 workers will be needed in the aviation and aerospace industry over the next ten years, which increases the total need of the workforce to 12,283.

[39] Economic development-related growth will be accounted for in the final version of this report.

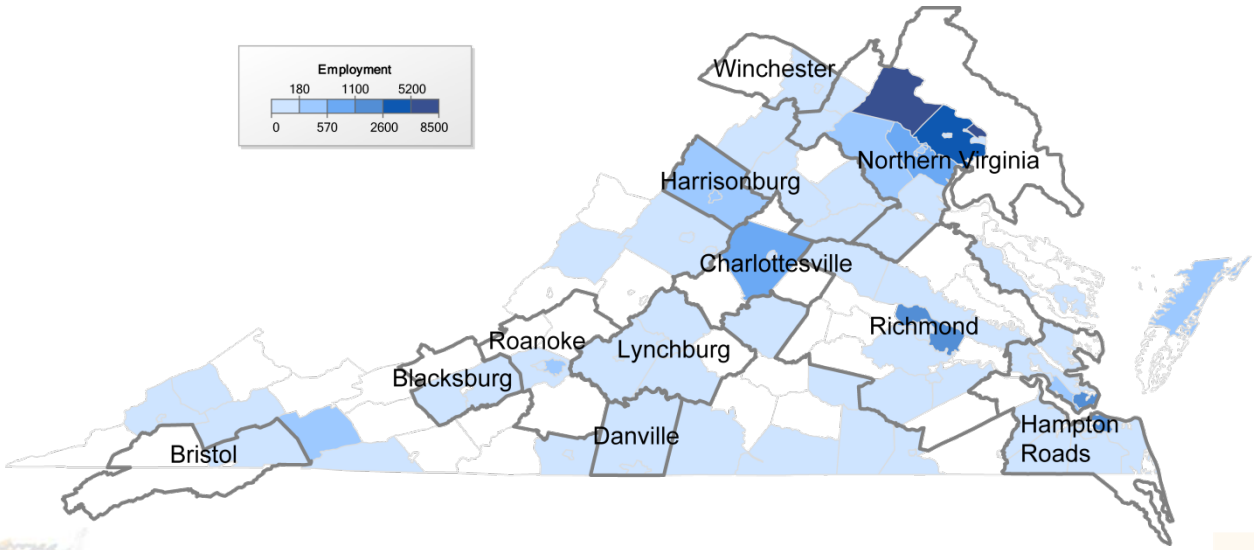
[40] Replacements are estimated based on information from the U.S. Bureau of Labor Statistics which should be considered a "minimum measure of replacement needs."

Replacement Demand for Aviation and Aerospace Workers, 2010Q2-2020Q2	
Industry	10-Year Replacement
Air Transportation	6,943
Airport Operations	997
Other Support Activities for Air Transportation	564
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	679
Aircraft Manufacturing	98
Aircraft Engine and Engine Parts Manufacturing	10
Other Aircraft Parts and Auxiliary Equipment Manufacturing	160
Guided Missile and Space Vehicle Manufacturing	311
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	45
Satellite Telecommunications	97
Flight Training	43
Space Research and Technology	452
Total Aviation and Aerospace	10,399
Source: JobsEQ	

4.2.7. MSA Aviation and Aerospace Industry Summary

Ninety-four percent of Virginia's aviation and aerospace employment is located in its eleven metropolitan statistical areas. Based on 2009 employment, the MSA with the largest aviation and aerospace workforce is Northern Virginia. With 20,360 jobs, it accounted for more than two thirds (68%) of all Virginia aviation and aerospace employment. Hampton Roads came in second in 2009 with 15% of the state's aviation and aerospace employment. There is a significant drop in terms of employment after the top two metro areas. The Richmond and Charlottesville metros each had over 1,000 employees in the industry. The remaining metro areas each employed less than 500 people in aviation and aerospace.

Virginia Aviation and Aerospace Employment by County and City, 2010 Q2



In terms of job growth, smaller metro areas had rapid employment expansion rates in the last decade, including Harrisonburg, Blacksburg, and Winchester. Due to their small industry base, a small number of new jobs in these regions can generate relatively high job growth rates. For the top two MSAs, both Northern Virginia and Hampton Roads saw their aviation and aerospace workforce shrink from 2000 to 2009.

Virginia MSA Aviation and Aerospace Employment and Wage Summary

MSA	Annual Employment 2009	Annual Wages 2009	Annual Employment Growth Rate	Annual Wage Growth Rate
Blacksburg	22	$17,469	17.7%	11.1%
Bristol	14	$39,604	0.1%	10.0%
Charlottesville	1,011	$64,038	-0.9%	4.3%
Danville	22	$31,956	-1.9%	1.4%
Hampton Roads	4,323	$69,586	-3.2%	5.2%
Harrisonburg	>300	>$60,000	35.3%	15.0%
Lynchburg	191	$25,513	4.3%	2.2%
Northern Virginia	20,360	$68,395	-1.6%	2.6%
Richmond	1,337	$39,919	-3.1%	2.6%
Roanoke	486	$32,504	-2.0%	-1.1%
Winchester	39	$48,702	11.7%	8.5%
State Total	29,824	65,579	-1.7%	4.9%

Source: Chmura Economics & Analytics

Compared with the aviation and aerospace industry in other MSAs, Hampton Roads and Northern Virginia also had the highest annual average wages in 2009, at $69,586 and $68,395. As noted in the previous section, some industries in aviation and aerospace—such as space research, air traffic control, and satellite communications—had the highest average wages. Hampton Roads and Northern Virginia have some of the largest employers in these industries, including the NASA Langley Research Center and the two major airports serving the Washington metro area.[41]

4.2.8. PDC Aviation and Aerospace Industry Summary

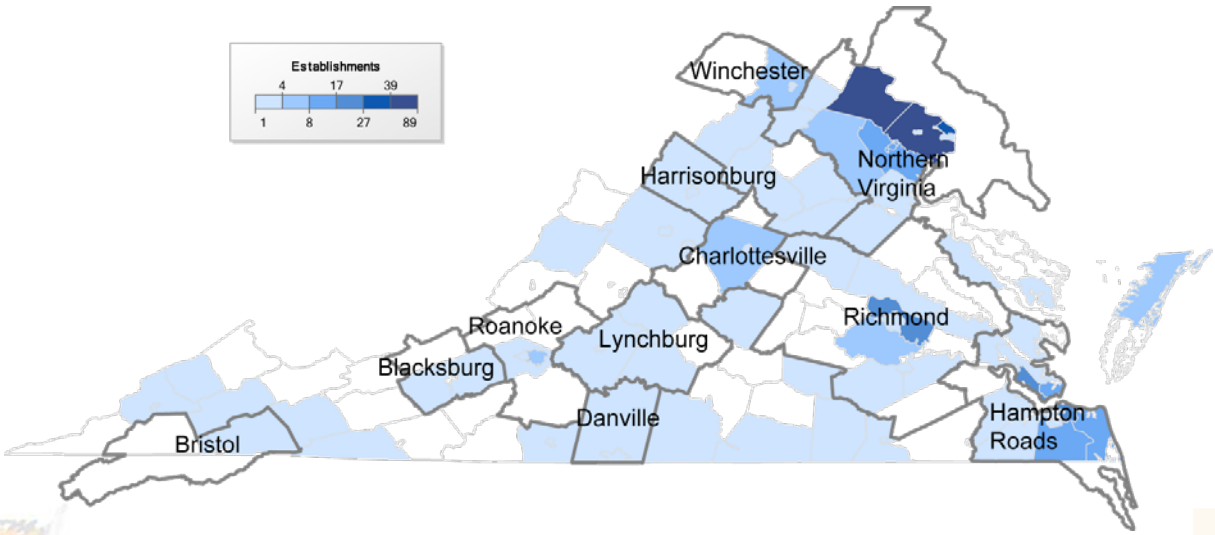
Among the 21 PDCs in Virginia, the Northern Virginia PDC had the largest workforce in the aviation and aerospace industry based on 2009 employment. With 19,965 jobs, it accounted for 67% of all Virginia aviation and aerospace employment. The Hampton Roads PDC came in second with 15% of the state's aviation and aerospace employment. After the top two, only the Richmond Regional PDC and Thomas Jefferson PDC had over 1,000 jobs in the aviation and aerospace industry. The rest employed less than 1,000. Eleven PDCs employed fewer than 100.

[41] Please see the Appendix document for details regarding the aviation and aerospace industry mix in each MSA.

PDC Aviation and Aerospace Employment and Wage Summary				
PDC	Annual Employment 2009	Annual Wages 2009	Annual Employment Growth Rate	Annual Wage Growth Rate
Accomack-Northampton	424	$71,388	5.2%	1.0%
Central Shenandoah	300	<$50,000	22.3%	13.0%
Central Virginia	191	$25,513	4.3%	2.2%
Commonwealth Regional Council	8	$67,399	1.3%	23.4%
Crater	83	$50,802	0.2%	8.9%
Cumberland Plateau	21	$42,491	NA	NA
George Washington Regional Commission	35	$42,675	13.3%	11.0%
Hampton Roads	4,326	$69,554	-3.2%	5.2%
LENOWISCO	<10	>$20,000	-0.2%	2.7%
Lord Fairfax	51	$57,747	7.3%	4.1%
Middle Peninsula	19	$49,473	1.3%	5.1%
Mount Rogers	600	$51,686	-1.8%	4.1%
New River Valley	22	$17,469	17.7%	11.1%
Northern Neck	<10	>$60,000	1.0%	13.7%
Northern Virginia	19,965	$67,565	-1.7%	2.4%
Rappahannock-Rapidan	581	$95,532	20.1%	13.5%
Richmond Regional	1,298	$39,027	-3.3%	2.3%
Roanoke Valley	486	$32,504	-2.0%	-1.1%
Southside	<10	>$10,000	6.8%	9.6%
Thomas Jefferson	1,030	$63,620	-0.8%	4.3%
West Piedmont	31	$29,173	0.0%	1.1%
State Total	29,824	65,579	20.1%	13.5%

In terms of wages, the aviation and aerospace industry in the Rappahannock-Rapidan PDC had the highest average wages in 2009 at $95,532; this was followed by Accomack-Northampton and Hampton Roads. The reasons for the wage differences can be attributed to the types of industries in each PDC and the type of workforce these industries need. This is analyzed in Section 5 and beyond.

Virginia Aviation and Aerospace Establishment by County and City, 2010 Q2



5. Baseline Gap Analysis

This section contains a baseline analysis of the occupation gaps in Virginia. First, the occupation mix of the aviation and aerospace industry is described. Then the overall occupation demand and supply is examined for the state. Projections of the supply and demand are compared to generate the baseline occupation gaps—the potential mismatches between supply and demand growth that can result in imbalances in the labor market for certain occupations.

5.1. Occupation Baseline of the Aviation and Aerospace Industry

5.1.1. Current Occupation Mix

Occupations are organized into thirty major occupation groups according to the Standard Occupational Classification system (SOC). The SOC codes at the two-digit level correspond to the major occupation groups that are discussed in this section. The SOC codes at the six-digit level correspond to the detailed occupations that are discussed in the following section.

The occupation mix within the aviation and aerospace industry in Virginia is primarily influenced by the aviation sub-industry mix in the state. Over half of the employment in the industry is from scheduled passenger air transportation and other airport operations. Related aviation industries such as air traffic control, other nonscheduled air transportation, and other support activities for air transportation boost the aviation-related occupations in the overall mix.

The largest major occupation group in the aviation and aerospace industry in Virginia is office and administrative support which employed 6,697 in the second quarter of 2010, accounting for 23% of all occupations in the industry. The next-largest groups are transportation and material moving (5,200 jobs or 18% of all aviation and aerospace employment); personal care and service (3,817 or 13%); and installation, maintenance, and repair (3,544 or 12%). These are followed by architectural and engineering (2,995 or 10%), production (2,174 or 7%), and business and financial operations occupations (1,609 or 5%). After the next two groups—management (1,261 or 4%) and computer and mathematical (856 or 3%)—the remaining groups account for 5% of all aviation and aerospace occupations.

Aviation and Aerospace Major Occupation Groups, Virginia, 2010 Q2			
SOC	Title	Employment	%
43-0000	Office and Administrative Support	6,697	23%
53-0000	Transportation and Material Moving	5,200	18%
39-0000	Personal Care and Service	3,817	13%
49-0000	Installation, Maintenance, and Repair	3,544	12%
17-0000	Architecture and Engineering	2,995	10%
51-0000	Production	2,174	7%
13-0000	Business and Financial Operations	1,609	5%
11-0000	Management	1,261	4%
15-0000	Computer and Mathematical	856	3%
41-0000	Sales and Related	397	1%
33-0000	Protective Service	233	<1%
19-0000	Life, Physical, and Social Science	224	<1%
37-0000	Building and Grounds Cleaning and Maintenance	176	<1%
25-0000	Education, Training, and Library	162	<1%
27-0000	Arts, Design, Entertainment, Sports, and Media	102	<1%
47-0000	Construction and Extraction	94	<1%
23-0000	Legal	35	<1%
29-0000	Healthcare Practitioners and Technical	34	<1%
35-0000	Food Preparation and Serving Related	<20	<1%
21-0000	Community and Social Services	<20	<1%
45-0000	Farming, Fishing, and Forestry	<20	<1%
31-0000	Healthcare Support	<20	<1%
Total		**29,638**	100%
Source: Chmura Economics & Analytics			

5.1.2. Top Thirty Occupations

The six-digit or detailed occupation view of the top aviation and aerospace industry occupations shows the influence of the airline industry, with nine of the ten top occupations being found heavily in the air transportation industry. These occupations are led by transportation ticket agents (2,899 workers), flight attendants (2,874), aircraft mechanics (2,207), and airline pilots (2,068). The sixth-largest occupation, aerospace engineers (776), is largely driven by the presence of NASA Langley in the state. Beginning with the 11th-most widespread occupation, the technical and production aspects of the aviation and aerospace industry show their influence with the appearance of several engineering occupations as well as production occupations (such as team assemblers as well as inspectors, testers, sorters, samplers, and weighers).

Top Thirty Aviation and Aerospace Detailed Occupations, Virginia, 2010 Q2			
SOC	Title	Employment	Average Wages (2008)
43-4181	Reservation and Transportation Ticket Agents and Travel Clerks	2,899	$30,800
39-6031	Flight Attendants	2,874	$31,500
49-3011	Aircraft Mechanics and Service Technicians	2,207	$52,600
53-2011	Airline Pilots, Copilots, and Flight Engineers	2,068	$103,800
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	885	$24,300
17-2011	Aerospace Engineers	776	$103,100
43-4051	Customer Service Representatives	694	$31,000
53-6099	Transportation Workers, All Other	669	$31,500
43-5011	Cargo and Freight Agents	628	$38,600
39-6011	Baggage Porters and Bellhops	592	$19,900
17-2199	Engineers, All Other	534	$98,700
43-1011	First-Line Supervisors/Managers of Office and Administrative Support Workers	533	$51,400
13-1199	Business Operations Specialists, All Other	370	$74,000
53-2012	Commercial Pilots	365	$64,200
51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	331	$41,100
49-9042	Maintenance and Repair Workers, General	320	$38,400
11-1021	General and Operations Managers	298	$119,600
17-2072	Electronics Engineers, Except Computer	284	$93,800
17-3029	Engineering Technicians, Except Drafters, All Other	277	$66,800
49-2091	Avionics Technicians	270	$46,600
51-2092	Team Assemblers	252	$26,000
43-5081	Stock Clerks and Order Fillers	248	$23,500
49-1011	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers	248	$61,600
39-6032	Transportation Attendants, Except Flight Attendants and Baggage Porters	246	$20,300
15-1032	Computer Software Engineers, Systems Software	240	$106,700
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	236	$34,600
15-1031	Computer Software Engineers, Applications	232	$92,600
43-5061	Production, Planning, and Expediting Clerks	232	$44,600
43-9061	Office Clerks, General	230	$28,500
17-2112	Industrial Engineers	228	$80,000
Source: Chmura Economics & Analytics			

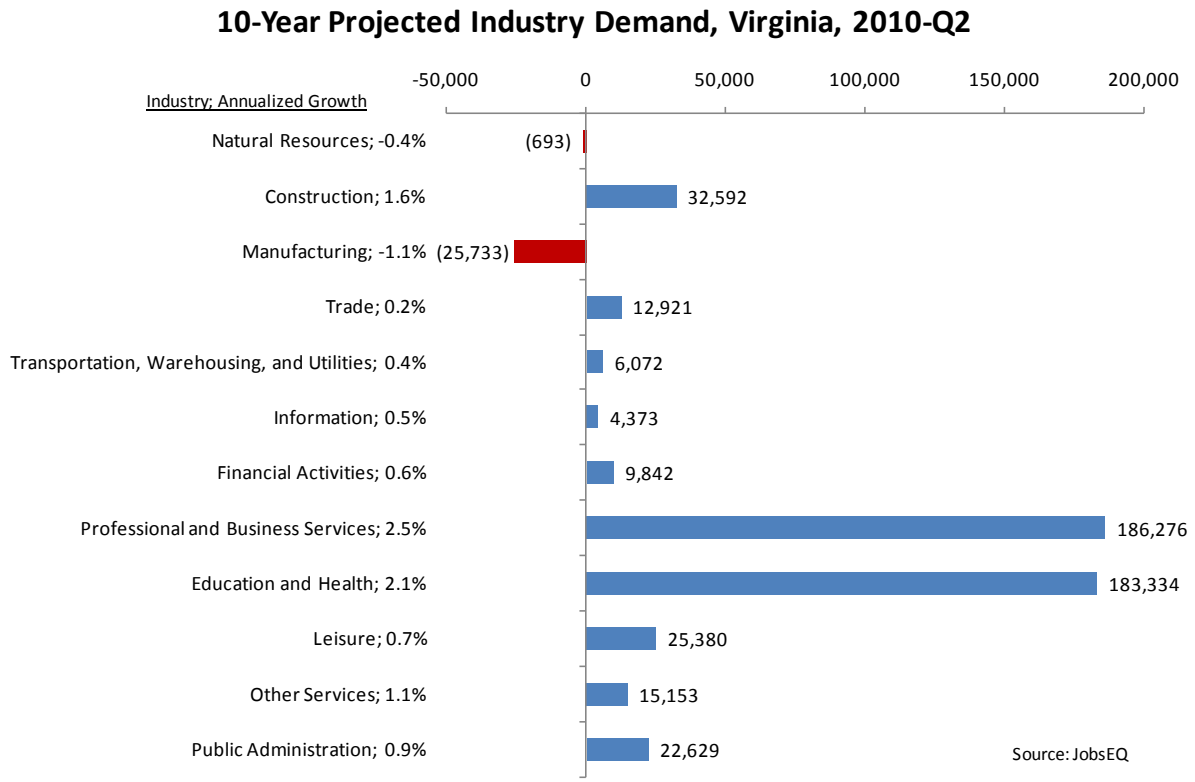
The average occupation wage in Virginia (based on 2008 occupation wage data) is approximately $43,200.[42] Sixteen of the top thirty aviation and aerospace occupations have higher-than-average wages. The highest wages among this group of occupations are found among airline pilots, general and operations managers, and among six engineer occupations—aerospace, electronics, industrial, computer applications software, computer systems software, and all other.

[42] This calculation uses 2008 occupation wage data along with the occupation mix present in Virginia in the second quarter of 2010.

5.2. Baseline Occupation Gaps

5.2.1 Industry Occupation Demand

Industry employment in Virginia is expected to grow an average annualized 1.3% over the next ten years (using the second quarter of 2010 as a starting point), adding 472,505 jobs. This industry job growth can also be viewed as occupation demand, since various occupations will need to fill the job expansions by industry. Most of the overall employment demand in Virginia over the next ten years is expected to come from two sectors: professional and business services (+186,276 jobs) and education and health services (+183,334 jobs). Only two sectors are expected to contract over the next ten years: manufacturing (-25,733 jobs) and natural resources (-693 jobs).



Growth within individual sectors is not expected to be uniform. In manufacturing, for example, some industries are forecast to experience sharp contractions in employment (such as cut and sew apparel, -8.6% per year) while others are expected to expand (such as medical equipment and supplies, +1.4% per year). Employment in aerospace product and parts manufacturing (NAICS 3364) is expected to contract slightly (-0.2% per year) during

the forecast window. These projections are based on national industry projections crossed with overall regional employment projections.[43]

In the professional and business services sector, strong growth over the next ten years is expected in computer systems design and related services (+60,343 jobs); management, scientific, and technical consulting services (+53,716); and architectural, engineering, and related services (+13,817). These industries use many skilled, technical and professional occupations that are held in common with the aviation and aerospace industry; fast job growth in these industries can thus contribute to keen competition for workforce services among these occupations.

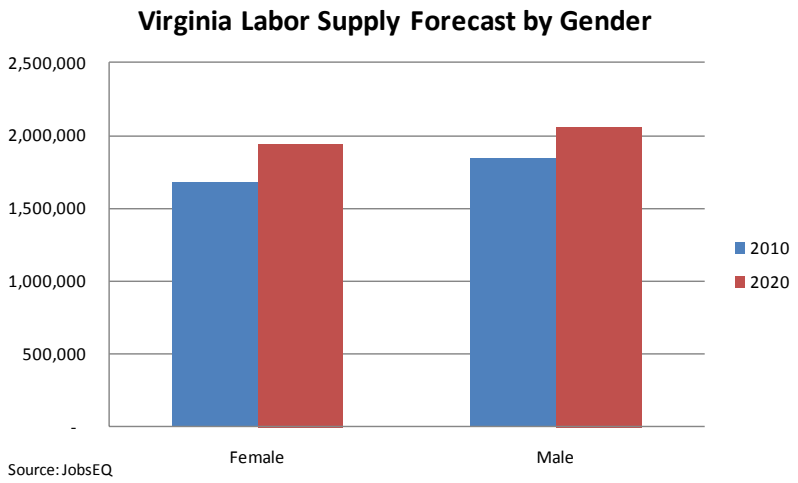
5.2.2. Supply of Workers

Virginia's labor market primarily consists of its residents, though it also includes out-of-state workers that commute into the state to work. The growth of supply in this labor market is influenced by a variety of factors: population growth, age mix (especially in terms of heavy retirement levels from aging baby boomers), participation rates, gender mix, and the educational attainment mix. In addition, some of these factors interact with one another. Persons with a higher educational attainment, for example, are generally more likely to participate in the labor market (that is, be either employed or looking for work) than those with a lower education and skills.

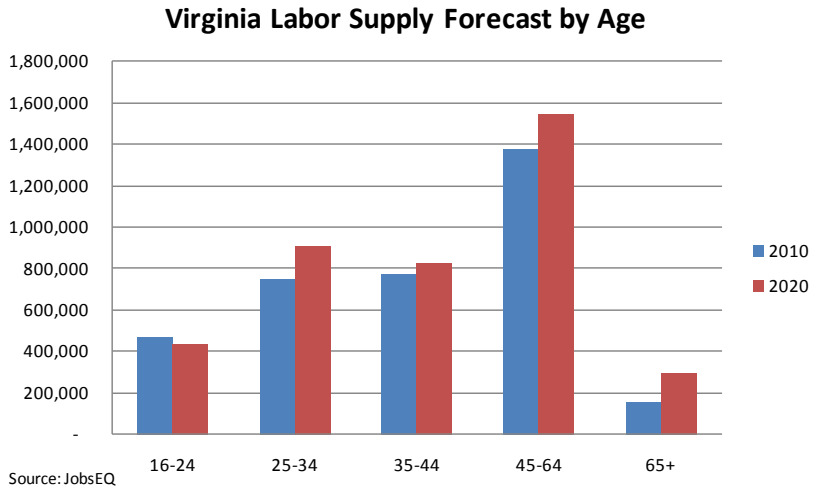
Overall industry demand also influences the supply of workers since workers will go where the jobs are located. If job growth in Virginia is higher than can be filled by residents who live within commuting distance, workers will migrate to fill those positions. Likewise, if the job growth dries up, workers would eventually seek employment elsewhere and possibly relocate to do so. Over the long-term, such as the 10-year forecast considered here, supply and demand of the labor force is expected to trend towards equilibrium to balance with each other.

The employed labor force in Virginia is expected to grow in terms of the male and female demographic, with the mix of females expanding. Female workers are estimated to have accounted for 47.6% of Virginia's at-place employment workers in the second quarter of 2010, and in ten years the female cohort is projected to fill 48.5% of available jobs. Over this period, the number of employed females is forecast to grow 15.6% in Virginia compared to 11.4% growth for males.

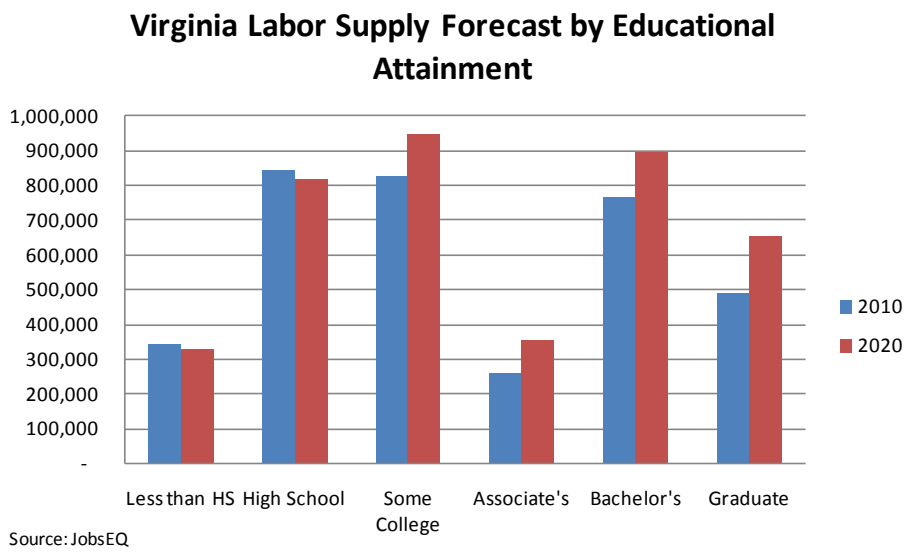
[43] The national projections are per the BLS 2008-2018 industry employment forecasts. Regional employment forecasts are per JobsEQ.



While retirements among aging baby boomers is expected to be a significant workforce event in the coming years, the impact will be slightly alleviated as more of the population age 65 and over is expected to participate in the workforce. Workers age 65 and older accounted for an estimated 4.3% of workers in the state in the second quarter of 2010 and this is expected to grow dramatically to 7.3% in 2020. The number of workers age 35 to 64 is expected to grow over the next ten years in Virginia, but this group is expected to make up a slightly smaller proportion of overall workers (59.3% in 2020 quarter 2 compared to 61.1% ten years earlier). The 25 to 34 cohort of workers is expected to grow quickly and to expand their share of the workforce in Virginia, from 21.3% in the second quarter of 2010 to 22.6% ten years later. The number of workers under the age of 25 is forecast to decrease over the next ten years, from 469,362 to 431,849. The decline within this cohort is due to both slow growth in population and a projected decline in participation rates.



Another significant trend is that the average educational attainment of the workforce is expected to increase. The number of employed workers in Virginia with a high school diploma or less is expected to drop over the next ten years by 4.4%. Over the same period, the number of workers with some college is expected to grow 14.9% and even larger increases are expected for other attainment levels: associate's degrees (+36.3%), bachelor's degrees (+16.9%), and graduate degrees (+34.0%).



5.2.3. Baseline Gaps

The trend of increasing educational attainment in workforce supply is critical for maintaining balance with industry demand, since industry demand is expected to generally grow quicker among occupations requiring higher educational attainment. This, however, is not the only factor influencing labor supply and demand balance. At the detailed occupation level, variations in replacement rates, age demographics (which affect expected retirement rates), job desirability, and training levels all influence the differences between supply and demand.

The projected differences between occupation supply and demand are known as the occupation gaps. These are described below using a ten-year forecast window. This long-term forecast does not necessarily correlate with short-term labor market imbalances. For example, a construction boom in a metro area can trigger a short-term, local demand for carpenters. After a long construction boom period ends, the same region might experience a short-term oversupply of carpenters. Each case is an example of a short-term gap, and these scenarios are not being described within the long-term gap analysis. Nevertheless, the short-term labor market baseline is briefly examined here first with a look at unemployment data.

5.2.3.1. Occupation Unemployment

Based on unemployment insurance claims filings in Virginia in November 2010 (the latest available data), the largest number of unemployed in the state were in the occupation groups of office and administrative support, production, and construction and extraction. These three groups together accounted for 38.8% of the unemployed.

However, the number of unemployed in the office and administrative support occupation group is not necessarily surprising given the large number of employed individuals in that group. Those occupations accounted for 16.4% of employment in the second quarter of 2010,[44] and also accounted for 16.5% of unemployment in November

[44] Occupation employment figures here and elsewhere in this report are based on a four-quarter moving average.

2010. In production and construction and extraction occupations, on the other hand, we find more than twice the percentage of workers among the unemployed than is found among the employed. Production occupations accounted for 5.2% of employed workers in the second quarter of 2010 compared to 11.2% of the unemployed in November. Similarly, construction and extraction occupations accounted for 4.5% of employment in the second quarter compared to 11.1% of unemployment in November. These disparities point to a short-term oversupply of these occupations.

Unemployment by Occupation Group, Virginia, November 2010

Occupation Group	Number of Unemployed (November 2010)	Percent of Total Unemployment	Percent of Total Employment (2010 Q2)
Office and Administrative Support	7,827	16.5%	16.4%
Production	5,319	11.2%	5.2%
Construction and Extraction	5,272	11.1%	4.5%
Sales and Related	4,158	8.8%	10.1%
Management	3,945	8.3%	4.9%
Transportation and Material Moving	2,893	6.1%	5.7%
Food Preparation and Serving Related	2,459	5.2%	8.4%
Installation, Maintenance, and Repair	2,009	4.2%	3.8%
Business and Financial Operations	1,974	4.2%	5.4%
Healthcare Support	1,579	3.3%	2.7%
Building and Grounds Cleaning and Maintenance	1,553	3.3%	3.7%
Computer and Mathematical	1,259	2.7%	4.2%
Education, Training, and Library	1,097	2.3%	6.9%
Healthcare Practitioners and Technical	1,022	2.2%	4.9%
Architecture and Engineering	874	1.8%	2.3%
Personal Care and Service	867	1.8%	2.8%
Military Specific	741	1.6%	N/A[45]
Arts, Design, Entertainment, Sports, and Media	720	1.5%	1.3%
Protective Service	661	1.4%	3.1%
Community and Social Services	600	1.3%	1.4%
Legal	268	0.6%	0.7%
Life, Physical, and Social Science	208	0.4%	1.3%
Farming, Fishing, and Forestry	204	0.4%	0.3%
Total	47,509	100%	100%

Source: BLS and JobsEQ®

On the other hand, some occupation groups were found in smaller percentages among the unemployed compared to their representation among the employed. For example, the education, training, and library occupation group accounted for 6.9% of the employed in the second quarter of 2010, yet only accounted for 2.3% of the unemployed in November of the same year.

[45] Military occupation employment data are not included in this data set.

5.2.3.2. Long-Term Occupation Gaps

Some of the largest potential gaps in Virginia are forecast to be in the major occupation groups of business and financial operations, healthcare practitioners and technical, and computer and mathematical. By 2020, these three groups are all projected to grow faster than average, use more highly-skilled workers, and provide better-than-average wages. On the other end of the spectrum are the groups with the largest projected surpluses: food preparation and service related, production, and transportation and material moving occupations. These groups each are projected to grow slower than average (or contract in the case of production), provide lower than average wages, and use many workers that require lower than average educational attainment.

Occupations Gaps by Major Occupation Groups, Virginia, 10-Years

2-Digit SOC	Title	Annual Supply Gap (or Surplus)	Current Employment (2010 Q2)	Projected Employment (2020 Q2)	Annual Growth Demand	Annual Replacement Demand
13-0000	Business and Financial Operations	1,899	190,026	233,905	4,388	3,800
29-0000	Healthcare Practitioners and Technical	1,567	171,380	207,827	3,645	3,529
47-0000	Construction and Extraction	1,118	158,260	182,960	2,470	2,804
15-0000	Computer and Mathematical	1,111	146,878	194,540	4,766	2,592
31-0000	Healthcare Support	992	93,730	121,343	2,761	1,050
39-0000	Personal Care and Service	724	98,041	121,123	2,308	2,433
49-0000	Installation, Maintenance, and Repair	644	134,931	148,854	1,392	2,638
33-0000	Protective Service	562	110,236	123,937	1,370	3,099
17-0000	Architecture and Engineering	329	79,430	92,965	1,354	1,675
21-0000	Community and Social Services	136	49,706	58,847	914	1,098
27-0000	Arts, Design, Entertainment, Sports, and Media	134	46,251	53,838	759	1,175
11-0000	Management	118	173,657	192,750	1,909	4,138
19-0000	Life, Physical, and Social Science	101	45,354	56,183	1,083	1,377
45-0000	Farming, Fishing, and Forestry	(126)	10,771	11,027	26	282
43-0000	Office and Administrative Support	(517)	579,025	638,947	5,992	11,939
23-0000	Legal	(522)	25,676	29,214	354	419
37-0000	Building and Grounds Cleaning and Maintenance	(613)	131,376	144,568	1,319	2,208
41-0000	Sales and Related	(697)	356,419	386,881	3,046	10,913
25-0000	Education, Training, and Library	(998)	244,685	282,799	3,811	5,428
53-0000	Transportation and Material Moving	(1,108)	202,550	214,088	1,154	4,919
51-0000	Production	(2,205)	182,351	178,653	(370)	3,662
35-0000	Food Preparation and Serving Related	(2,665)	294,682	323,625	2,894	10,377

Source: JobsEQ.com

By detailed occupation, occupations with projected occupation gaps are dominated by fast-growing occupations with several healthcare-related occupations near the top (registered nurses, home health aides, and personal and home care aides). Several technical occupations are also projected to be in danger of short supply, namely network systems and data communications analysts and computer systems analysts.

On the other end of the spectrum, occupations with a possible oversupply over the long term include occupations expected to contract (such as and packers and packagers) and those requiring little formal training (such as cashiers). Among occupations with a projected oversupply also include lawyers, which made the top ten list due to the keen competition for those jobs.

Top and Bottom Ten Occupation Gaps by Detailed Occupations, Virginia, 10-Years						
6-Digit SOC	Title	Annual Supply Gap (or Surplus)	Current Employment (2010 Q2)	Projected Employment (2020 Q2)	Annual Growth Demand	Annual Replacement Demand
29-1111	Registered Nurses	828	58,571	71,125	1,255	1,023
43-4051	Customer Service Representatives	680	56,520	68,906	1,239	1,779
31-1011	Home Health Aides	644	23,648	35,301	1,165	236
39-9021	Personal and Home Care Aides	476	18,513	27,092	858	231
15-1081	Network Systems and Data Communications Analysts	453	9,457	15,714	626	170
43-1011	First-Line Supervisors/Managers of Office and Administrative Support Workers	434	35,786	40,771	498	807
43-4171	Receptionists and Information Clerks	323	28,319	33,169	485	764
13-2011	Accountants and Auditors	315	32,871	41,223	835	556
15-1051	Computer Systems Analysts	310	24,124	31,637	751	520
47-2111	Electricians	303	17,352	19,800	245	420
35-1012	First-Line Supervisors/Managers of Food Preparation and Serving Workers	(259)	20,767	22,360	159	198
37-2012	Maids and Housekeeping Cleaners	(279)	27,891	29,392	150	501
53-7064	Packers and Packagers, Hand	(313)	15,233	14,740	(49)	253
15-1021	Computer Programmers	(339)	18,620	19,503	88	350
37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	(348)	61,471	65,606	414	1,161
23-1011	Lawyers	(414)	14,033	15,631	160	262
43-6014	Secretaries, Except Legal, Medical, and Executive	(416)	49,231	52,970	374	663
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	(532)	49,348	49,618	27	1,588
35-3031	Waiters and Waitresses	(1,069)	61,292	65,669	438	3,383
41-2011	Cashiers	(1,223)	94,256	98,742	449	4,233
Source: JobsEQ						

5.3. MSA Baseline Occupation Gaps

The baseline long-term occupation gaps by Virginia metropolitan area show uniformity in some cases as well as variation in others. For example, the business and financial operations occupation group is projected to have a shortfall in each metro area and the food preparation and serving related occupation is expected to have a surplus. On the other hand, the biggest exception is the Northern Virginia region which is unique among the MSAs due to its extremely high educational attainment among its workforce as well as its industry mix which includes a large high-tech industry. Because of these factors, the Northern Virginia MSA has projected long-term surpluses in some occupation groups requiring high skills (such as management) where all the other metro areas have a projected shortfall.

Annual 10-Year Occupation Gaps by MSA, 2010 Q2												
SOC	Title	Blacks-burg, VA MSA	Bristol, VA MSA	Charlott-esville, VA MSA	Danville	Hampton Roads, VA MSA	Harrison burg, VA MSA	Lynch-burg, VA MSA	Northern Virginia, VA MSA	Rich-mond	Roan-oke	Win-ches-ter
13	Business and Financial Operations	36	17	57	12	391	25	68	542	406	48	27
29	Healthcare Practitioners and Technical	43	31	64	28	428	35	114	(153)	483	116	45
47	Construction and Extraction	5	2	13	3	110	23	19	820	79	44	29
15	Computer and Mathematical	23	7	36	3	314	15	29	183	223	30	12
31	Healthcare Support	23	12	43	15	86	26	35	421	170	24	10
39	Personal Care and Service	29	14	29	18	124	16	32	144	113	38	10
49	Installation, Maintenance, and Repair	(9)	(6)	13	(10)	(79)	3	(23)	873	(23)	(12)	(6)
33	Protective Service	12	6	14	6	28	8	12	306	65	12	7
17	Architecture and Engineering	7	0	8	(0)	134	4	38	(47)	105	1	11
21	Community and Social Services	11	11	7	13	108	6	34	(335)	125	30	11
27	Arts, Design, Entertainment, Sports, and Media	11	5	3	3	53	3	19	(99)	68	8	4
11	Management	16	10	10	7	129	7	47	(439)	161	11	17
19	Life, Physical, and Social Science	10	3	12	2	92	5	16	(194)	79	12	7
45	Farming, Fishing, and Forestry	(3)	(1)	(13)	(2)	8	(4)	(1)	(39)	(27)	(1)	4
43	Office and Administrative Support	39	(8)	17	(11)	(571)	(8)	(70)	999	(496)	(140)	(49)
23	Legal	0	1	(6)	(0)	(29)	(1)	3	(478)	(13)	(1)	1
37	Building and Grounds Cleaning and Maintenance	(17)	(9)	(45)	(8)	(126)	(18)	(35)	54	(209)	(18)	(12)
41	Sales and Related	(26)	(10)	(34)	(7)	(276)	(22)	(46)	179	(239)	(16)	(39)
25	Education, Training, and Library	40	37	(39)	45	279	24	118	(2,422)	373	72	51
53	Transportation and Material Moving	(40)	(28)	(40)	(32)	(216)	(52)	(106)	316	(392)	(53)	(47)
51	Production	(132)	(68)	(37)	(72)	(465)	(55)	(182)	40	(429)	(157)	(42)
35	Food Preparation and Serving Related	(81)	(28)	(111)	(13)	(534)	(39)	(118)	(651)	(633)	(52)	(53)
Source: JobsEQ.com												

5.4. PDC Baseline Occupation Gaps

Among the PDC regions of Virginia, variation of projected occupation gaps is due to several factors, including the relative size of occupation employment in the regions, variation in expected regional employment growth rates, varying population growth expectations, and variations in the relative educational attainment among the workforce. Similar to the Northern Virginia MSA, the Northern Virginia PDC stands out among the regions for its differences in projected occupation gaps. Due to the high educational attainment among its population, the region has projected surpluses in occupation groups such as architecture and engineering where most other regions

have a projected shortfall. On the other hand, the Northern Virginia PDC has a projected labor shortfall in installation, maintenance, and repair occupations, an occupation group that has a projected labor surplus in most other Virginia PDCs.

Annual 10-Year Occupation Gaps by PDC, 2010 Q2, Group 1

SOC	Title	Accomack-Northhampton	Central Shenandoah	Central Virginia	Commonwealth Regional Council	Crater	Cumberland Plateau	George Washington Regional Commission
11	Management	4	(1)	47	17	45	12	68
13	Business and Financial Operations	7	37	68	19	96	19	129
15	Computer and Mathematical	5	17	29	7	64	8	102
17	Architecture and Engineering	5	1	38	4	26	3	44
19	Life, Physical, and Social Science	2	5	16	5	19	4	27
21	Community and Social Services	3	7	34	12	46	13	18
23	Legal	(1)	(3)	3	1	2	0	7
25	Education, Training, and Library	10	10	118	59	144	43	78
27	Arts, Design, Entertainment, Sports, and Media	2	6	19	5	10	5	5
29	Healthcare Practitioners and Technical	12	60	114	32	152	36	93
31	Healthcare Support	3	55	35	9	53	13	31
33	Protective Service	4	22	12	7	20	7	56
35	Food Preparation and Serving Related	(11)	(55)	(118)	(43)	(172)	(25)	(306)
37	Building and Grounds Cleaning and Maintenance	(7)	(26)	(35)	(13)	(37)	(7)	(80)
39	Personal Care and Service	5	49	32	9	22	15	23
41	Sales and Related	(6)	(24)	(46)	(24)	(91)	(16)	(175)
43	Office and Administrative Support	(12)	(16)	(70)	(9)	(207)	(15)	(25)
45	Farming, Fishing, and Forestry	(5)	(4)	(1)	(11)	(6)	(1)	(8)
47	Construction and Extraction	2	53	19	(6)	57	(32)	40
49	Installation, Maintenance, and Repair	(3)	9	(23)	(7)	3	(9)	4
51	Production	(5)	(134)	(182)	(31)	(156)	(43)	(31)
53	Transportation and Material Moving	(16)	(70)	(106)	(42)	(96)	(33)	(91)

Source: JobsEQ

Annual 10-Year Occupation Gaps by PDC, 2010 Q2, Group 2								
SOC	Title	Hampton Roads	LENOWISCO	Lord Fairfax	Middle Peninsula	Mount Rogers	New River Valley	Northern Neck
11	Management	133	10	46	19	18	20	3
13	Business and Financial Operations	396	14	57	19	29	39	5
15	Computer and Mathematical	316	5	24	8	10	25	2
17	Architecture and Engineering	134	5	18	7	0	8	0
19	Life, Physical, and Social Science	93	3	13	8	5	11	1
21	Community and Social Services	112	14	25	8	27	14	2
23	Legal	(28)	0	3	1	1	1	(1)
25	Education, Training, and Library	297	44	123	57	80	52	7
27	Arts, Design, Entertainment, Sports, and Media	55	3	11	5	8	12	1
29	Healthcare Practitioners and Technical	436	31	81	27	63	46	11
31	Healthcare Support	88	10	18	3	25	24	7
33	Protective Service	33	7	17	4	13	13	1
35	Food Preparation and Serving Related	(539)	(32)	(119)	(44)	(35)	(87)	(9)
37	Building and Grounds Cleaning and Maintenance	(128)	(9)	(37)	(14)	(15)	(20)	(5)
39	Personal Care and Service	125	13	26	5	31	31	6
41	Sales and Related	(281)	(28)	(58)	(23)	(10)	(29)	(5)
43	Office and Administrative Support	(577)	(10)	(57)	(19)	(16)	40	(10)
45	Farming, Fishing, and Forestry	5	(1)	2	(3)	(3)	(6)	(2)
47	Construction and Extraction	108	(24)	37	5	7	4	4
49	Installation, Maintenance, and Repair	(81)	(6)	(9)	(7)	(15)	(10)	(2)
51	Production	(481)	(18)	(117)	(32)	(169)	(142)	(6)
53	Transportation and Material Moving	(225)	(31)	(107)	(34)	(54)	(46)	(11)
Source: JobsEQ								

Annual 10-Year Occupation Gaps by PDC, 2010 Q2, Group 3								
SOC	Title	Northern Virginia	Rappahannock-Rapidan	Richmond Regional	Roanoke Valley	Southside	Thomas Jefferson	West Piedmont
11	Management	(519)	66	107	13	5	23	21
13	Business and Financial Operations	417	73	336	51	11	69	32
15	Computer and Mathematical	104	46	199	33	4	40	19
17	Architecture and Engineering	(75)	19	86	1	1	15	3
19	Life, Physical, and Social Science	(215)	12	67	13	2	14	6
21	Community and Social Services	(361)	26	81	33	10	13	25
23	Legal	(480)	1	(16)	(1)	(0)	(4)	(0)
25	Education, Training, and Library	(2,519)	111	212	85	28	(5)	103
27	Arts, Design, Entertainment, Sports, and Media	(111)	22	55	9	2	5	8
29	Healthcare Practitioners and Technical	(270)	70	405	124	24	72	61
31	Healthcare Support	389	5	142	27	8	45	29
33	Protective Service	247	20	48	14	5	15	12
35	Food Preparation and Serving Related	(320)	(153)	(521)	(52)	(10)	(133)	(29)
37	Building and Grounds Cleaning and Maintenance	134	(60)	(162)	(19)	(6)	(54)	(16)
39	Personal Care and Service	114	9	81	43	14	31	35
41	Sales and Related	333	(35)	(168)	(13)	(5)	(44)	(12)
43	Office and Administrative Support	999	9	(463)	(140)	(18)	15	(33)
45	Farming, Fishing, and Forestry	(21)	(40)	(8)	(1)	0	(15)	(3)
47	Construction and Extraction	776	(18)	85	45	4	9	10
49	Installation, Maintenance, and Repair	867	(8)	(7)	(18)	(8)	16	(20)
51	Production	97	(74)	(306)	(190)	(52)	(68)	(181)
53	Transportation and Material Moving	420	(97)	(257)	(64)	(22)	(61)	(75)
Source: JobsEQ								

6. Sales, Productivity, and Relocations

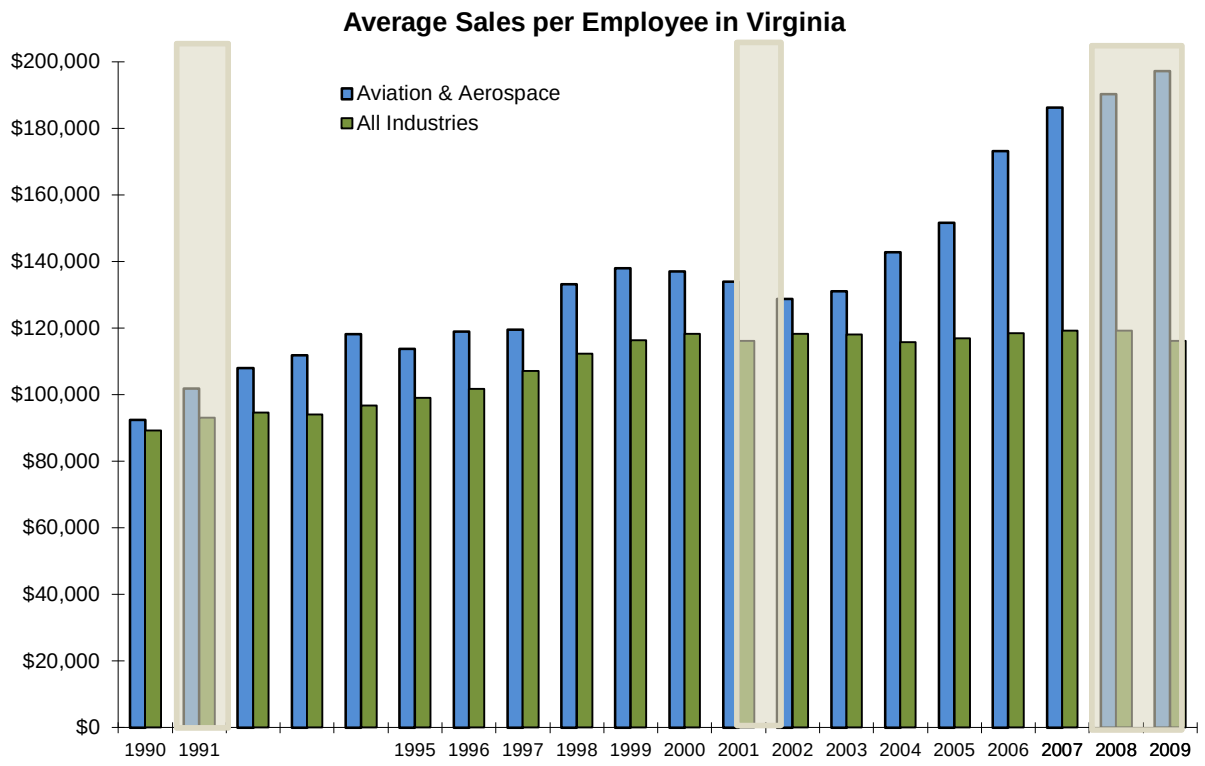
The health of the aviation and aerospace industry and its contribution to the state economy can be assessed based on its sales, productivity, and net attraction of new firms. The National Establishment Time-Series (NETS) database, developed by Walls & Associates and based on the Dun and Bradstreet (D&B) database[46] is used to supplement the QCEW in several ways (See Appendix A of this document for more detail) for this assessment:

- Since it is survey-based, it contains more small business proprietors that are not required to pay unemployment insurance.[47]
- It provides firm-specific and industry-specific sales.
- It identifies when a company has either entered Virginia from another state or exited the state.

6.1. Sales and Productivity

The NETS data offer some important insights about sales and productivity within the aviation and aerospace industry. Sales per employee are used as a measurement of the productivity of the industry in the region and over time. In the past two decades, the average sales per employee have more than doubled, from $92,456 in 1990 to $197,144 in 2009, averaging 4.1% per year. The productivity in the aviation and aerospace industry declined in 2001 and 2002, as the industry experienced severe challenges after the September 11 terrorists' attacks. Since then, productivity has been growing at 6.3% per year.

[46] Chmura acquired the NETS data for the state of Virginia to supplement the Quarterly Census of Employment and Wages (QCEW) database obtained from the Virginia Employment Commission. The NETS database in annual and starts with 1992.
[47] The NETS database captures additional employment, especially proprietor employment and partners in small businesses. QCEW only tracks employment that is covered by the unemployment insurance program. As a result, many proprietors (such as partners in small firms) are not included in the QCEW database. NETS database aims to include all business establishments in the country, including proprietors.



Source: Chmura Economics & ics. Shaded areas are recession period

The productivity of Virginia's aviation and aerospace industries is much higher than the overall productivity of all industries combined. In 2009, the average sale per employee for average industry was $116,105, only about 63% of the average sales per employee in aviation and aerospace industries. In addition, productivity growth in the aviation and aerospace industry outpaced the state average. From 1990 to 2009, average sales per employee in the aviation and aerospace industry averaged 4.1% per year, compared with only 1.4% growth statewide. If the current trend continues, the productivity of the aviation and aerospace industry will be even larger than other industries in the future. While high productivity implies high wages for industry workers, the flip side is that companies may meet the increasing demand through increasing productivity, rather than hiring more workers.

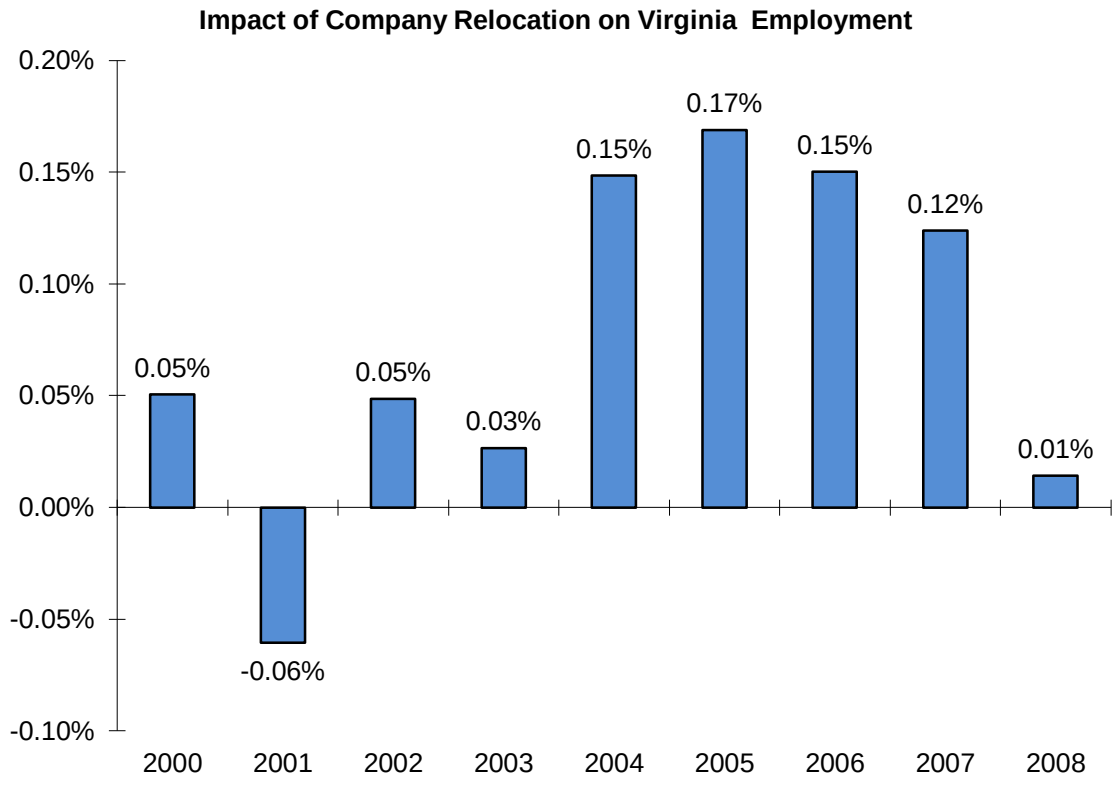
In the past two decades, total sales for both smaller aviation and aerospace firms (with employment < 50) and large firms (with employment ≥50) have grown at a similar pace.[48] From 1990 to 2009, total sales by smaller firms grew by 6.5% per year, while total sales for larger firms grew by a similar 6.4% per year.

[48] The aviation and aerospace industry generally requires a large amount of investment as well as specialized technology and employees to start a firm. For that reason, it is relatively difficult to start a company in the aviation and aerospace industry. As a result, it is not surprising that the NETS database reported less employment in the aviation and aerospace industry than QCEW. In fact, the NETS database missed some establishments in this industry in Virginia that were included in the QCEW database.

6.2. Company Relocations

The NETS database identifies the previous company location of businesses before they expand into a new location. This variable can provide additional information not currently captured by the industry and occupation projection made by Bureau of Labor Statistics (BLS). BLS forecasts are based on national industry trends. Cross-state movements, however, have little effect on the national employment projection because they cancel each other out. For state employment projections, using the BLS forecasts without considering movements of companies may result in under or overestimation of the state's future employment.

Due to its central location on the east coast, and close proximity to the nation's capital, Virginia has attracted several high-profile business relocations in recent years. For example, Northrop-Grumman and Science Applications International Corporation (SAIC) moved their headquarters from California to Northern Virginia. The NETS data confirms that Virginia is a net benefactor of company relocations. As the following chart shows, based on data from 2000 to 2008, on average, employment as a result of net in-moves[49] accounted for 0.08% of the total employment in Virginia.

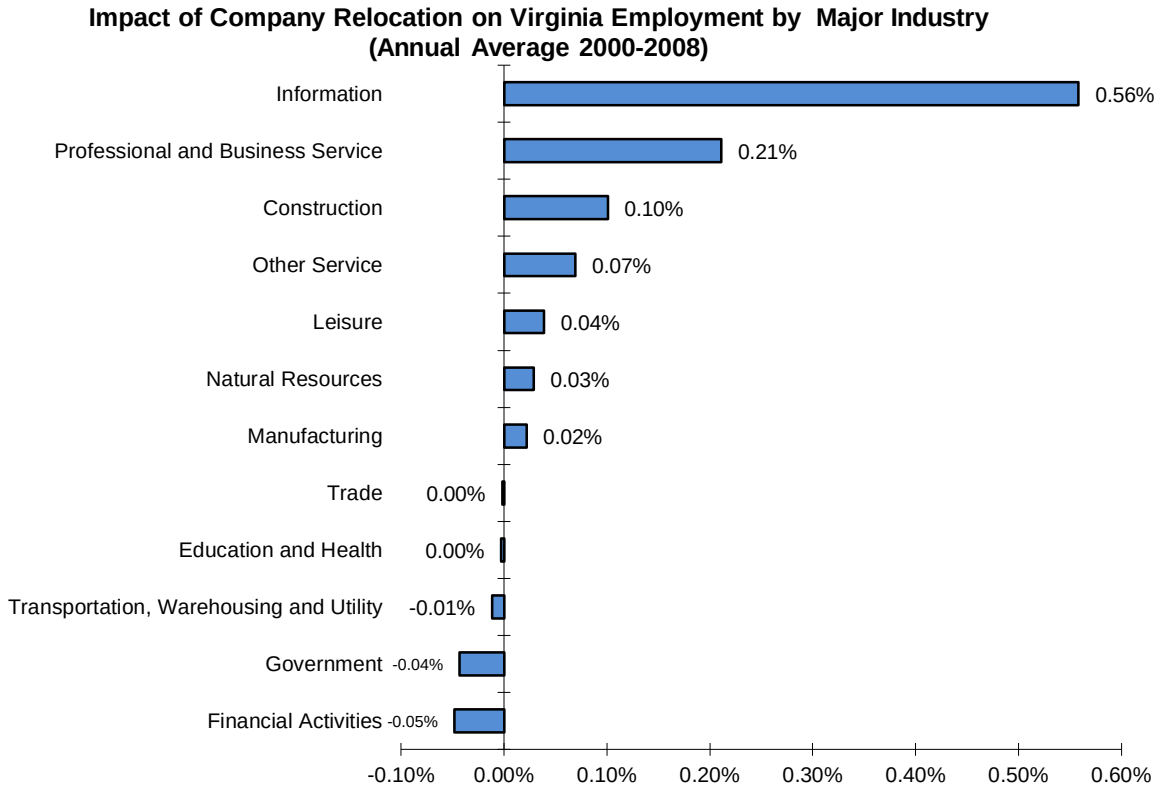


Source: Chmura Economics & Analytics

Among major industry sectors, the information sector benefited the most from company relocations. The sector gained 0.56% of all their jobs per year through company relocations. It is followed by professional and technical

[49] This represents the number of jobs moving in to Virginia minus those moving out.

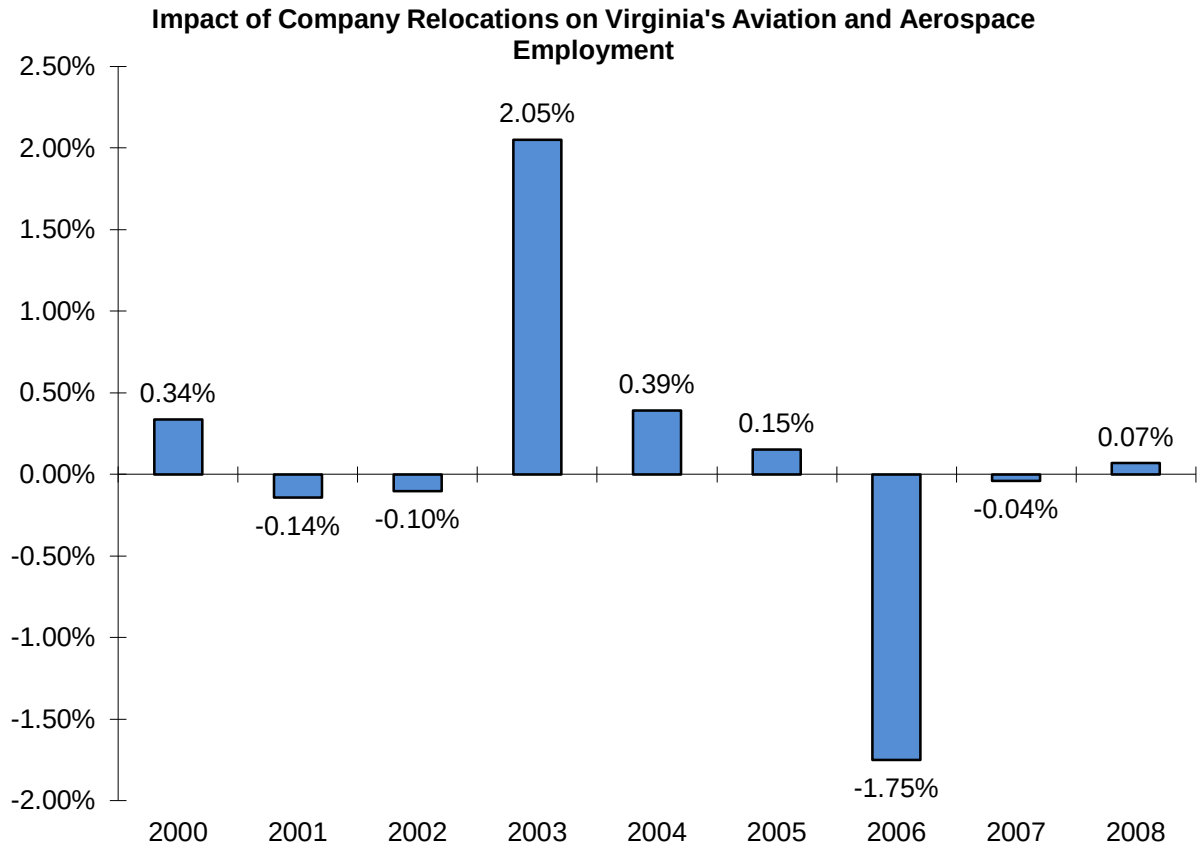
services, with 0.21% of their annual employment coming from company relocations. However, company relocations have limited impacts on the industry sectors such as trade and education and health care. Those industries normally have stronger ties with the local community and are less prone to move. On the other hand, Virginia has been losing companies in financial activities and government sectors as a result of company relocations.



Source: Chmura Economics & Analytics

Virginia's aviation and aerospace industry has been a beneficiary of net relocations in the recent past. The NETS data show that based on data from 2000 to 2008, on average, employment as a result of net in-move[50] accounted for 0.03% of the total employment in this industry. This is lower than the 0.08% for state as a whole. However, there is a wide swing in terms of this percentage across this same 8-year period, as shown in the following chart.

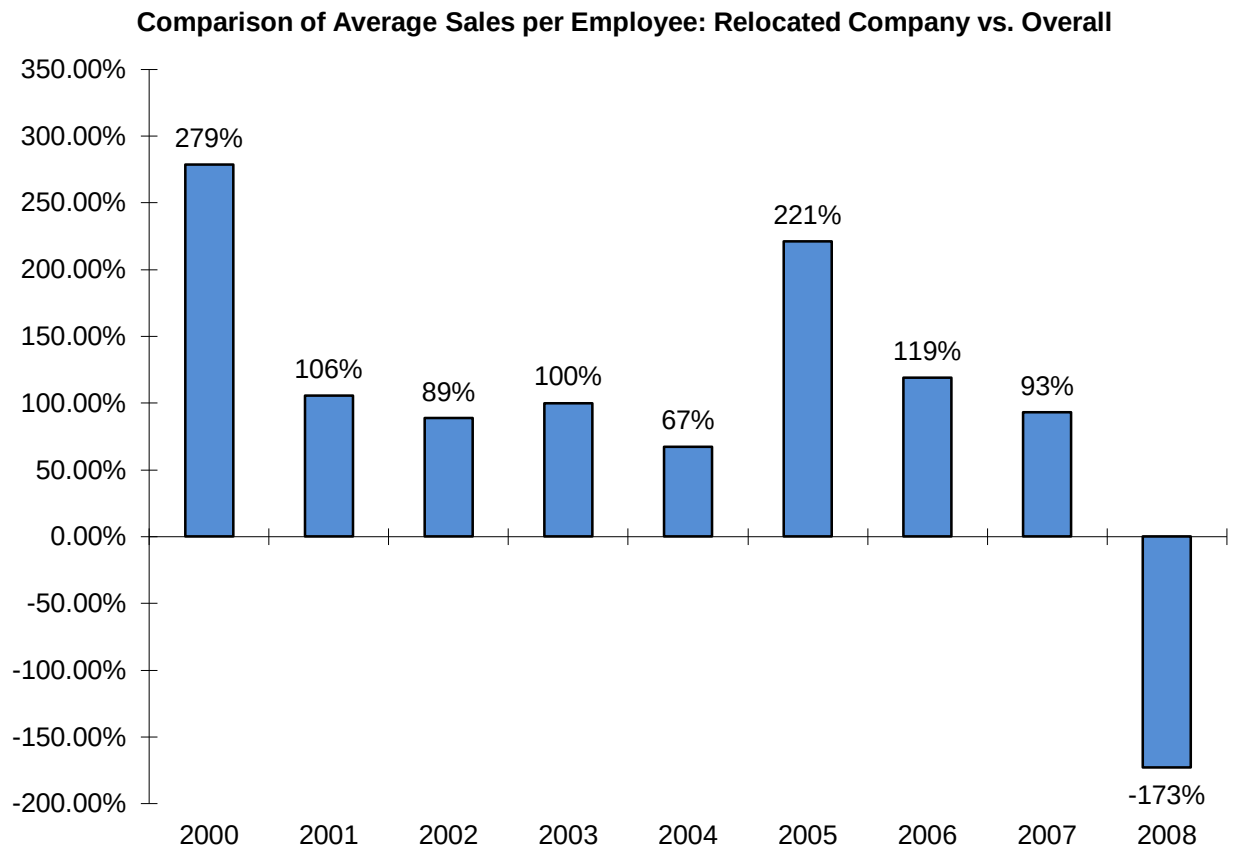
[50] This represents the number of jobs moving into Virginia minus those moving out.



Source: Chmura Economics & Analytics

The average sales per employee in Virginia's aviation and aerospace industry, which is a measure of the productivity of the industry, averaged $153,518 per year from 2000 to 2009. There is no clear indication that the companies that moved into Virginia were more productive than existing companies. As the following chart shows, in some years such as 2000, 2005, and 2006, companies expanding to Virginia had much larger sales per employee than existing firms in Virginia.[51] But in years such 2008, 2004, and 2002, the sales per employees of the companies moving into Virginia were smaller than existing firms in Virginia. In 2008, the companies moving out of Virginia had an average sale of $2.5 million per person, resulting in a total sales reduction even though Virginia gained more employees due to relocation.

[51] In the following chart, a percentage over 100% means the average sales per employee of companies moving in is higher than the existing companies in Virginia.

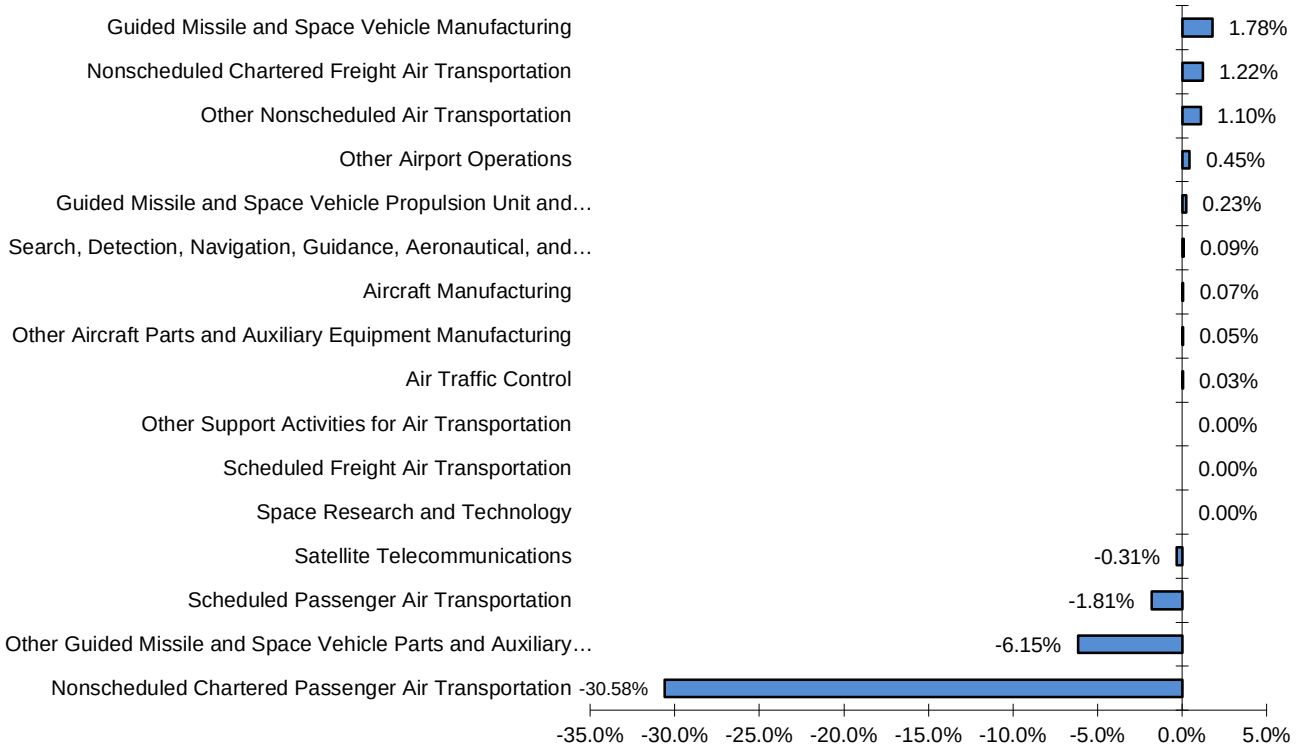


Source: Chmura Economics & Analytics

Among subsectors in Virginia's aviation and aerospace industry, guided missile and space vehicle manufacturing benefited the most from company relocations. The sector gained 1.78% of all their jobs per year through company relocations. Nonscheduled chartered freight air transportation gained 1.22% while other nonscheduled air transportation gained 1.10% employment per year from company movement. However, company relocations and expansion have limited impacts on the industry sectors such as air traffic control, and space research and technology. Those industries, many of them government agencies, are less prone to move.

The overall effect of company relocation on Virginia's aviation and aerospace industry is 0.03% per year. Based on the current employment of close to 30,000 in this industry, the company relocation would translate into about 9 additional workers per year.

Impact of Company Relocations on Virginia Employment by Aviation and Aerospace Subsector (Annual Average 2000-2008)



Source: Chmura Economics & Analytics

Comparing the productivity of moved-in companies with those existing companies by subsectors within aviation and aerospace industry, there appears be no clear pattern. With some industries, such as aircraft manufacturing, the expanding company demonstrated a clear advantage in sales per employee than existing firms. But for other subsectors, average sales per employee of the companies moving into Virginia were smaller than existing firms in Virginia. The diverging results are not surprising as companies may expand or relocate to Virginia for different reasons. Some of those relocating companies, due to the development of new technology or products, are in the process of rapid growth, and they would enjoy a higher productivity than existing firms. But other firms may relocate due to cost cutting to improve efficiencies, implying that they may not be as efficient as existing firms.

7. Business Survey

7.1. Results Summary

Section 7.1 is a brief, high-level summary of results with fuller details found in the remainder of Section 7.

In the spring of 2011, an online survey was conducted targeting businesses in the aviation and aerospace industry. Sixty-six completed responses were obtained with 55 from aviation and aerospace industries as defined with the NAICS-based definition used in this report. Forty-eight of these 55 respondents are members of the aviation industry, defined to be all air transportation industries (all industries in the aviation and aerospace definition beginning with the numeric identifier 48) as well as flight training. Seven of the 55 respondents are classified as aerospace firms, the definition of which comprises the remainder of industries within the aviation and aerospace definition.[52] The remaining eleven respondents are classified as "related industry" firms which fall outside the NAICS-based definition but are nevertheless clearly highly dependent upon and intertwined with aviation and aerospace. If a different method of defining the aviation and aerospace industry was used, these firms may well fall within the definition. Therefore, these related industry firms were included in the analysis but excluded from certain aggregations to maintain consistency with the NAICS-based definition analysis.

The respondent firms were associated with total Virginia employment of 7,730, or an average of 117 employees per business. Aerospace employers were particularly large on average, with average employment of 642 workers. Entrepreneurial businesses—those with ten or fewer employees—were well represented in the sample with 27 responses, 25 of which were from the aviation component. Ninety-two percent of the employment reported was full-time workers with 6% being part-time and the remainder being seasonal.

Respondents were asked about their employment growth over the coming three years. The overall expectation for aviation and aerospace businesses was 2.9% growth over the coming year and 1.4% annual average growth over the coming three years. This expectation is consistent with the industry quickly recouping job losses incurred during the recession and getting back on track with the long-term growth projection assumption of 0.6% per year.

Respondents listed specific occupations in relation to several questions: occupations for which qualified employees were lacking for job openings, occupations where pending retirements were critical, technical occupations which lacked training support, occupations difficult to retain, and occupations among the most impactful upon business success. Taken together, a picture emerges of the many occupations critical to the success of aviation and aerospace businesses in Virginia. The occupations are many and vary from business to business. While none of these occupations should be ignored, we describe in summary here the four occupations and occupation groups most frequently mentioned as being associated with workforce issues: mechanics, maintenance workers, pilots, and engineers.

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[52] In other words, aviation industries are usually designated by 48, such as: air transportation, 481; airport operations, 48811; other support activities for air transportation, 48819; and flight training, 611512. Aerospace industries consist of all aerospace manufacturing industries (334511, 336411, 336412, 336413, 336414, 336415, and 336419) as well as, satellite telecommunications (517410), and space research and technology (927110).

A number of aviation-specific technical occupations were cited as being critical. The two detailed SOC occupations that capture much of this group are aircraft mechanics and service technicians, SOC 49-3011, and maintenance and repair workers, general, SOC 49-9042. Each of these occupations was mentioned by roughly a quarter of aviation respondents as among the most impactful upon their business success. Other technical occupations that appear to be critical within the aviation industry include the following: avionics technicians (SOC 49-2091); air traffic controllers and airfield specialists (SOC 33-2011); first-line supervisors/managers of mechanics, installers, and repairers (SOC 49-1011); and maintenance workers, machinery (SOC 49-9043).

The broad occupation of pilots (SOC 53-2010) includes two detailed occupations: airline pilots, copilots, and flight engineers (SOC 53-2011) and commercial pilots (SOC 53-2012). Pilots were mentioned as critical occupations by both aviation respondents and related industry businesses. Several respondents reported that pilots were not in sufficient supply for their organization. Among respondents who said pending retirements among skilled occupations was a critical workforce issue for their organization, none mentioned pilots, specifically, as an occupation with pending retirements being a critical issue.

Engineers (SOC 17-0000) were frequently cited as occupations associated with workforce issues, especially aerospace engineers (17-2011) and electronics or electrical engineers (17-2070). These occupations were most mentioned by aerospace businesses as not being in sufficient supply. One respondent cited pending retirements in these occupations as being a critical workforce issue.

The workforce trends cited as most critical by survey respondents were lack of qualified employees for job openings (said to be critical by 33% of respondents) and escalating compensation requirements (reported as critical by 29% of respondents). About half of entrepreneurial firms said they had no critical workforce issues while a little less than a third (31%) of larger employers stated they had no critical workforce issues.

Only 15% of respondents reported no trends that will impact workforce planning. Close to two-thirds of respondents (64%) said they see economic trends impacting workforce planning—these impacts include fuel costs, the cost of wages or benefits, and impacts precipitating from the slow overall economy. Forty-one percent of respondents reported seeing regulatory trends impacting workforce planning—more so among aerospace and related industry respondents. Technological trends were seen as having workforce planning impact by a little over a quarter of respondents (27%) while customer requirements were stated to impact planning by 20% of survey takers.

When asked about the skill sets of new hires, the four skills most mentioned as being in short supply were: program management skills, critical thinking, decision making, and work ethic. Aviation respondents most often cited critical thinking and decision making as being in short supply. Among aerospace respondents, STEM skills were most often lacking. In all, nine of twelve skills were designated as being in short supply by 32% or more of respondents.

In other results, employee retention was cited as a difficulty by 14% of respondents; reasons given for this difficulty included salary, hours, and professional growth. Forty-four percent of firms with more than ten employees reported having recruitment programs for prospective employees in contrast to only seven percent of entrepreneurial firms with recruitment programs. Over three quarters (78%) of employers reported having training programs for existing employees.

7.2. Methodology

The Virginia Aviation and Aerospace Workforce Survey was conducted online from March 29, 2011 to April 21. Respondents were sent an email invitation—from Randall Burdette, Director of the Virginia Department of Aviation—along with two reminders if they did not respond. After the initial emails were sent, bounce-backs due to wrong email addresses were removed. Some of these email addresses were able to be corrected; at the same time, additional email contacts were gathered. While the first wave of surveying had a deadline of April 13, a second wave with new or corrected contact information lasted until April 21. Besides the automatically scheduled reminders, critical and large employers that did not respond initially were contacted personally to elicit higher participation from this group.

In all, 282 survey invitations were sent out. Responses, as measured by those who at least opened the online survey, numbered 88 for a 31% response rate. Twenty-two of these responses, however, were incomplete. The usable sample of 66 completed responses is equivalent to a 23% completion rate.

The targeted audience of the survey was the businesses that fall under the NAICS-based definition of aviation and aerospace used in this report. As such, industry-based lists such as the NETS database were utilized for this purpose. To assist in obtaining contact information—and email addresses in particular—this contact information was overlaid on contact lists obtained from the Virginia Department of Aviation and from the Virginia Aviation Business Association. It was acknowledged that the introduction of these latter lists might introduce respondents falling outside of the NAICS-based definition; however: (1) these could be disaggregated during analysis as appropriate and (2) these allow for a wider net at this point of data collection and could further illuminate the appropriateness and perhaps limitations of the NAICS-based definition.

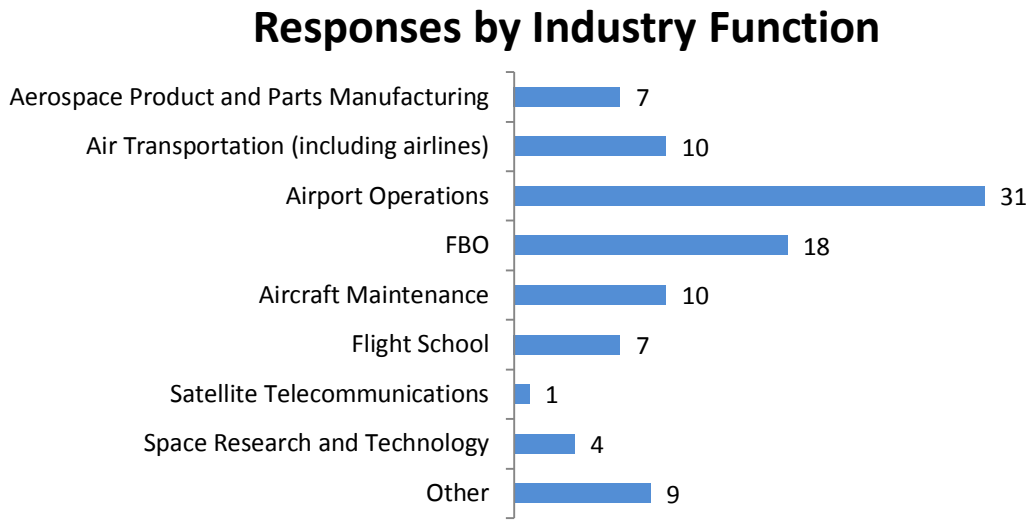
The survey questionnaire is found in Appendix B of this document.

7.3. Industry and Employment Distribution

Respondents were asked to classify the function of their organization. Respondents were given nine categories to choose from along with an open-ended “other” category; in addition, respondents were allowed to choose more than one category. These results thus sum to more than the number of respondents.

The top response was airport operations, designating 31 of the 66 respondents. The category chosen next-most often was FBO (fixed-base operator), designating 18 of the respondents. Tied for the third most-popular category of response with ten responses each were air transportation (including airlines) and aircraft maintenance. Seven respondents used flight school to fully or partially describe their function. Aerospace-related functions were chosen least, led by aerospace product and parts manufacturing (7 responses), space research and technology (4), and satellite telecommunications (1).

There were nine “other” responses that comprised three respondents offering professional support services, two medical transport operations, a public education entity, a skydiving school, and an aerial vegetation control operation.



For analysis purposes, respondents were grouped into four categories based upon their responses and other available information.[53] According to these designations, 48 respondents belong to the aviation category and seven to the aerospace category (despite the small number in aerospace, the average employment size of these firms is relatively large). Within the NAICS-based aviation and aerospace industry definition, the aviation category includes all air transportation industries as well as flight training. The aerospace sector comprises the remainder which comprises the manufacturing industries, satellite telecommunications, and space research and technology.[54]

Survey Respondents by Major Category	
Aviation	48
Aerospace	7
Related Industries	11

Eleven firms are in the category "related-industries." These firms fall outside the NAICS-based definition; however, they clearly are highly dependent upon and intertwined with the aviation and aerospace industries. These related firms largely (1) provide products or professional services—such as engineering, information technology, and research support—with aviation and aerospace companies being the primary consumers, or (2) use aviation as a primary component of their operations—such as for medical services or crop dusting. If the NAICS-based method of defining the aviation and aerospace industry were not so blunt, these related firms would

[53] The online survey allowed for tracking of results based upon the recipient's unique email invitation link. Thus, responses could be linked with company names and other databases to further fill out and inform the analysis.

[54] In other words, aviation = 481, air transportation; 48811, airport operations; 48819, other support activities for air transportation; and 611512, flight training; and aerospace = all aerospace manufacturing industries (334511, 336411, 336412, 336413, 336414, 336415, and 336419) as well as 517410, satellite telecommunications, and 927110, space research and technology.

be likely candidates for inclusion within the definition. For this reason, this group will be included in the analysis though excluded from certain aggregations to maintain consistency with the NAICS-based definition analysis.

The aviation and aerospace firms in the survey combined for employment of 6,452 in Virginia, covering about 22% of the industry's employment in the state. The related industries accounted for an additional 1,278 jobs. The aerospace respondents were much larger on average compared to the other two groups. Aerospace respondents had average employment of 642 compared to 116 for related industry respondents and 41 for respondents in aviation. In the sample, the vast majority of entrepreneurial companies—those with employment of ten or fewer employees—were in the aviation component. The aviation respondents included 25 entrepreneurial firms while the aviation and related industries components each had one.

Virginia Employment of Survey Respondents		
	Total Employment	Average Firm Employment
Aviation	1,958	41
Aerospace	4,494	642
Aviation and Aerospace Total	**6,452**	**117**
Related Industries	1,278	116

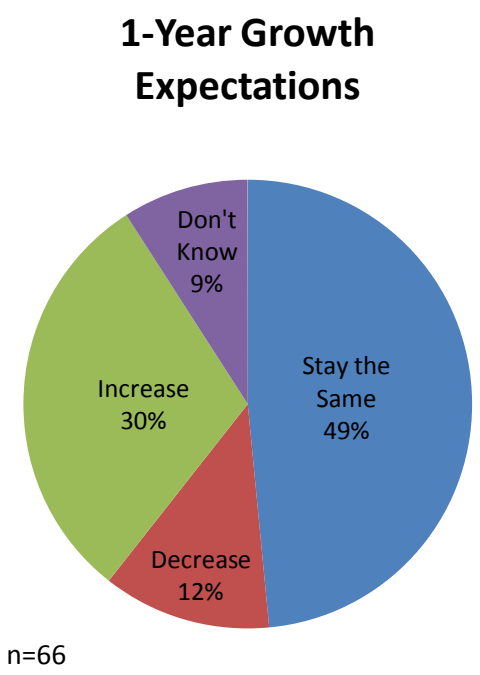
The aviation and aerospace respondents reported that 92% of their employment consisted of full-time workers with 6% being part-time and 1% being seasonal.[55] Aviation respondents had more part-time workers (11%) compared to aerospace respondents (4%). Respondents in the related-industries group reported 6% part-time workers and 3% seasonal workers.

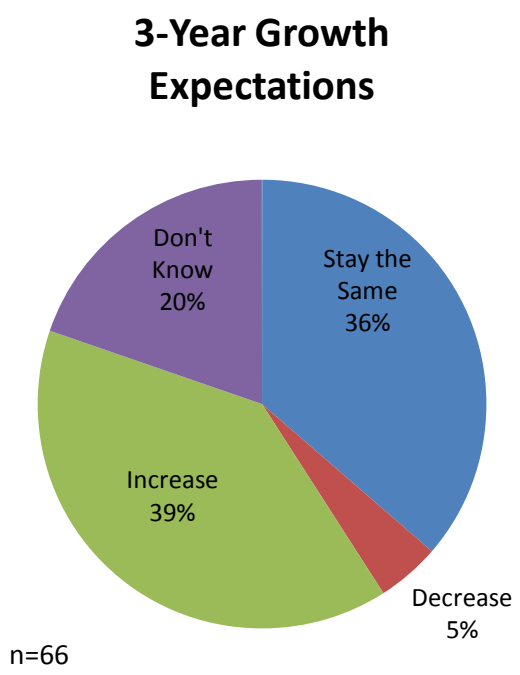
7.4. Growth Expectations

Respondents were asked how they expected their employment would change over the coming twelve months and over the coming three years. Over the next year, about half (49%) expected to stay the same with three-tenths (30%) expecting job growth and 12% expecting a decline. Aerospace firms were especially optimistic, with five of seven expecting growth and the remaining two expecting to hold steady.

Expectations for the coming three years show more firms expecting growth and fewer firms expecting declines (though as seen in the actual size of employment change, the overall growth expectations are more moderate). Over the next three years, 39% of respondents expect to expand employment while 36% expect to stay the same and 5% anticipate a decrease. Twenty percent of respondents could not predict over the three-year time frame, a much higher percentage than the eight percent who were uncertain over the one-year forecast window. Aerospace expectations were more muted for the three-year period (as compared to one-year expectations) with just three expecting job growth, one expecting a decline, one projecting the status quo, and two being unsure.

[55] Figures do not sum to 100% due to rounding.



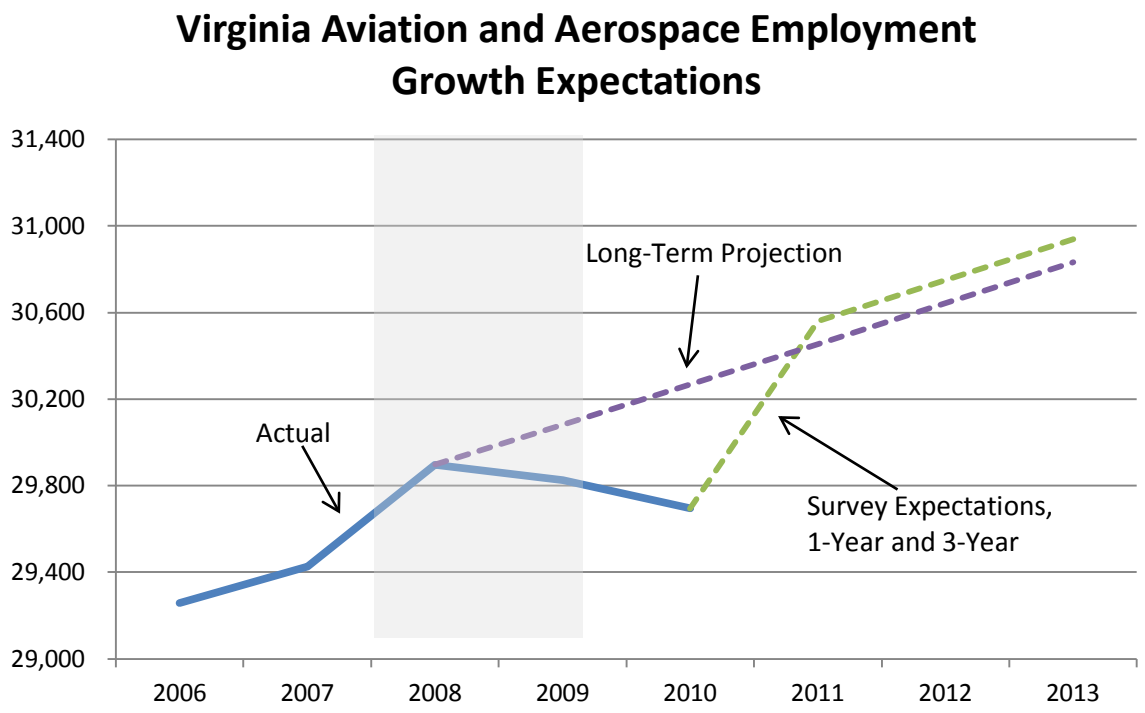


The percent change in employment expected by respondents is more muted for the three-year period compared to one-year expectations. Overall, the respondents expected 4.2% growth over the next twelve months compared to 1.9% annual average growth over the next three years (equivalent to 5.7% total growth over three years). Aerospace and related industries both have high growth expectations over the coming year (5.1% and 3.9%, respectively). The related industry respondents had higher growth expectations (3.4% annual average) for the three-year period compared to the aviation and aerospace respondents.

Annual Average Employment Growth Expectations		
	1-Year	3-Year
Aviation	1.9%	1.3%
Aerospace	5.1%	1.6%
Related Industries	3.9%	3.4%
Total Respondents	4.2%	1.9%
Aviation and Aerospace (weighted by the actual industry mix)	**2.9%**	**1.4%**

Based on the survey results, the aviation and aerospace industry expectations—using a weighted average following the actual industry mix in Virginia—are for 2.9% employment growth over the next year and 1.4% annual average growth over the coming three years. While this growth is faster than the annual average 0.6% job growth expected in aviation and aerospace in Virginia over the next ten years, these expectations are fairly consistent with one another when compared in light of the recent recession. Aviation and aerospace employment in Virginia had a pre-recession peak of 29,897 in 2008 before pulling back to 29,694 in 2010. The fast short-term growth expectations among survey respondents are consistent with recapturing lost employment due to the recession and getting back on track with long-term growth expectations with the 2008 employment level as the baseline. Applying 1-year and 3-year survey expectations to actual 2010 aviation and aerospace employment in Virginia

brings the industry's employment to 30,940 by 2013, similar to the 30,833 in employment that would have followed if the industry followed the long-term growth projection of 0.6% per year beginning in 2008.



7.5. Workforce Issues and Trends

Most of the respondents (61%) reported having at least one critical workforce issue, though nearly half (48%) of aviation respondents said they had no workforce issues, much higher than among aerospace (14%) or related-industry (18%) respondents. Entrepreneurial firms in the sample were more likely to have no critical workforce issues. Among respondents with more than ten employees, 69% reported having a critical workforce issue. The most-cited critical workforce issue was lack of qualified employees for job openings (33%) followed by escalating compensation requirements (29%) and pending retirements among skilled employees (15%).

"Which workforce issues are critical to your organization?"				
	Aerospace	Aviation	Related-Industries	Total
Lack of qualified employees for job openings	57%	23%	64%	33%
Pending retirements among skilled employees	29%	15%	9%	15%
High turnover rates	14%	10%	9%	11%
Escalating compensation requirements	43%	25%	36%	29%
Lack of regional training support for technical positions	29%	8%	9%	11%
Other	0%	8%	9%	8%
We have no critical workforce issues	14%	48%	18%	39%
	n=7	n=48	n=11	n=66

Having no critical workforce issues was tied to the size of the employer. Among entrepreneurial firms, 52% reported having no critical workforce issues. In contrast, just 31% of larger employers had no critical workforce issues. (This difference in response is statistically significant with 90% confidence.)

Lack of qualified employees for job openings was found among most related-industry respondents (64%), over half of aerospace respondents (57%), and less than a quarter of aviation respondents (23%). When asked which occupations were lacking, respondents most often indicated mechanics (5 responses), maintenance personnel (3), engineers (3), and pilots (2). Full unedited responses are provided below, grouped by the industry category of the respondents:

- Aviation
    - Aircraft fuelers
    - Airframe & Power Plant Mechanics
    - ARFF, LEO, Airfield maintenance (lighting/pavement)
    - Customer Service Rep
    - Instructor
    - Line Services
    - Maintenance tech
    - Manager Level in Operations and in Maintenance and in Properties
    - Mechanics
    - Pilots, mechanics
- Aerospace
    - Electro-Optical Fields, Scientists
    - Engineering/ electrical eng
    - Engineers
    - NDT, Metal machinist
    - A&P Mechanics
- Related Industries
    - Engineering technicians/mechanics/engineers
    - Helicopter maintenance
    - Herbicide Applicators
    - IT Security
    - Pilots
    - Skydiving Instructors

Pending retirements of skilled employees was cited as a critical workforce issue in 15% of all respondents including 2 of 7 aerospace respondents and 7 of 23 in aviation. When asked to specify in which occupations there were issues, a management position was mentioned most frequently (3 times). Eight respondents provided details on this question:

- Aviation
    - Airport Finance
    - Airport Manager, Accountant

    - Director of Operations, Director of Maintenance
    - Flightline Attendant
    - Mechanics
    - Some concern regarding facility management, electrical & electronics systems
- Aerospace
    - Engineers (Aerospace, Electrical, Mechanical)
- Related Industries
    - Program Managers

Regarding lack of regional training support for technical positions, seven respondents elaborated:

- Aviation
    - Airfield lighting, ARFF, LEO
    - Airframe and Powerplant Mechanics and Avionics installation and maintenance
    - Airport specific training is usually somewhere else at great cost
    - Very unique skill set for maintenance tech
- Aerospace
    - All the technical classes have been removed from our local Eastern Shore Comm. college.
    - High precision metal machining and related quality processes....outdated training facilities
- Related Industries
    - Community college does not offer these programs

Five respondents, four of which are from the aviation category, mentioned an “other” critical issue. Four of these issues stemmed directly from money issues: lack of funding, insurance costs, and high cost of living. Full text responses follow:

- Aviation
    - Continued Decline in GA [general aviation]
    - High cost of living area
    - Lack of funding to continue with present number of employees
    - Lack of personnel due to funding
- Related Industries
    - Insurance costs

Only 15% of respondents see no trends that will impact workforce planning. Close to two-thirds of respondents (64%) said they see economic trends impacting workforce planning while 41% anticipate regulatory trends impacting workforce planning. Technological trends were seen as having workforce planning impact by a little over a quarter of respondents (27%) while customer requirements were stated to impact planning by 20% of survey takers.

"In which of the following categories do you see trends that will impact your workforce planning?"				
	Aerospace[56]	Aviation	Related-Industries	Total
Technological	33%	21%	55%	27%
Regulatory	67%	35%	55%	41%
Customer Requirements	50%	17%	18%	20%
Economic	83%	63%	64%	64%
Other	17%	0%	9%	3%
None	0%	19%	9%	15%
	n=6	n=48	n=11	n=65

Economic trends were the leading category of trend seen as impacting workforce planning among aviation and aerospace respondents. When asked to specify how the economy would impact their planning, responses covered a wide range of topics, though multiple responses included fuel costs (4), the cost of wages or benefits (3), budget issues (3), and operating or flight hour costs (2). Full responses follow verbatim:

- Aviation
  - "Living Wages"
  - Budget reductions
  - Budget restraints
  - Consumer trends and company profitability
  - Cost of Benefits, particularly medical
  - Cost of fuel
  - Down economy effect aviation squarely as discretionary income is diminished
  - Economy impacting personnel budget
  - Fuel Prices
  - Funding for adequate staff to maintain reasonable safety and customer service
  - Hiring freeze
  - Increased cost of payroll, training, and retention
  - Offering competitive wage rates and escalating cost of benefits
  - Pilots
  - Poor economy leads to less revenue for the airport. Less revenue means not hiring additional staff.
  - Slow growth
- Aerospace
  - Budget uncertainty, shifting funding priorities at Federal level
  - Fx rates [foreign exchange], civil aero travel, price of oil, etc.

[56] The sample size for aerospace is smaller for this question due to a lack of response from one respondent.

    - General economic impacts to vendors.
    - Increased operating costs
- Related Industries
    - Concerns with federal budget, delays in funding, potential for cuts at federal level
    - Cost of fuel
    - Flight hour cost
    - Municipal and government funding; impacts on small business
    - Pay and benefits

Regulatory trends were cited as impacting workforce planning by most of the respondents in aerospace (67%) and in related industries (55%) as well as by 35% of aviation respondents. In specifying how regulatory trends impacted planning, some specific requirements were mentioned (such as ARFF and ADS-B) though many others mentioned increasing or changing regulations in general. The FAA was mentioned by three respondents. Full unedited responses follow verbatim:

- Aviation
    - Always new requirements with no funding
    - Complex and conflicting regulations present hiring and training decisions
    - Constant lobbying effort required to fight issues such as ARFF staffing requirements, union, etc.
    - Constantly increasing regulations requiring additional manpower, but no funding
    - Equipage required for NextGen ATC System
    - FAA regulations
    - More restrictive regulatory requirements
    - Security
    - Surprise inspections ca use misinformation to be supplied [response unedited]
    - The FAA is making life harder all the time
    - Too many and inconsistent throughout the DOT
- Aerospace
    - DOD funding
    - Requirements for ADS-B
    - The government wants to control more each day. Small business can't survive with BIG government.
- Related Industries
    - FAA Requirements
    - Requirements and rule changes

Technological trends were cited by 27% of respondents as affecting workforce planning. Technology was of most concern among related industries (55%) as compared to aerospace respondents (33%) or aviation firms (21%). Text describing these issues for the respondents follows:

- Aviation
    - Airfield systems

    - Avionics and Navigation
    - Increasing complexity of aircraft avionics and technical architecture
    - Less human involvement
    - Not large enough to support IT positions but increasingly difficult to manage contract services
- Aerospace
    - Rapid pace of technological change; candidates with needed skills
- Related Industries
    - New avionics equipment
    - New technologies
    - Remote workers

Customer requirements were cited by half of aerospace respondents as impacting workforce planning. Customer requirements were cited less than a fifth of respondents in aviation (17%) and related industries (18%). Descriptions of these issues follow:

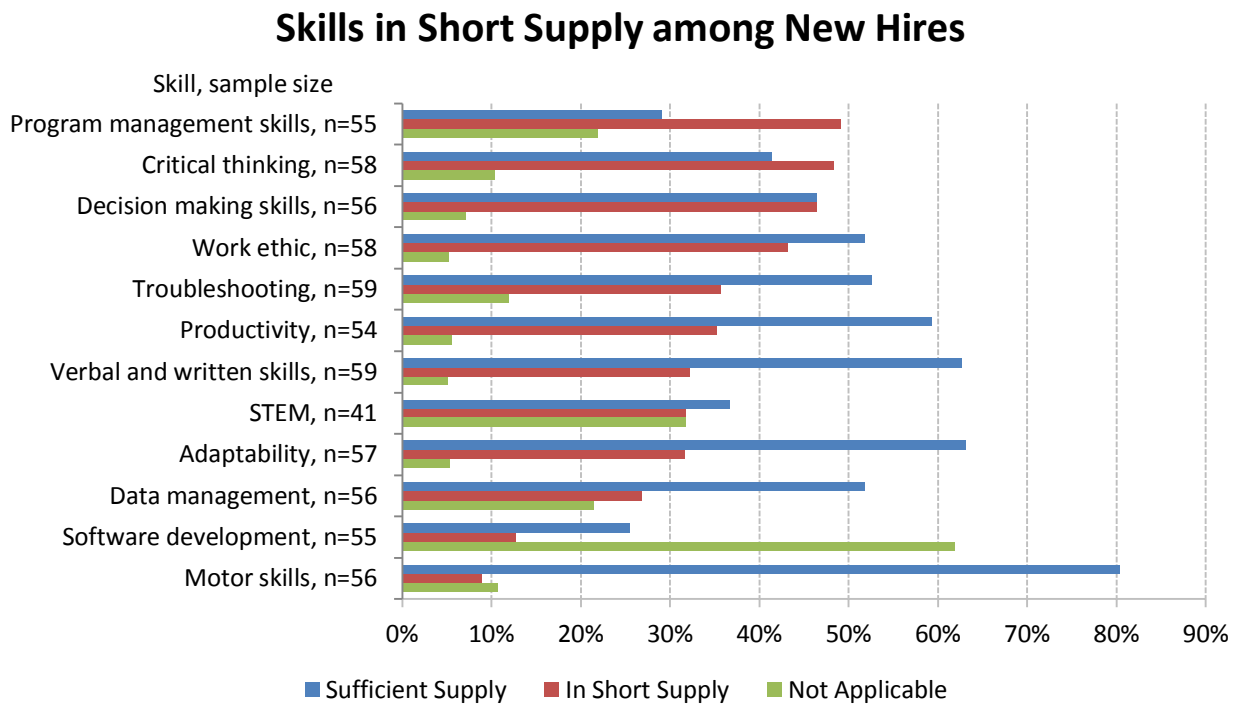
- Aviation
    - Customer base seems to be growing allowing for expansion of operations
    - GA [general aviation] personal sector is drying up and so are the revenues they produce
    - Increased Demand
    - More demands, but paying less for services
- Aerospace
    - Efficiency demands, capacity shortages forecasted
    - Securing new business

Two respondents mentioned trends in the "other" category that will affect workforce planning. An aerospace respondent described this other trend as "mission/programmatic direction." A related industries respondent cited two trends in their text response: "taxes; health insurance costs."

7.6. Skills

Survey respondents were given a list of twelve skills and asked to indicate which are in shortage among their organization's new hires. Nine of the twelve skills were in short supply among 32% or more of the respondents (excluding respondents who "didn't know").[57] Four of the skills were in short supply among over 40% of respondents, namely: program management skills (49%), critical thinking (48%), decision making skills (46%), and work ethic (43%). Of the twelve, the skill most often in sufficient supply was motor skills, sufficient among 80% of respondents.

[57] In the chart shown here, the sample size excludes respondents who did not answer the question or who marked "don't know/other."



Program management skills were cited as being in short supply among new hires by 49% of respondents, with 29% having the skills in sufficient supply and 22% saying it was not applicable. Put another way, where applicable, this skill was in short supply among 63% of respondents. This skill was cited as being in short supply more often among aerospace respondents (71%) compared to related industries (60%) and aviation (42%).

Critical thinking skills were ranked second among the skills most in short supply, marked so by 48% of respondents with 41% saying it was in sufficient supply and 10% marking it as not applicable. Critical thinking was more often in short supply among related industry respondents (60%) compared to aviation (46%) and aerospace (43%).

Decision making skills were as likely to be in short supply (46%) as in sufficient supply (46%) while the remaining 7% of respondents said it was not applicable. This skill was said to be in short supply by 56% of related industry respondents, 45% of aviation respondents, and 43% of aerospace firms in the sample.

Work ethic was found to be in short supply among 43% of respondents though 52% said it was in sufficient supply. Only 5% said the skill was not applicable (and this 5% represents three respondents with three or fewer employees each). Work ethic was cited as being in short supply by 56% of related industry respondents, 43% in aerospace, and 40% in aviation.

Troubleshooting skills were said to be in short supply among new hires by 36% of respondents; 53% said they were in sufficient supply with the remaining 12% saying they were not applicable. Troubleshooting was most in short supply among aviation respondents, 42% of whom stated the skill was lacking among new hires. A third (33%) of related industry respondents said the skill was in short supply while all (7 of 7) of the aerospace respondents said this skill was in sufficient supply.

Productivity skills were cited as being in short supply by 35% of respondents while 59% said they were in sufficient supply with only 6% saying these skills were not applicable. Productivity skills were in short supply among 37% of aviation respondents, 33% of aerospace, and 29% of related industries.

Verbal and written skills were said to be in short supply by nearly a third (32%) of respondents. Sixty-three percent said these skills were in sufficient supply while only 5% said the skills were not applicable. Verbal and written skills were most often in short supply among aviation respondents (35%) and related industries (33%) while only 14% (1 of 7) aerospace respondents cited a lack of these skills in new hires.

STEM skills—science, technology, engineering, and mathematics—were classified in nearly equally thirds: 32% of respondents said the skills were in short supply, 37% said in sufficient supply, and 32% said the skills were not applicable. Differences by industry category for this skill are striking. A decided majority (86%) of the aerospace respondents said this skill was lacking as did 38% of related industry respondents. Meanwhile, only 15% of aviation respondents cited this skill as being in short supply with 46% saying it was not applicable.

Adaptability was in short supply among 32% of respondents with 63% saying it was in sufficient supply and only 5% saying it was not applicable. Adaptability was cited as lacking by 57% of aerospace respondents, 29% of aviation, and 25% of related industry respondents.

Data management skills were in short supply among 27% of respondents with 52% saying they were in sufficient supply and 21% saying they were not applicable. Related industry and aviation respondents were similarly likely to cite these skills as being in short supply as 30% and 28%, respectively, designated these skills as lacking. Data management skills were in short supply among 14% of aerospace respondents.

Software development skills were most often designated as not applicable, by 62% of respondents. These skills were cited as being in short supply by 13% of respondents with 25% saying they were in sufficient supply. These skills were similarly cited as being in short supply by between 11% and 14% of respondents in each of the three categories of aviation, aerospace, and related industries. The difference by industry category, however, was that these skills were not applicable among two-thirds or more of aviation and related industry respondents but not applicable among only 14% of aerospace respondents.

Motor skills were in short supply among the new hires of 9% of respondents with 80% saying they were in sufficient supply and the remaining 11% saying they were not applicable. Motor skills were least in short supply among aviation respondents, only 5% of whom cited this skill as lacking among new hires. This skill was cited as being in short supply among 25% of related industry respondents and 14% of aerospace respondents.

Overall, the top two shortages among aviation respondents were critical thinking (46%) and decision making (45%). Aerospace skill shortages were led by STEM (86%) and program management (71%). Related industries most often cited a lack of critical thinking (60%), and program management (60%).

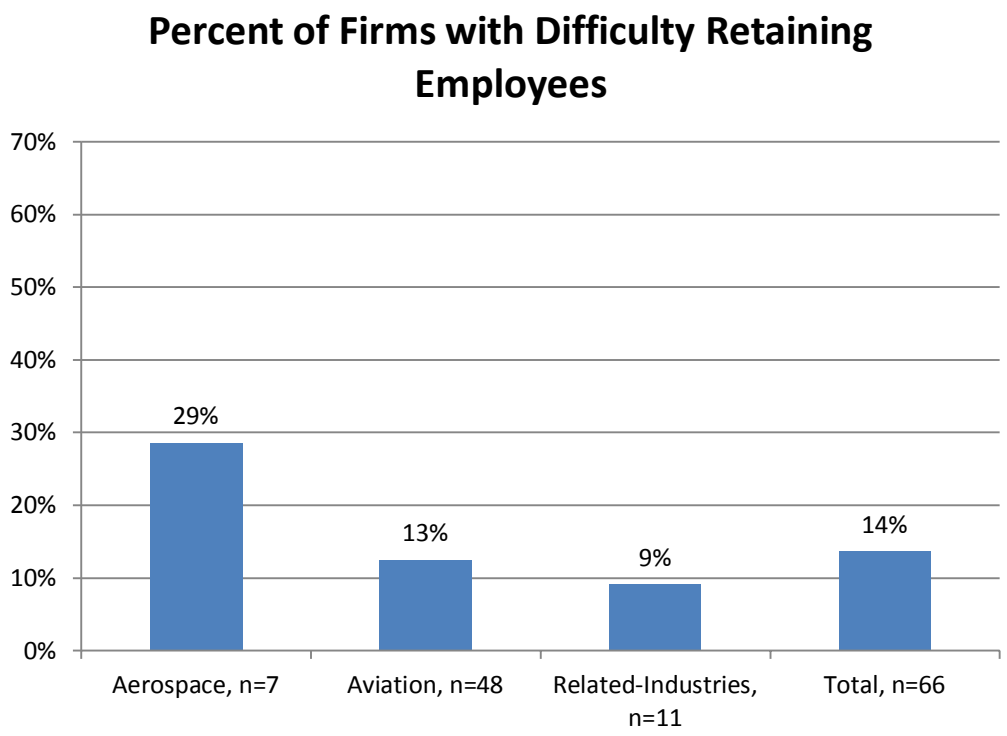
Respondents were also asked to list any **other skills** besides the twelve provided or required certifications that were in short supply to meet workforce needs. Nine respondents, three from each industry category, provided these responses:

- Aviation
    - Ability to pass a drug test
    - Analytical, management and leadership skills

    - ARFF [Aircraft Rescue Fire Fighting] certifications
- Aerospace
    - Aerospace Engineers
    - Mechanical
    - Non-destructive testing...precision metal working related
- Related Industries
    - Ability to pass certification exams
    - Budgets/finance/accounting
    - Certifications

7.7. Employee Retention

Employee retention difficulties were cited by about one in seven respondents (14%). Differences by industry category were not striking—aerospace respondents more often cited retention difficulty (29%) but this is not a statistically significant difference.



If respondents were having employee retention difficulties, they were asked to list the occupations. Seven respondents provided addition details here; the unedited text responses follow:

- Aviation
    - Electricians, Maintenance Technicians, Grounds workers
    - Flight Instructors, mechanics

    - Line Service Techs
    - Line techs, budget cuts
    - Ramp lineman
- Aerospace
    - Federal procurement specialists
    - Yes but it is typical to this field, everyone jumps at the $.

Respondents with employee retention difficulties were asked about the reasons individuals have given for leaving their organization. Answers in quotation marks were provided by the respondents; other answers originated from provided text options that were checked by the respondents. Multiple responses are noted parenthetically:

- Aviation
    - Working elsewhere for a higher salary (3x)
    - Professional growth (2x)
    - Hours (2x)
    - Changing field of work
    - "Weekends off"
    - "Budget cuts"
- Related Industries
    - "The work is hard; requires out of town travel"

7.8. Impact Occupations

Respondents were asked to list up to five occupations that have the biggest potential impact on the success of their business. Respondents were also asked to state if these occupations were in sufficient supply and the number of current vacancies, if any.

This question allowed free responses by respondents rather than pre-supplied occupation titles in order to elicit a wide range of responses and to ease the task of the survey takers. These responses were subsequently aggregated, where possible, to reflect SOC occupations (either at the detailed occupation or 6-digit SOC level or at higher aggregate levels).[58]

[58] The first two digits of the SOC (Standard Occupational Classification) code define "major groups," the first three digits define "minor groups," the first five digits define "broad occupations," and the first six define "detailed occupations."

7.8.1. Top Impact Occupations

Aircraft Mechanics and Service Technicians, SOC 49-3011

Aircraft mechanics and service technicians were listed among the occupations having the biggest impact by 32% of all respondents, including 28% of aviation respondents. Of the respondents listing this occupation, 42% said the occupation is not in sufficient supply for their organization. These respondents further stated they had 20 vacancies for this occupation, equivalent to 2.4% of the total employment of these employers. Titles that respondents used to describe this occupation included the following: mechanic, aircraft mechanic, technician, line service technician, aircraft mechanic technician, and helicopter technician.

Top Executives, SOC 11-1000

Respondents mentioned a number of management occupations having a large impact on their businesses. The top executives SOC minor group (3-digit SOC code) includes general and operations managers (11-1021) as well as chief executives (11-1011). Twenty-nine percent of respondents listed these occupations among those having the biggest impact, including half of the aerospace respondents. A third of these respondents said the occupation is not in sufficient supply for their organization, though a total of only six vacancies were listed for these executives while total employment among these employers was over 3,000. This occupation was described with titles including: functional manager, program manager, administrative, management, general manager, airport director, airport manager, president, and director.

Maintenance and repair workers, general, SOC 49-9042

While this detailed SOC occupation is used to describe group of responses, it is acknowledged that additional SOC occupations may capture some of the responses being referred to herein, such as the supervisory roles described.[59] Maintenance and repair workers was mentioned as an impactful occupation by 21% of respondents, all of which were in the aviation industry—put another way, 24% of aviation respondents listed this occupation as impactful. Forty-six percent of these respondents said maintenance and repair workers were not in sufficient supply in their organization—though only one vacancy was reported. This occupation was described under the following: airfield maintenance worker, airport maintenance technician, director of maintenance, GSE mechanics, maintenance, skilled maintenance, airport maintenance supervisor, and airport maintenance personnel.

Pilots, SOC 53-2010

Pilots is a broad occupation (5-digit SOC) encompassing two detailed occupations (6-digit SOC): 53-2011, airline pilots, copilots, and flight engineers; and 53-2012, commercial pilots. Pilots were mentioned as impactful occupations by 14% of all respondents, including 9% of aviation respondents and 36% of related industry respondents. A third of these respondents said pilots were not in sufficient supply for their organization. This occupation was described using the following titles: pilot, flight instructor, Learjet pilot.

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[59] Listed separately, these supervisory positions may best be described by SOC 49-1011, first-line supervisors/managers or mechanics, installers, and repairers. In addition, the occupation maintenance workers, machinery (SOC 49-9043) may be applicable to some of these occupations.

Engineers, SOC 17-2000

Aerospace engineers (17-2011) were listed by two aerospace respondents as an occupation among those with the biggest impact. Electronics or electrical engineers (17-2070) were also listed twice—by one aerospace industry and one related industry respondent. Other engineer types were listed once each: chemical, manufacturing, research, and simply "engineers." Seven of the eight respondents who listed engineers also reported having vacancies in these occupations. Moreover, 63% of these respondents reported that the occupation was not in sufficient supply for their organization. In all, six of the eight engineer responses were elicited from aerospace employers with the remaining two coming from related industry respondents.

7.8.2. Other High Impact Occupations

Customer Service Representatives, SOC 43-4051

Customer service representatives were listed among those occupations having the biggest impact by six aviation respondents, or 11% of all aviation respondents. A third of these respondents stated the occupation is not in sufficient supply in their organization though none of the respondents reported any current vacancies. This occupation was described using the following titles: customer service, customer service representative, customer service agents, and customer service tec (sic).

Miscellaneous Teachers and Instructors, 25-3090

This occupation category describes four miscellaneous education occupations described as impactful by one aviation respondent and three related industry respondents. The titles used for these occupations were: education specialist, educators, instructors, and skydiving instructors. Three of these four respondents said the occupation was not in sufficient supply for their organization. These respondents reported 6 vacancies, equivalent to 3.8% of these respondents' total employment.

Security Guards, SOC 33-9032

This occupation was listed among the most impactful by four aviation respondents, or 7% of all aviation respondents. The occupation was described as: police officer or public safety officer. One of the four respondents said the occupation was not in sufficient supply for their organization and no respondent reported current vacancies.

Avionics Technicians, SOC 49-2091

Avionics technicians were reported among the most impactful occupations by two aviation respondents and one related industry respondent. Though just one of the three said the occupation was not in sufficient supply in their organization, all three reported vacancies—the total 4 vacancies in this occupation is equivalent to 3.4% of these three respondents' total employment.

Fire Fighters, SOC 33-2011

Two aviation respondents listed fire fighters among the most impactful occupations, with one specifying an ARFF (Airport Rescue & Fire Fighting) fire fighter. These respondents did not list any current vacancies and reported the occupation was in sufficient supply.

Air Traffic Controllers and Airfield Operations Specialists, SOC 53-2020

This occupation category was listed among the most impactful by two respondents, one from aviation and one from related industries. No vacancies were reported and both employers said the occupations were in sufficient supply. The verbiage used to describe these occupations was: air traffic control skills and airport operations specialist.

Computer Occupations

Computer-related occupations were listed among the most impactful by three related industry respondents, describing the occupation titles as: IT solution architects, computer programmers, and IT. Two of the three said the occupations were not in sufficient supply, and ten vacancies were reported in these occupations amounting to 1.1% of these three employers' total employment.

Other Technical Occupations

This category is somewhat of a catch-all for technical occupations that could not be classified in any of the aforementioned groups. Fifteen responses fall into this category. Four aerospace employers provided these occupation titles: metal machinist, non-destructive testing, physical scientists, and mechanical. Eight aviation respondents gave these responses: airfield lighting/approach systems, ramp lineman, chief inspector, flight technician, ground handling techs, line fueler, line supervisor, and linemen. Three related-industry respondents provided these titles: certified commercial applicator, registered technicians, and engineering technician. Seven of the fifteen respondents (47%) said the occupation they reported was not in sufficient supply in their organization.

Other Management, Business, and Finance Occupations

This is another category for occupations that could not be aggregated elsewhere. Eighteen responses fall into this group. To describe the occupations, two respondents from the aerospace industry used these titles: human resources and business development. Thirteen aviation responses used these titles: engineering/project management, management assistant, accountant, administrative support staff, air service development manager, avionics supervisor, clerical, director of finance, facility maintenance manager, operations supervisor, properties manager, recruiter, and data management accounting. Three related industries offered these titles: program assistant, legal, and marketing personnel. Seven of the eighteen (39%) reported the occupation was not in sufficient supply in their organization—though the vast majority did not list any vacancies.

Medical Occupations

Two related industry respondents each listed two medical occupations among the most impactful in their businesses, described thus: nurse, medic, flight medics, and flight nurses. One of the two employers reported multiple vacancies for these positions and said the occupations were not in sufficient supply.

Sales Occupations

Two occupations were reported in sales occupations, described as: sales and parking cashier. The sales occupation was described as not being in sufficient supply and having current vacancies.

7.9. Recruitment and Training

Twenty-nine percent of the survey respondents reported having recruitment programs for prospective employees. Seventy one percent of aerospace respondents were most likely to have recruitment programs, compared to 20% of aviation respondents. Overall, having recruitment programs was related to firm size; a smaller percentage (7%) of entrepreneurial companies (with ten or fewer employees) had recruitment programs compared to larger firms (44%).

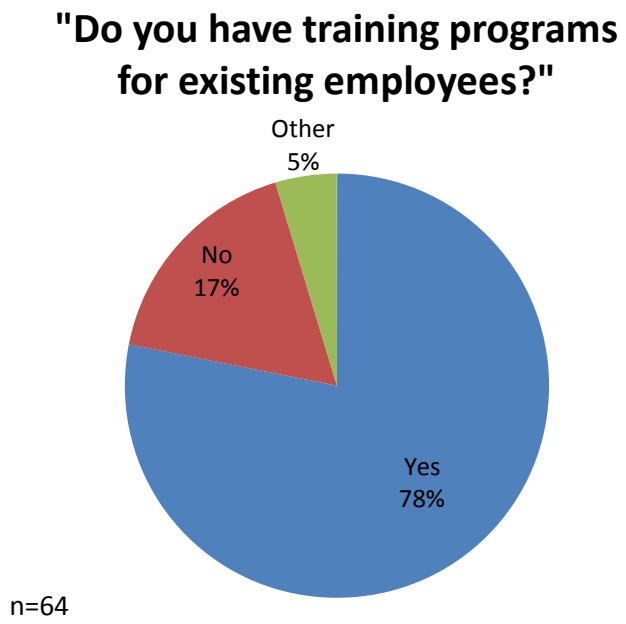
"Do you have recruitment programs for prospective employees?"				
	Aerospace	Aviation	Related-Industries	Total
Yes	71%	20%	36%	29%
No	29%	80%	64%	71%
	n=7	n=45	n=11	n=63

Respondents with recruitment programs were asked what programs they had and these responses follow:

- Aviation
  - CTI
  - Home Office Based Screenings
  - Instructor
  - On line apps
  - Online recruitment and dedicated staff at corporate office
  - Our web site
  - PeopleScout
  - Via Corporate
- Aerospace
  - College fairs and job fairs.
  - Co-Op programs, internships, summer student programs. Also participate in job fairs, professional association meetings, etc.
  - Intern, Coop, STEM
  - Run by HR - Job fairs, etc.
  - Various
- Related Industries
  - Bonus, training, etc
  - Intern Program
  - Pilot, Nurse, Medic
  - Variety, schools, online

Over three quarters of respondents (78%) reported having training programs for existing employees. This response was fairly consistent across the industry groups, varying from 73% of related industry respondents to

86% of aerospace with aviation at 78%. Within the sample, training programs were less prevalent among entrepreneurial firms (70%) compared to larger employers (84%).



Respondents having training programs described these:

- Aviation
  - 3 week policy and procedures
  - Airfield maintenance, safety, line operations
  - Company Sponsored
  - Computer Based Training
  - EDGE, Various
  - FAA
  - FAA check rides
  - Fuel Handling from provider
  - Fueling systems
  - General workplace training via ADP, specialized training (such as police & fire) via specific internal and external programs
  - HR & IT related
  - In house
  - Indoctrination and as needed factory and OJT
  - Local Technical Training Only
  - Management training
  - NATA Safety First (2x)
  - On line/ work place
  - OSHA, Indoctrination, aircraft specific (technicians and pilots), Safety First Training, Customer Service Training
  - Provided by fuel supplier
  - QA, Security, OSHA, Flightline
  - Recurrent

    - Safety and security
    - Safety/Security/Policy/Procedures
    - Safety/Technical
    - Shell aviation procedures, our policy and procedures, spill control
    - Skills, security, driver, personnel policy, numerous off airport training courses.
    - SWPP-SPPC-Line OPs-Customer Service-Fueling
    - Technical and developmental, provided by 3rd party vendors, e.g. FlightSafety International.
    - They vary depending on department
    - Training through AAAE
    - TSA, Local
- Aerospace
    - Extensive internal programs...public programs outdated
    - In house training and OJT.
    - Informal, room for improvement
    - Many
    - Training for new supervisors, refresher training for existing supervisors, mid-level leadership training, early career leadership training, leading through influence, required training (ethics, IT security, etc.), developmental training
    - Various
- Related Industries
    - All
    - In house and State certifications
    - Industry approved training and certification programs
    - IT & Professional Development
    - On the Job Training
    - On-line cont education and skill check-offs
    - Tech, educational, etc
    - We provided targeted external and internal training as needed. Much of what is needed is on the job training.

7.10. Final Comments

As a final question, respondents were asked if they have any final thoughts regarding either workforce skills in the aviation and aerospace industries in Virginia or training and education programs for these industries. These unedited responses echo, clarify, and elaborate upon the survey findings presented above:

- Aviation
    - Airport Specific Training - airfield lighting, pavement management, wildlife management is far flung and expensive to travel too. Help would be to bring training to the airports in Virginia similar to the State Fire Academy's ARFF Responder Training.
    - … we have seen high turnover in some areas in recent years due to retirement, and may see other departments impacted by the same over the next few years. We have not always been in the position of not having critical workforce shortages, but readily admit that the economy has made it an "employers' market" for the past few years. Aside from retirement, the next challenge for the airport is to offer competitive compensation to our employees. We survey locally (police and fire, dispatch, and entry-level positions) and beyond (operations, senior management) to remain competitive.
    - Liberty University's School of Aeronautics, in Lynchburg, VA is a great resource for trained professionals in many aviation related fields. Here is a link/web address to their web site that provides information on their programs: http://www.liberty.edu/index.cfm?PID=147.

    - No. Thanks for your efforts
    - The skilled labor pool in the Richmond area is inadequate for our needs. If a pilot or technician vacancy arises we perform a national search to find the highest quality candidates willing to relocate.
    - We are a very small organization where the loss of one person can have a significant impact. Airport maintenance involves a combination of some very routine mechanical skills and some very technical skills that require considerable training. With only one maintenance tech in the work force, it is hard to fill this position with someone who already has the full complement of skills for the job. Bookkeeping/accounting also presents a unique challenge, dealing appropriately with state grants, federal grants and City contributions to the operating budget are examples of "other than ordinary" accounting requirements as is dealing with government accounting standards. It has been an ongoing, multi-year, On-The-Job learning experience to bring the current accountant to her current level of expertise. Replacing her will be a challenge. My position, Airport Manager, is also unique. It is said that an airport manager is a jack of all trades and a master of none, and that is very true. At a small airport, the manager must at the same time be a generalist and a person who is detail oriented. He must also be an innovator who is able to develop solutions on the run. While there are some good academic training opportunities, nothing is available to train an airport manager for the breadth and depth of functions, responsibilities and technical challenges that he will encounter. I am nearing retirement and came to this job with 24 years of military aviation as an Air Force officer, ten years previous experience in the management of general aviation airports, and a Master of Aviation Management degree from Embry-Riddle Aeronautical University. That fairly unique background provided me with about as good a preparation for this position as I could have, but these kinds of people are not readily available. Even with that background and an additional ten years experience on the job here. I find unexpected and unique challenges on almost a daily basis.
    - We have no paid employees. This is a privately owned public airport.
    - What we need to know in the aviation industry is how many pilots are there now and what is the projection year over year for new pilots replacing those that are aging out. What airplane/technological changes will be brought to market that affects the need for General Aviation airports? What are the services that will be required to be competitive in the future?
- Aerospace
    - At the vocational level, the public technical training programs are outdated and utilize old and overly simplistic methods/technology to teach students. This leaves students unprepared to perform advanced manufacturing jobs. Employers are having to utilize internal, stand alone and costly training programs to meet their requirements. A significant investment in vocational readiness would be a key area for the Commonwealth to attract more advanced manufacturing to the region and facilitate expansion of existing related operations.
    - Put [some] mechanical classes back in our Virginia Comm. Colleges
- Related Industries
    - Cost effective training for those interested in becoming helicopter pilots
    - Currently we are able to find highly qualified candidates in VA. Industry future shortages may be in the areas of avionics and maintenance technicians. Future shortages may also occur in the pilot and air traffic control skills areas.
    - Finding skilled labor in the A&P Mechanics and Avionics field is very difficult. Working with the military to encourage their ranks to obtain their A&P [while] enlisted is KEY to them being successful in the civilian world.

8. Occupation Demand

To facilitate an examination of occupation demand in greater detail, this section looks at the two components of the aviation and aerospace industry separately, as the occupation mix and needs of these components can be strikingly different. These industry components are described in the below table. The aviation portion comprises the air transportation industries of the combined aviation and aerospace definition along with flight training; the aerospace portion consists of the rest which are the manufacturing industries, satellite telecommunications, and space research and technology.

Aviation and Aerospace Industry Definition	
NAICS	**Description**
Aviation Industries	
481	Air Transportation
48811	Airport Operations
48819	Other Support Activities for Air Transportation
611512	Flight Training
Aerospace Industries	
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Mfg
336411	Aircraft Manufacturing
336412	Aircraft Engine and Engine Parts Manufacturing
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing
336414	Guided Missile and Space Vehicle Manufacturing
336415	Guided Missile and Space Vehicle Propulsion Units
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment
517410	Satellite Telecommunications
927110	Space Research and Technology

8.1. Aviation

Among the aviation occupations with the most employment are service-oriented positions such as ticket agents and flight attendants. Of the fifteen occupations with the most aviation employment in Virginia, four are STEM occupations and all four of these are associated with critical workforce issues identified by survey respondents. These occupations are: aircraft mechanics and service technicians; airline pilots, copilots, and flight engineers; commercial pilots; and avionics technicians.

Top Thirty Occupations - Virginia Aviation Industries					
SOC	Title	2010Q2 Employ-ment	10-Year Growth Demand	Minimum 10-Year Replacement Demand	STEM
43-4181	Reservation and Transportation Ticket Agents and Travel Clerks	2,899	379	647	
39-6031	Flight Attendants	2,874	412	639	
49-3011	Aircraft Mechanics and Service Technicians	2,073	315	400	✓
53-2011	Airline Pilots, Copilots, and Flight Engineers	2,067	287	699	✓
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	845	5	271	
53-6099	Transportation Workers, All Other	669	125	239	
43-5011	Cargo and Freight Agents	628	184	143	
39-6011	Baggage Porters and Bellhops	592	100	153	
43-4051	Customer Service Representatives	583	128	183	
43-1011	First-Line Supervisors/Managers of Office and Administrative Support Workers	493	69	111	
53-2012	Commercial Pilots	361	91	122	✓
49-9042	Maintenance and Repair Workers, General	274	37	42	
39-6032	Transportation Attendants, Except Flight Attendants and Baggage Porters	246	37	55	
49-2091	Avionics Technicians	228	52	38	✓
49-1011	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers	223	16	58	
53-7199	Material Moving Workers, All Other	220	(1)	25	
43-5081	Stock Clerks and Order Fillers	202	18	46	
43-9061	Office Clerks, General	169	26	23	
11-1021	General and Operations Managers	168	8	49	
53-7061	Cleaners of Vehicles and Equipment	163	4	58	
13-1199	Business Operations Specialists, All Other	153	24	34	
43-3031	Bookkeeping, Accounting, and Auditing Clerks	134	18	16	
53-2021	Air Traffic Controllers	132	15	45	✓
43-5061	Production, Planning, and Expediting Clerks	132	9	32	
33-9032	Security Guards	131	18	27	
43-6011	Executive Secretaries and Administrative Assistants	118	20	16	
37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	117	8	22	
51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	108	32	23	
53-6051	Transportation Inspectors	105	22	25	
53-2022	Airfield Operations Specialists	100	18	34	

The total demand for an occupation is generally the growth demand plus the replacement demand.[60] Thus, for example, there is a total projected demand for 1,051 additional flight attendants in Virginia's aviation industry over the next ten years; 412 of these jobs are due to growth—the expansion in the number of employed flight attendants—and 639 jobs are due to replacements due to turnover and retirements. Note, however, that this latter demand is called the "minimum" replacement demand as this measure underestimates the number of new entrants needed in an occupation.[61]

Aviation occupations in Virginia that are predominantly employed by airlines are mostly found in Northern Virginia. The Northern Virginia MSA is the employment home of over 80% of ticket agents, flight attendants, and airline pilots. Most other aviation occupations still have a majority employed in Northern Virginia but have larger presences in other Virginia locations. Aircraft mechanics and service technicians, for example, have 69.4% of their aviation employment in the Northern Virginia MSA with 12.6% in the Hampton Roads MSA, 7.2% in the Richmond MSA, and 10.7% in the remainder of the state. An exception to these distribution patterns are commercial pilots, about 35% of whom in Virginia are employed at nonscheduled air transportation. Only 38.8% of commercial air pilots are employed in the Northern Virginia metro area and 38.6% in Virginia are employed outside of the three largest MSAs.

Regional Distribution - Top Fifteen Aviation Occupations					
SOC	Occupation	Northern Virginia MSA	Hampton Roads MSA	Richmond MSA	Other VA
43-4181	Reservation and Transportation Ticket Agents and Travel Clerks	83.7%	6.1%	5.5%	4.7%
39-6031	Flight Attendants	85.4%	5.1%	5.3%	4.3%
49-3011	Aircraft Mechanics and Service Technicians	69.4%	12.6%	7.2%	10.7%
53-2011	Airline Pilots, Copilots, and Flight Engineers	85.5%	5.4%	5.2%	3.9%
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	72.4%	12.6%	6.8%	8.3%
53-6099	Transportation Workers, All Other	72.5%	11.9%	6.8%	8.8%
43-5011	Cargo and Freight Agents	77.1%	9.8%	6.2%	6.8%
39-6011	Baggage Porters and Bellhops	72.3%	12.9%	6.8%	8.0%
43-4051	Customer Service Representatives	76.6%	9.7%	6.3%	7.4%
43-1011	First-Line Supervisors/Managers of Office and Administrative Support Workers	80.2%	7.5%	5.9%	6.4%
53-2012	Commercial Pilots	38.8%	10.5%	12.1%	38.6%
49-9042	Maintenance and Repair Workers, General	74.6%	10.8%	6.5%	8.2%
39-6032	Transportation Attendants, Except Flight Attendants and Baggage Porters	70.3%	14.0%	7.0%	8.7%
49-2091	Avionics Technicians	64.8%	15.8%	7.7%	11.6%

[60] When growth is projected to be negative, total demand is equal to the replacement demand—the projected decline in employment is not subtracted out. For an explanation, see: http://www.bls.gov/emp/ep_replacements.htm.
[61] For further details, see: http://www.bls.gov/emp/ep_replacements.htm.

8.2 Aerospace

Half of the employees in Virginia's aerospace industries are in STEM-related occupations, including the four largest occupations and 14 of the largest 30. Engineers account for the three largest occupations in aerospace industries: aerospace engineers (746 employees); engineers, all other (507); and electronics engineers, except computer (283).

The aerospace industry includes some production occupations that are projected to decline in overall numbers within this industry in Virginia. These include electrical and electronic equipment assemblers and machinists. These occupations, however, still are forecast to have net demand in the state due to replacement needs.

Top Thirty Occupations - Virginia Aerospace Industries					
SOC	Title	2010Q2 Employ-ment	10-Year Growth Demand	Minimum 10-Year Replacement Demand	STEM
17-2011	Aerospace Engineers	746	131	154	✓
17-2199	Engineers, All Other	507	80	105	✓
17-2072	Electronics Engineers, Except Computer	283	34	65	✓
17-3029	Engineering Technicians, Except Drafters, All Other	264	31	50	✓
51-2092	Team Assemblers	251	(0)	56	
15-1032	Computer Software Engineers, Systems Software	226	103	19	✓
51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	223	67	47	
17-2112	Industrial Engineers	221	61	56	✓
13-1199	Business Operations Specialists, All Other	217	34	48	
51-2022	Electrical and Electronic Equipment Assemblers	210	(18)	32	
15-1031	Computer Software Engineers, Applications	201	93	17	✓
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	184	6	30	
51-4041	Machinists	183	(6)	24	
17-2141	Mechanical Engineers	173	20	44	✓
17-3023	Electrical and Electronic Engineering Technicians	170	16	32	✓
17-2071	Electrical Engineers	159	21	36	✓
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	147	31	38	
11-9041	Engineering Managers	138	23	28	✓
49-3011	Aircraft Mechanics and Service Technicians	134	20	26	✓
11-1021	General and Operations Managers	130	6	37	
51-1011	First-Line Supervisors/Managers of Production and Operating Workers	121	(5)	16	
13-1111	Management Analysts	115	40	20	
43-4051	Customer Service Representatives	110	24	35	
19-2099	Physical Scientists, All Other	109	10	28	✓
43-6011	Executive Secretaries and Administrative Assistants	109	19	15	
11-9199	Managers, All Other	107	12	28	
51-2023	Electromechanical Equipment Assemblers	106	(11)	16	
13-1041	Compliance Officers, Except Agriculture, Construction, Health and Safety, and Transportation	101	33	11	
43-5061	Production, Planning, and Expediting Clerks	100	7	24	
13-2011	Accountants and Auditors	80	20	14	✓

The aerospace occupation distribution in Virginia has more variation than the aviation industry. About half the aerospace employment in the state is found in the Northern Virginia metro area with approximately a quarter found in the Hampton Roads MSA. Nevertheless, the top four aerospace occupations in the state have their largest presence in the Hampton Roads area due to the NASA Langley Research Center. These four occupations are all engineering-related: aerospace engineers; engineers, all other; electronics engineers, except computer; and engineering technicians, except drafters, all other.

The Charlottesville metro area accounts for about 9% of aerospace industry employment in the state, but approximately a quarter of employment in search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing. Therefore, while the Charlottesville MSA has small shares of aerospace employment in some occupations (such as 1.5% of aerospace engineers), its share is fairly larger for aerospace occupations such as team assemblers (18.7%) and electrical and electronic equipment assemblers (22.7%).

Regional Distribution - Top Fifteen Aerospace Occupations

SOC	Occupation	Northern Virginia MSA	Hampton Roads MSA	Charlottesville MSA	Other VA
17-2011	Aerospace Engineers	19.2%	63.6%	1.5%	15.6%
17-2199	Engineers, All Other	26.8%	54.6%	4.0%	14.6%
17-2072	Electronics Engineers, Except Computer	33.9%	47.8%	8.0%	10.3%
17-3029	Engineering Technicians, Except Drafters, All Other	9.9%	75.8%	1.4%	12.8%
51-2092	Team Assemblers	67.1%	4.6%	18.7%	9.6%
15-1032	Computer Software Engineers, Systems Software	62.6%	10.8%	13.4%	13.3%
51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	61.9%	7.8%	0.8%	29.5%
17-2112	Industrial Engineers	60.8%	11.4%	11.7%	16.1%
13-1199	Business Operations Specialists, All Other	42.7%	37.5%	5.3%	14.5%
51-2022	Electrical and Electronic Equipment Assemblers	68.2%	3.9%	22.7%	5.1%
15-1031	Computer Software Engineers, Applications	49.5%	27.5%	10.2%	12.8%
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	64.6%	6.1%	10.2%	19.1%
51-4041	Machinists	63.7%	6.7%	7.2%	22.5%
17-2141	Mechanical Engineers	62.3%	9.8%	13.6%	14.3%
17-3023	Electrical and Electronic Engineering Technicians	47.4%	31.0%	13.5%	8.1%

Outside of the Northern Virginia, Hampton Roads, and Charlottesville metropolitan areas, no other MSA in Virginia employs more than a fraction of a percent of total aerospace employment in the state. However, rural areas in the state account for about 14% of the industry's employment, including areas such as the Mount Rogers and Accomack-Northhampton PDCs.

9. Training Alignment

This section examines training output in Virginia with a focus on the three occupations most identified in the business survey as critical and subject to supply issues: (1) aviation maintenance, (2) pilots, and (3) engineers.

9.1. Training Capacity

Before the occupation profiles begin, a few notes on the data are necessary.

This section includes analysis of the training provided by postsecondary institutions and other providers that report data through the Integrated Postsecondary Education Data Systems (IPEDS). These training programs are grouped according to the Classification of Instructional Programs (CIP) and are linked to occupations through a training program to occupation crosswalk provided by the National Center for Education Statistics.[62]

Virginia's production of postsecondary-trained occupations is quantified through a measure called "training capacity." Training capacity is the ratio of awards to occupations at the regional level compared to the nation. A training capacity of 1.00 for Virginia means the state is producing postsecondary awards for an occupation at the same rate as the nation. A training capacity of 1.10 means the state is 10% above the rate in the nation, and so forth.

While training capacity is helpful in this analysis, a few caveats must be pointed out. First, some four-year awards and postgraduate degrees are granted to individuals who lived outside the state before attending school and who leave the state and work elsewhere after graduation. In addition, most academic programs are linked with more than one occupation, so a simple one-to-one correspondence between degrees and occupations is not directly available. Moreover, the crosswalk between programs and occupations is not exhaustive and may include significant omissions. Lastly, the CIP classification of awards from individual institutions is made at those institutions and so the accuracy of these codes will vary according to the care that was taken at each institution. Thus, these caveats should be kept in mind when examining training capacity and exploring subsequent details.

9.2. Occupation Training Profiles

9.2.1. Aviation Maintenance

Three aviation maintenance occupations are profiled in this section: aircraft mechanics and service technicians (SOC 49-3011), avionics technicians (SOC 49-2091), and aircraft structure, surfaces, rigging, and systems assemblers (SOC 51-2011). The first of these occupations—aircraft mechanics and service technicians—, accounts for over three-quarters of the aviation and aerospace employment of these three occupations.

These three occupations are presented together in this section because of the similarity in training programs. Four academic programs are associated with these occupations, three of which are available in Virginia: aircraft powerplant technology/technician, airframe mechanics and aircraft maintenance technology/technician, and avionics maintenance technology/technician. These programs in Virginia produced 161 awards in the 2008-2009

[62] The NCES training program to occupation crosswalk can be found here: http://nces.ed.gov/pubs2002/cip2000/occupationalcrosswalk.asp.

academic year from four schools: Aviation Institute of Maintenance-Chesapeake, Aviation Institute of Maintenance-Manassas, Blue Ridge Community College, and Hampton University. (Liberty University in Lynchburg began an aviation maintenance program in 2010 with an initial graduating class of 11 in December 2010; 23 are in the program in 2011.)[63]

Training Program to Occupation Crosswalk Matrix – Aviation Maintenance				
	01.0205 Agricultural Mechanics and Equipment/Machine Technology	47.0608 Aircraft Powerplant Technology/ Technician	47.0607 Airframe Mechanics and Aircraft Maintenance Technology/ Technician	47.0609 Avionics Maintenance Technology/ Technician
49-3011 Aircraft Mechanics and Service Technicians	✓	✓	✓	
49-2091 Avionics Technicians			✓	✓
51-2011 Aircraft Structure, Surfaces, Rigging, and Systems Assemblers		✓	✓	✓
2008 - 2009 Academic Year Awards[64]				
Aviation Institute of Maintenance-Chesapeake	-	-	71	3
Aviation Institute of Maintenance-Manassas	-	-	77	3
Blue Ridge Community College	-	2	5	-
Hampton University[65]	-	-	-	0

Aircraft mechanics and service technicians and avionics technicians have a similar level of education, with 69% and 72% of workers in these two occupations, respectively, having a college education.[66] According to the BLS Occupation Outlook Handbook (OOH), although a few people enter these two occupations through on-the-job training, most receive training at an aviation maintenance technician school certified by the FAA. In contrast, only 38% of aircraft structure, surfaces, rigging, and systems assemblers have a college education.

The training output of Virginia's schools for these occupations is fairly equal to that of the nation. According to 2008 to 2009 academic year data, Virginia had training capacities of 0.93, 0.98, and 1.02 for the three aviation

[63] Per the Liberty School of Aeronautics, April 2011.
[64] Dashes in this table indicate that the program was not available. All awards are at the certificate or 2-year degree level.
[65] Hampton University had 2 graduates from the avionics maintenance program in 2009-2010.
[66] Educational attainment data are national figures per the 2008 Employment Projections Program of the Bureau of Labor Statistics.

maintenance occupations. Liberty University's pace in 2011 may put the state at better than average for graduates for these three occupations—a step in the right direction toward meeting the high demand for aviation maintenance skills in the state.

Virginia Training Capacity, 2008-2009 Academic Year							
SOC	Title	Total Employment 2010	Aviation and Aerospace Employment 2010	Minimum Projected Ann. Avg. Demand[67] (2010-20)	% College Educated	Degrees and Awards	Training Capacity
49-3011	Aircraft Mechanics and Service Technicians	3,076	2,207	106	69%	133	0.93
49-2091	Avionics Technicians	398	270	16	72%	20	0.98
51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	346	331	18	38%	9	1.02

Military exits are an important source of workers for these occupations. According to the Department of Defense, in the period from October 2009 through September 2010, over 600 individuals with aviation maintenance skills left the military and entered civilian life in Virginia.[68] These exits included 382 aircraft mechanics and service technicians and 288 avionics technicians. In all, there are more than 4 times as many military exits with these skills than postsecondary graduates. However, it is not clear how many of the ex-military enter into these same occupations as civilians. In the business survey, for example, one respondent commented about skilled labor in A&P (Airframe and Powerplant) Mechanics and Avionics and that "…working with the military to encourage their ranks to obtain their A&P [while] enlisted is KEY to them being successful in the civilian world."

9.2.2. Pilots

Aircraft pilots and flight engineers are grouped within a broad occupation (SOC 53-2010) encompassing two detailed occupations groups: airline pilots, copilots, and flight engineers (SOC 53-2011); and commercial pilots (SOC 53-201). These two detailed occupations are linked to the same two training programs: (1) airline/commercial/professional pilot and flight crew, and (2) flight instructor. The former program is available in Virginia at Averett University and had two graduates in the 2008-2009 academic year..

[67] The projected demand includes all Virginia employment, not just within the defined aviation and aerospace industry. This demand is described as "minimum" since the replacement demand depends upon an occupation replacement rate from the BLS that is understated; more can be read about this here: http://www.bls.gov/emp/ep_replacements.htm.

[68] Military exits are assigned to a geography based on an individual's post-service address. The civilian occupations of military exits are crosswalked from the military occupations when separation occurred.

However, data issues arise because Averett University also has a pilot training program, but it is classified as a general aviation program. This program had 24 graduates in the 2008-2009 academic year. Averett and Liberty universities thus combined for 26 pilot graduates in that academic year.

Training Program to Occupation Crosswalk Matrix – Pilots			
	49.0102 Airline/Commercial/Professional Pilot and Flight Crew	49.0108 Flight Instructor	49.0101 Aeronautics/Aviation/Aerospace Science and Technology, General
53-2011 Airline Pilots, Copilots, and Flight Engineers	✓	✓	
53-2012 Commercial Pilots	✓	✓	
2008 - 2009 Academic Year Awards			
Averett University	2	-	-
Liberty University	-	-	24

Virginia's 26 pilot graduates in the 2008-2009 academic year translate into a training capacity that is well below average in the nation. Virginia's training capacity of 0.38 for aircraft pilots and flight engineers means the state's number of graduates per employment for this occupation is 38% of that in the nation. Postsecondary schools in the nation granted 2,464 awards in the 2008-2009 academic year in the two training programs that were crosswalked to pilots. In other words, if the Commonwealth were to pull up to the national average rate of graduates for pilots, it would graduate approximately 69 per year, more than doubling its current output.

Virginia Training Capacity, 2008-2009 Academic Year							
SOC	Title	Total Employment, 2010	Aviation and Aerospace Employment, 2010	Minimum. Projected Annual Avg. Demand (2010-20)	% College Educated	Degrees and Awards	Training Capacity
53-2010	Aircraft Pilots and Flight Engineers	2,988	2,433	150	93%	26	0.38

The minimum projected annual average demand for pilots in Virginia is 150—this includes replacements due to retirements and turnover as well as growth due to an expected increase in the number of these jobs. This demand well eclipses the number of postsecondary graduates in the state. However, military exits in the Commonwealth can fill this gap. From October 2009 through September 2010, 179 military exits entered civilian life in Virginia with aircraft pilot and flight engineer skills.

9.2.3. Engineers

9.2.3.1. Aerospace Engineers

Aerospace engineers (SOC 17-2011) are linked with only one training program: aerospace, aeronautical, and astronautical engineering. This program also is linked with two other occupations: engineering managers and engineering teachers, postsecondary. Since both of these occupations are also linked with dozens of other engineering programs, the vast majority of output from this training program can be assumed to flow into the aerospace engineering occupation. Two schools in Virginia offer this program: the University of Virginia and Virginia Polytechnic Institute & State University (Virginia Tech), combining for 137 degrees in the 2008-2009 academic year, 28 of which were postgraduate degrees.

Virginia Awards, 2008-2009 Academic Year			
	Certificates and 2-year Degrees	4-year Degrees	Postgraduate Degrees
14.0201 Aerospace, Aeronautical and Astronautical Engineering			
University of Virginia-Main Campus	0	9	0
Virginia Polytechnic Institute & State University	0	100	28

This training 2008-2009 training output in Virginia gives the state an above average training capacity for aerospace engineers. With a training capacity of 1.21, the state's number of graduates per employment was 21% higher than average in the nation.

Virginia Training Capacity, 2008-2009 Academic Year							
SOC	Title	Total Employment, 2010	Aviation and Aerospace Employment, 2010	Minimum Projected Annual Avg. Demand (2010-20)	% College Educated	Degrees and Awards	Training Capacity
17-2011	Aerospace Engineers	2,190	776	84	97%	137	1.21

Military exits provided 32 aerospace engineer entrants into the Virginia labor market from October 2009 to September 2010. While these exits boosted the total number of aerospace engineer labor market entrants in Virginia, the number of annual entrants due to postsecondary training is not easy to compute. For one, the postgraduate degrees cannot simply be added on top of the 4-year degree earners since many of the postgraduate students may have earned 4-year aerospace degrees prior to entering graduate school. Furthermore, many of these degree earners may have come from out-of-state and will not necessarily work in Virginia after graduation.

9.2.3.2. Electrical and Electronic Engineers

Electrical and electronic engineers (SOC 17-2070) is a broad occupation group comprising two detailed occupations: (1) electrical engineers (SOC 17-2071), and (2) electronics engineers, except computer (SOC 17-2072). These occupations receive training through only one program: electrical, electronics, and communications engineering. This program is also linked to engineering managers and postsecondary engineering teachers—thus, for reasons described earlier, the vast majority of the output from this training program can be assumed to flow into electrical and electronic engineers. Eight Virginia schools awarded degrees in this program in the 2008-2009 academic year, combining for 350 degrees, 145 of which were postgraduate degrees.

Virginia Awards, 2008-2009	Certificates and 2yr Degrees	4yr Degrees	Postgraduate Degrees
14.1001 Electrical, Electronics and Communications Engineering			
George Mason University	0	58	46
Hampton University	0	6	0
Norfolk State University	0	13	3
Old Dominion University	0	29	0
University of Virginia-Main Campus	0	39	26
Virginia Commonwealth University	0	40	0
Virginia Military Institute	0	6	0
Virginia Polytechnic Institute & State University	0	114	70
TOTAL	**0**	**305**	**145**

This postsecondary training output translates into a below-average training capacity for electrical and electronic engineers in Virginia. The training capacity of 0.73 means the number of graduates per employment in the Commonwealth is 27% below average in the nation for electrical and electronic engineers. Military exits would not boost supply very much in this instance; from October 2009 to September 2010, only three military exits entered civilian life in Virginia with the classification of one of these occupations.

Virginia Training Capacity, 2008-2009 Academic Year							
SOC	Title	Total Employment, 2010	Aviation and Aerospace Employment, 2010	Minimum Projected Ann. Avg. Demand (2010-20)	% College Educated	Degrees and Awards	Training Capacity
17-2070	Electrical and Electronic Engineers	8,471	447	303	96%	450	0.73

One can produce a rough estimate of the new entrants into Virginia's labor market by taking the number of degrees and awards, subtracting out the postsecondary awards so as to not double-count, and then add in the

number of military exits. This gives an annual supply of 308, not much above the minimum projected annual average demand—consistent with the picture of tight demand obtained from the business survey.[69]

9.2.3.3. Other Engineers

Besides aerospace and electrical and electronic engineers, the other engineering occupations most utilized in the aviation and aerospace industry include three specific types of engineers—industrial, mechanical, and materials. There are also two engineering occupations that cover a variety of fields—engineers, all other; and engineering managers.

For the specific types of engineers, industrial and materials engineers benefit from above-average training capacity in the Commonwealth, 1.52 and 1.16, respectively. Nevertheless, as of the 2008-2009 academic year, only two schools in the state offer training for each of these occupations. Industrial engineers can receive training through the industrial engineering program (CIP 14.3501) at either Virginia Tech or George Mason University. Materials engineers could receive training via the materials engineering program (CIP 14.1801) at either the University of Virginia or Virginia Tech. Mechanical engineers have more options in the state with five schools offering the mechanical engineering program (14.1901).[70] Nevertheless, this represents below-average training capacity of 0.78 for this widely-used occupation.

The engineering managers occupation group is linked to engineering programs in many fields. This occupation's above-average training capacity of 1.36 is one measure of the overall engineering training capacity in the Commonwealth. Similarly, the engineers, all other occupation is linked to many engineering programs—including some general programs such as engineering, general (CIP 14.0101), and engineering, other CIP (14.9999). This also includes programs in specific engineering fields not listed elsewhere such as systems engineering (CIP 14.2701) and polymer/plastics engineering (14.3201). In sum, the engineers, all other occupation has an above-average training capacity of 1.35 in the state.

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[69] Two more items to note about this "back-of-a-napkin" calculation: first, the NCES database counts awards, not individuals. Thus some graduates may have a double major in electrical engineering and something else and enter the workforce for a career in this other occupation; second, this calculation assumes a zero net in-flow or out-flow of electrical engineering students in the state.

[70] Schools offering this mechanical engineering program are (in order from most to least graduates in the 2008-2009 year): Virginia Tech, University of Virginia, Old Dominion University, Virginia Commonwealth University, and the Virginia Military Institute.

Virginia Training Capacity, 2008-2009 Academic Year							
SOC	Title	Total Employment 2010	Aviation and Aerospace Employment, 2010	Minimum Projected Annual Avg. Demand (2010-20)	% College Educated	Degrees and Awards	Training Capacity
17-2199	Engineers, All Other	4,834	534	176	96%	516	1.35
17-2112	Industrial Engineers	4,741	228	251	92%	193	1.52
17-2141	Mechanical Engineers	7,163	175	265	94%	534	0.78
11-9041	Engineering Managers	5,475	143	203	95%	612	1.36
17-2131	Materials Engineers	479	74	21	94%	48	1.16

9.2.4. Other Aviation and Aerospace Occupations

9.2.4.1. Maintenance and Repair Occupations

Postsecondary award data is of limited value for the occupations of maintenance and repair workers, general and first-line supervisors/managers of mechanics, installers, and repairers. Not only are many of these workers not college-educated, but each is linked to only one training program which have limited crossover with aviation and aerospace applications. General maintenance and repair workers, for example, are associated with the training program building/construction site management/manager (CIP 46.0412) that "…prepares individuals to supervise, manage, and inspect construction sites, buildings, and associated facilities."[71] The first-line supervisor occupation is associated with the training program operations management and supervision (CIP 52.0205), described as: "…prepares individuals to manage and direct the physical and/or technical functions of a firm or organization, particularly those relating to development, production, and manufacturing."[72] These two training programs have a small output in Virginia (1 award in the 2008-2009 academic year), but increasing capacity of these programs in Virginia appears to be of limited value for the aviation and aerospace industries.

Virginia Training Capacity, 2008-2009 Academic Year							
SOC	Title	Total Employment, 2010	Aviation and Aerospace Employment, 2010	Minimum Projected Ann. Avg. Demand	% College Educated	Degrees and Awards	Training Capacity
49-9042	Maintenance and Repair Workers, General	31,748	320	922	43%	-	-
49-1011	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers	11,014	248	368	54%	1	0.01

[71] http://nces.ed.gov/pubs2002/cip2000/occupationallookup6d.ASP?CIP=46.0412.
[72] http://nces.ed.gov/pubs2002/cip2000/occupationallookup6d.ASP?CIP=52.0205

Military exits are an important source of skilled labor for these maintenance and repair occupations. From October 2009 through September 2010, 208 first-line supervisors/managers of mechanics, installers, and repairers entered civilian life in Virginia. No military exits were recorded for the occupation maintenance and repair workers, general. However, other maintenance and repair occupations number among Virginia military exits that may have the skills needed to enter this occupation within the aviation and aerospace industry. These military exits included 227 electrical and electronics repairers, commercial, and industrial equipment; 140 electric motor, power tool, and related repairers; and 42 electrical and electronics installers and repairers, transportation equipment.

9.2.4.2. Air Traffic Controllers and Airfield Operations Specialists

Air traffic controllers and airfield operations specialists (53-2020) are designated as two different and detailed occupations: air traffic controllers (53-2021) and airfield operations specialists (53-2022). These occupations are associated with the same training program: air traffic controller (CIP 49.0105). This program included 2 graduates in the 2008-2009 academic year from Hampton University in Virginia. Postsecondary training data for these occupations, however, are of limited value. There are three main pathways to train as an air traffic controller with the FAA: (1) being an air traffic controller with prior experience, (2) applicants from the general public, and (3) successfully completing an aviation-related program through the FAA's Air-Traffic Collegiate Training Initiative (AT-CTI). There are 36 approved AT-CTI schools in this program - the only one in Virginia being at Hampton University.[73] The variety of pathways for air traffic controllers means the postsecondary award data are of less value than if it were the one or dominant pathway. For airfield operations specialists, the most significant source of training is long-term on-the-job training.[74] Therefore, the postsecondary awards data for this occupation is also of limited value. With these caveats in mind, we note that Virginia's training capacity of air traffic controllers and airfield operations specialists is 0.07, or less than a tenth of the average in the nation.

Virginia Training Capacity, 2008-2009 Academic Year

SOC	Title	Total Employment, 2010	Aviation and Aerospace Employment, 2010	Minimum Projected Annual Avg. Demand (2010-20)	% College Educated	Degrees and Awards	Training Capacity
53-2020	Air Traffic Controllers and Airfield Operations Specialists	1,834	233	85	83%	2	0.07

Military exits in Virginia closely match the combined annual average demand for air traffic controllers and airfield operations specialists. From October 2009 to September 2010, exiting military in Virginia included 59 air traffic controllers and 29 airfield operations specialists. These 88 exiting military surpass the 85 projected annual average demand for these occupations in the state.

[73] http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/acquisition/aja51/cti/AT-CTI_Schools.cfm.
[74] http://www.bls.gov/oco/oco20060.htm.

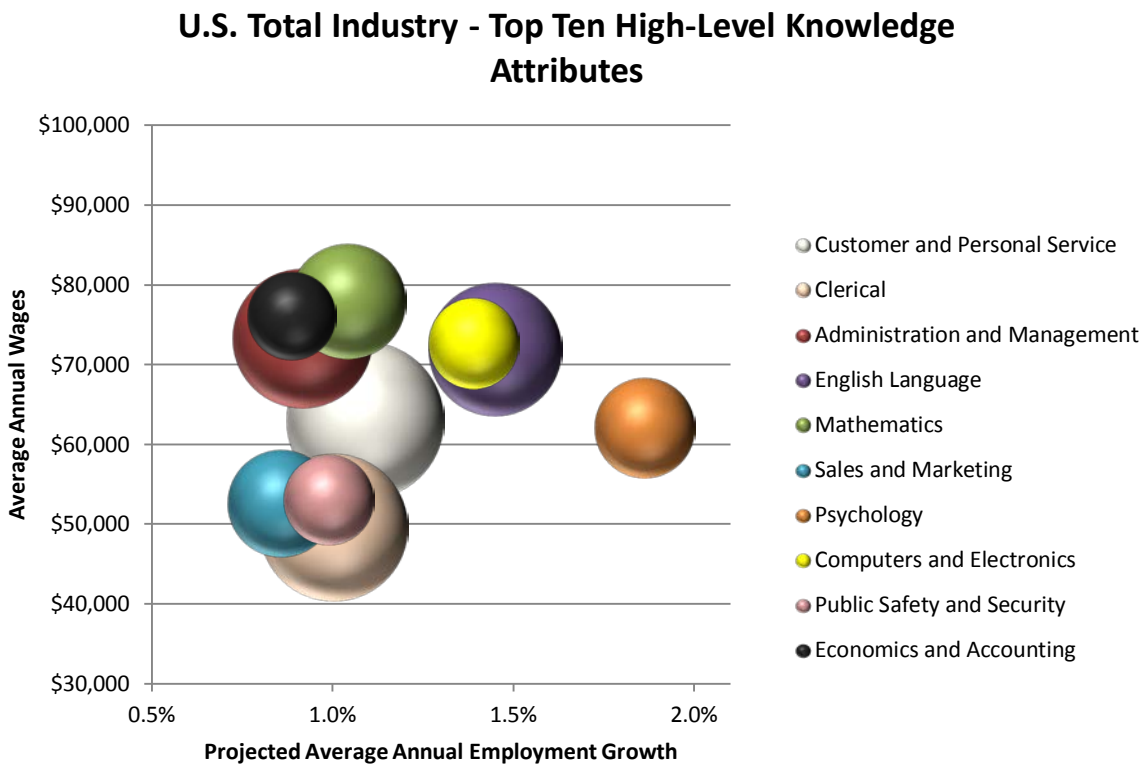
(A final note regarding these occupation data: the majority of air traffic controllers in Virginia are employed in the government operations sector in regulation and administration of transportation programs, designated as NAICS 926120. This industry is not included in the aviation and aerospace definition in Virginia as more than half of its employment is in organizations with non-aviation purposes.)

10. Skills Clusters

Rather than only focusing on postsecondary training awards, occupation training can also be examined by looking at the skills underlying the occupation. This can be done via skills clusters—an analysis of the skills needed within the workforce, disaggregated from the occupation classification view. This perspective can give insights into the skills underlying the workforce and can point to the importance of certain skill sets, especially within the industry groups of aviation and aerospace as defined in this report.

10.1. Baseline U.S. Skills

The cluster chart below shows the ten largest knowledge attribute clusters in the nation. There are 31 knowledge attributes in all as defined by O*NET.[75] The ten shown below are those knowledge skills that are required most often at a high skill level for the work done within occupations in the nation. For example, customer and personal service is the top knowledge attribute needed, with about 21% of all workers needing this skill at a high level within their occupation. The next most prevalent knowledge attribute is clerical, needed by about 18% of workers, followed by administration and management at 16%. (The size of the bubbles in the skills cluster charts corresponds to the percentage of workers needing that attribute.)



[75] The Occupational Information Network: http://www.onetonline.org/.

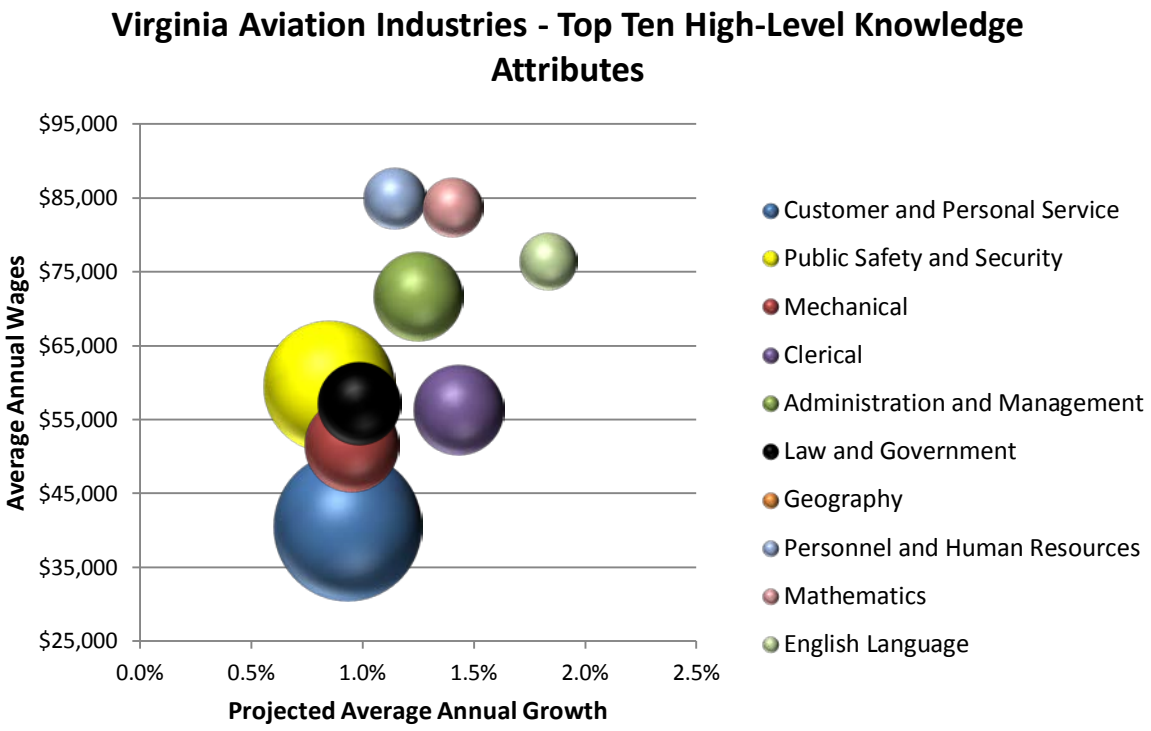
Of the top ten knowledge attributes, the occupations needing mathematics at a high level have the highest average wages (which are shown vertically in these charts). High average wages generally correspond with high demand, indicating a premium is being paid for these skills. This is in contrast to the top knowledge attributes garnering lower average wages: clerical, sales and marketing, and public safety and security.

Projected average annual employment growth is shown on the horizontal axis in the skills clusters charts. Of the top ten knowledge attributes, psychology has the fastest forecasted growth rate—meaning, the occupations that require exceptional levels of this skill are expected to grow quickly, at about 1.9% per year. On the other end of the spectrum, sales and marketing is expected to grow slowest among the top ten, by a little under 0.9% per year.

10.2. Aviation Skills

Based on the aviation industry employment mix in Virginia, we can see the contrast between the overall skills clusters for the nation and the skills clusters for Virginia's aviation industries. As with the nation's overall occupation mix, the top knowledge attribute needed at a high-level in Virginia's aviation industries is customer and personal service—not surprising given the large numbers of ticket agents and flight attendants. However, this attribute is needed by a relatively larger percentage in aviation - 33% compared to 21% in the nation's overall mix. Public safety and security is the second-most needed high-level knowledge attribute in Virginia's aviation industries, considered a need by 26% of employees which is much more than the 7% need in the nation's overall mix.

After these two skills, there is a large drop in the percentage of employees needing a specific skill. The third-most needed high-level skill for Virginia's aviation industries is mechanical skills, needed in a high-level by 13% of employees. This skill corresponds with occupations identified as critical such as aircraft mechanics and service technicians. The tenth-largest high-level attribute, English language, is used by about 5% of occupations.

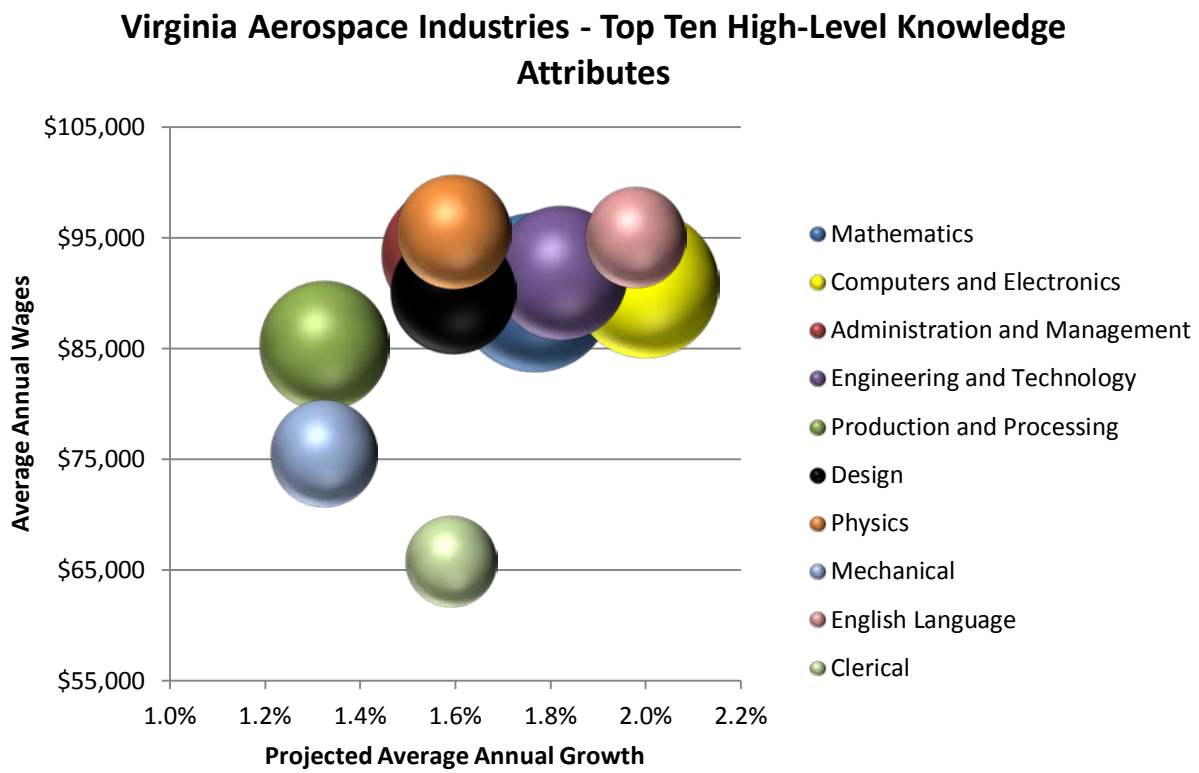


Though customer and personal service is the largest knowledge attribute in Virginia's aviation industry, occupations that require this attribute at a high level receive below-average wages in the industry. Among the top ten knowledge attributes, the highest average wages are associated with the skills of personnel and human resources (required among top executives) and mathematics.

10.3. Aerospace Skills

The aerospace skills cluster for high-level knowledge attributes shows several sharp contrasts with the top aviation skills. Compared to the aviation industry, the top knowledge attributes in Virginia's aerospace industry are (1) more clustered in a high-wage bracket, (2) generally projected to grow faster, (3) have less variation in size between the largest and smallest, and (4) include more STEM-related skills.

STEM knowledge attributes dominate among the top ten used in Virginia's aerospace industries, beginning with the two largest high-level attributes, mathematics (found among 48% of the workforce) and computer and electronics (41%). Also among the top ten are engineering and technology capability (used at a high-level by 34% of the workforce) as well as physics (25%).



While there is variation in size among the top aerospace knowledge attributes, the variation is about half of what is found in aviation. In Virginia's aerospace industries, the tenth-largest knowledge attribute is clerical, used at a high level by about 16% of the workforce, or one-third the number of workers that use mathematics. The ratio of the number of workers using the top and tenth-largest knowledge attributes in aviation (customer and personal service compared to English language) is more than six to one.

Of the top ten knowledge attributes in aerospace, all are associated with occupations having projected annual growth rates of 1.3% or higher. The fastest of these is computer and electronics with projected growth of 2.0% per year. This compares with Virginia's aviation industry in which only three of the top ten are forecast to grow at 1.3% or faster, and in which the top three are expected to grow slower than 1.0% per year.

Finally, the top knowledge attributes in Virginia's aerospace industries are largely clustered in the $85,000 to $95,000 annual wage range. A reason for this is that there are a large number of engineers in aerospace industries and these occupations have these knowledge attributes in common. For example, aerospace engineers require nine of the top ten knowledge attributes at a high level—the only exception being clerical skills.

11. Best Practices

A literature review and case studies provide best practices around issues of workforce development. It also sheds light on workforce issues and development approaches both inside and outside the Commonwealth. Finally, this step in the aviation and aerospace project, helped bridge gaps between the research and the application of its findings.

Recurring issues with workforce development and policy creation fell into the following main categories in the literature and case studies reviewed:

1. Macroeconomic trends: broad regional-level changes in the economy that impact the workforce underpinning the regional economies, such as business cycles and demographics.
2. Microeconomic trends: the trends among individuals, firms, and training providers, such as letting the needs of the local market drive academic offerings.
3. Organizational structure: how employees, employers and educators create strategies that drive effectiveness and productivity, such as programs that reach out to high schools to build a pipeline of workers and particularly STEM education in K-12.

The literature review and case studies generally show that the outstanding human capital issues fall into five broad areas for workforce planning:

1. An aging workforce
2. Increasing levels of technology and skills required
3. Knowledge of safety skills
4. STEM occupational needs
5. Matching supply to local business needs

11.1. Publications and Workforce Perspectives

Publication: ***ACRP Synthesis 18: Aviation Workforce Development Practices.*** Authors: Seth B. Young. International Aviation Management Group, Inc. Columbus, OH. (2010 National Academy of Sciences)[76]

> The content was collected through a literature review and surveys of airport operators and industry experts. It provides gaps between skill sets and educational and advancement in career opportunities for the aviation industry's workforce. The report gave a structured evaluation of why workforce development planning is needed in a general sense for all industries. (This study did not include a review of practices for flight crew, airline management and air traffic management positions.) The methodology for this review included discussions with key organizations among the different sectors in aviation along with interviews with higher education.

[76] The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare.

The study contrasted the aviation industry's approach to workforce development and some associated issues. It pointed out that most of the airports are highly regulated by the federal government and by their federal policies because they are publically-held operations. Due to the funding models for public entities, the resources have not typically been available for workforce development. Consequently, workforce has focused on professional development and not on the overall workforce needs for the aviation industry. Another concern was the aging of these professionally-developed workers that need to replace them over the next 2 to 10 years.

The primary research came from 11 airport operators, 30 colleges and universities, and 12 aviation consulting firms doing business in the state of Ohio. The airport operators that participated in the study covered large-hub commercial services, small general aviation airports, as well as corporate structures. The skills competencies were taken from aviation skills requirements and were included in the interviews with colleges and universities as well as consultants. The respondents all agreed that technology skills would help improve productivity and safety.

The publication also provided some best practices that focused on airport and university partnerships. Some of the universities formed industry advisory boards. The industry advisory boards helped the universities align curriculum to meet the demands in the changing aviation and aerospace sectors. It should be noted that this report excluded flight crew, airline management, and air traffic management positions. The ACRP Synthesis 18 study focused on civil aviation workforce development and the importance of a region's establishing and fostering collaborative relationships between both the supply of training and the demand for skills and education.

Publication: ***A Plan for the Future: 10-Year Strategy for the Air Traffic Control Workforce 2010-1019.***
Authors: Federal Aviation Administration Air Traffic Organization.

This report was the fifth (annual) update to the controller workforce plan for the Federal Aviation Administration (FAA). The update included changes in air traffic staffing forecasts, controller retirements, and other factors that impacted their 2010 plan. Given that safety issues top the priorities for the FAA, the role of managing the National Airspace System (NAS) required a pipeline of skilled controllers. Safety, skill, and knowledge are particularly important because the main consumers are the public.

The FAA applied a strategy to 'staffs to traffic' to match the number of air traffic controllers at its facilities with traffic volume and workload.[77] The demand for controllers varies with the spreads in the traffic due to the swinging trends in the aviation traffic volume. For example, volume declined by 21% and was not expected to return to year 2000 levels anytime soo. Nevertheless, the FAA has hired 7,000 new air traffic controllers in the last five years. The controllers hired since 2005 have completed training and are replacing retirees as certified professional controllers (CPCs).

Technology continues to be a driver of change for air traffic controllers, pilots, aircraft operators and the flying public. The FAA is quickly moving from a ground-based navigation system to operations that utilize more satellites (NextGen[78]). The transition is expected to be a long and gradual process that is still under

[77] A Plan for the Future: 10-Year Strategy for the Air Traffic Control Workforce 2010-2019.
[78] NextGen stands for Next Generation Air Transportation System.

development. The most important role for the workforce is to ensure that air travel for the consumers continues to be safe. Therefore, safety is an important initiative that connects the entire workforce to the changes in the industry due to the changing technology landscape.

Publication: ***A Special Report: Launching the 21st Century American Workshop***. December 2008. Author: Aerospace Industries Association.

The Aerospace Industries Association (AIA) released this workforce report in December 2008; it was preceded by the August 2008 *Launch into Aerospace* which was a white paper describing a workforce crisis that was developing within the aerospace industry. One suggestion was the need to make government a partner in order to achieve a highly-skilled workforce. This issue covered a "push" for the AIA to become a participant in the "coalition of coalitions" dedicated to promote STEM (science, technology, engineering and math) to the stakeholders in government, business, academia, workforce development, education, and related non-profits.

The speed to issue security clearances was also cited as a need. For example, the United States produced 122,450 total engineering and science graduates in 2007, but less than two-thirds were eligible for high-level security clearances based on citizenship.

The AIA December 2008 report focused on three areas of concern for the national aviation workforce:

1. Aging science and engineering workers
2. Declining 'homegrown' STEM workers
3. Lack of interest in STEM careers

Publication: ***Advanced Manufacturing Industry: Addressing the Workforce Challenges of America's Advanced Manufacturing Workforce***. (2005). Emergency Training Association (ETA)/Business Relations Group Report.

This report from the Department of Labor's ETA division focused on workforce in the U.S. manufacturing industry. The workforce has moved away from the old economies of manual labor to one of robotics, lean manufacturing, higher productivity, and just-in-time inventories. This shift toward a more productive workforce requires both more integrated and more highly-skilled laborers. The ETA supported this shift toward skills development through its High Growth Job Training Initiative (HGJTI). The HGJTI was aimed at enabling workforce investment areas and their governing boards to focus on retooling the dislocated, lower-skilled workers through both training and boosting skills that support high-growth and high-demand industries in manufacturing. The workforce challenges that were associated with the HGJTI initiative were:

1. Training for innovation: maintaining the competitive edge
2. Enhancing the flow of new workers: "pipeline development"
3. Confronting a negative public image
4. The challenges of employing workers from "alternative sources": immigration
5. Hiring employees with adequate foundational skills and competencies
6. The added challenges to small and medium-sized manufacturers
7. Matching training providers to business needs
8. The challenges to incumbent worker training
9. Training the supply chain

Solutions were identified to address the noted challenges to the workforce:

1. Capacity-building (ensured the infrastructure trained and educated an adequate supply of workers for advanced manufacturing).
2. Pipeline development (maintain practices and processes to ensure an ongoing supply of prepared workers).
3. Training for innovation (ensure training and education programs are aligned with the needs from employers and that they provide innovative and creative solutions).

HGJTI was evaluated for how well it drove change locally by replacing the national models with regional ones; it also stressed that local leaders ought to promote local solutions to meet local workforce needs. The appendix included a listing of locally funded initiatives. In Virginia, the Greater Peninsula Workforce Investment Board received a $1,965,000 grant to implement a program to deliver a highly-skilled workforce for its high-growth, high-performance sectors in Southeast Virginia.

Publication: ***Aviation Week: 2009 Workforce Study.*** Contributing partners were the Aerospace Industries Association; the Aerospace Industries Association; the American Institute of Aeronautics and Astronautics; and the National Defense Industries Association. The report was made in an association with Hitachi Consulting. July 20, 2009.

The primary objective of this study was to provide a single source of aviation and defense workforce data. However, the format for the study changed between a 2008 Workforce Advisory Board review and the July 2009 report, rendering an inability to compare longitudinal data with previous studies. On a positive note, this new format allowed benchmarking for the percentage of employees eligible for retirement and the percentage of employees who actually retired. The data were expanded in 2009 to include eligibility for retirement, actual retirement, and forecasts for retirement eligibility two and five years out.

The 2009 Workforce Study report provided a number of key findings. One of the most pressing issues was the aging and retiring workforce; 5.7 % retired in 2008 versus 2% reported the year before; those eligible to retire remained roughly the same at 13%. Retirement eligibility was forecast to increase to approximately 18% in 2011 and just over 20% in 2013. Also alarming was the apparent disconnect between the skills that are most in demand and the hiring plans for the next 5 years (2009—2014). For example, the engineering skills that deemed to be most in demand actually saw a drop in demand for 2011—2013. The rationale for this decline was tied to the business environment: heavy production load combined with a decline in new contracts.

Publication: ***Degrees for What Jobs? Raising the Expectations for Universities and Colleges in a Global Economy.*** (March, 2011) National Governors Association (NGA).

The NGA study was the most recent of the literature reviews among the six included in this report. The study makes a strong argument for letting the needs of the marketplace be at the center of academic success by students and jobseekers. The study points out the longstanding disconnect between higher education institutions (broad liberal arts) and economic development. Some states are recognizing that there are ways to align postsecondary education with states' economic goals. Some examples included policymakers from Minnesota, North Carolina, Ohio, and Washington. These states are focusing on the following areas:

1. Set clear expectations for higher education's role in economic development.

2. Emphasize rigorous use of labor market data and other sources to define goal and priorities.
3. Encourage employers' input in higher education.
4. Require public higher education institutions to collect and publically report impacts.
5. Emphasize performance as an essential factor in funding.

Policy development needs to include mapping the connections between degree attainment and job placement, and the policy agenda for ensuring competitiveness needs to be comprehensive. Education and industry need a systemic way to communicate the needs by markets to the educational pipeline. One example of progress is that the NGA promotes real-world education and curriculum agenda such as STEM.

Publication: ***Planting the Seeds for a Diverse U.S. STEM Pipeline: A Compendium of Best Practice K-12 STEM Education Programs.*** (Updated 2010) The Bayer Foundation.

K-12 STEM education programs were considered best practices for this compendium if they inspire students to grow their interest in STEM subjects; provide opportunities for students to get to know individuals in STEM occupations; introduce students to the various career opportunities in STEM fields; and demonstrate the power of public-private partnerships to improve education and student achievement.[79] None of the 38 K-12 best practice programs were specific to Virginia or aviation and aerospace. However, the following programs were supported by local aviation and/or aerospace firms and several were available to all states in the nation:

1. **Great Explorations in Math and Science (GEMS)** was established in 1984 and is a leading resource for innovative science and math education. There are more than 70 GEMS Teachers Guides and Handbooks that provide supplemental-learning experienced for pre-school through eighth grade. There are 65 GEMS sites and centers in 33 states. It is supported by companies such as Boeing Corporation and agencies such as NASA.
2. **MIND Research Institute**, which was founded in 1998, is a national nonprofit organization dedicated to research on learning and the brain and the application of this research to the development of K-12 math education programs. MIND developed a visually-based math education process. Animated representations of math concepts are presented via its Spatial Temporal (ST) Math computer software games. MIND was used in 700 schools in 22 states in 2009 with almost 150,000 students and more than 6,000 teachers participating.
3. **St. Louis Regional Engineering Academy (SLREA)** is a regional partnership that supports Project Lead the Way (PLTW) curriculum. It began in one school in 2002 by offering the program to 20 students. The program grew to 22 high schools with more than 2,100 students in the last six years. Boeing and GKN Aerospace support this program.
4. **Project Lead The Way (PLTW)**, established in 1996, is a nonprofit organization that partners with middle schools and high schools to prepare students in STEM-related fields. It is said to be the nation's leading provider of rigorous STEM education programs. As of 2010, more than 3,400 schools in all 50 states have more than 300,000 students enrolled the PTWL classes.

[79] These criteria are based on guidelines provided by Building Engineering and Science talent (BEST) Commission, National Science Education Standards and National Science Resources Center.

Corporations like Lockheed Martin, Northrop Grumman, and Rolls Royce have underwritten national and state initiatives for teacher training.

11.2. Case Studies

The case studies identified here underscore a theme in the literature review that local business needs should drive academic and training offerings. Moreover, the following case studies show the diversity and creativity used by firms education providers as they seek to build their future workforce pipeline.

1. **Areva NP Inc. (Virginia)**
    a. Home of one of the world's largest designers of nuclear power plants, reactors, and maintenance equipment. Areva employs about 1,700 people in Lynchburg, Virginia.
    b. It sponsors roughly 45 aspiring engineers enrolled in the community college/University of Virginia program.
2. **Boeing**[80]
    a. Boeing's workforce strategies are built on principals that guide their educational involvement. Those principals include the idea that everyone deserves and quality education and parents are the first and most important teachers.
    b. Five strategies address workforce development based on stated principles.
        i. Early learning that gives parents and other caregivers access to training and resources.
        ii. Professional development to teachers in primary and secondary education.
        iii. Leadership development to primary and secondary education school leaders.
        iv. Curriculum alignment based on the highest international standards to primary and secondary education.
        v. Higher education strategies include enhancing undergraduate math, science, business, engineering, and technology curricula.
3. **MathScience Innovation Center** (Virginia)
    a. The mission of the MathScience Innovation Center (MSiC) is "to be the innovator, incubator and advocate of 21st Century math and science programs for the Capital region's K-12 educators and students."[81]
    b. Based on its 2015 plan, "the MSiC will lead educational, business, and community partners to implement 21st century math and science programs that will create the skills, enthusiasm, and commitment needed to prepare K-12 educators and students for rapid scientific and technological change."[82]
4. **NASA Langley (Virginia)**
    a. Encourages future applicant pool by going to colleges, elementary schools, and high schools to try to get students interested in STEM education.
    b. Brings students in as coops and teaches them the skills needed.

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[80] This section draws, in part, from "A Special Report: Launching the 21st Century American Aerospace Workforce," Aerospace Industries Association, December 2008, pages 22-33.
[81] Source: http://www.msinnovation.info/index.html, accessed May 25, 2011.
[82] Source: http://www.msinnovation.info/ctr/2015_plan.pdf, accessed May 25, 2011.

5. **Northrop Grumman**[83]
    a. Defining the Future was designed and implemented by Northrop Grumman. The programs under this initiative are geared toward the declining number of engineering students in technical and vocational schools in the United States. It relies heavily on the partnerships between community and employee volunteers.
6. **Rolls-Royce North America**[84]
    a. Rolls-Royce supports a number of initiatives dealing with workforce capacity building.
    b. Is linked to the U.S. Department of Energy's High School Leadership Summit to focus the pipeline of prospective workers on the value of rigor and relevance to engineering occupations.
    c. Building the Innovation Generation is a coordinated effort between industry, government, and education and training offering internships for students and faculty to sharpen engineering and leadership skills.
    d. Pathways to Engineering efforts focus on fifth-grade math and served as a bridge to the Project Lead the Way students. The initiative links into Indiana University-Perdue University at Indianapolis and included earned credit hours and internships with Rolls-Royce.
    e. High School Senior Internship Program emphasizes supporting outstanding students with an interest in engineering fields.
    f. FIRST Robotics is an initiative to help kids see that math and science is "cool."
    g. Minority Engineering Advancement Program focuses on recruiting and retaining minority students.
    h. Try-Math-Lon is a competition sponsored by the National Society of Black Engineers to improve recruitment and retention of minority students.
    i. The Commonwealth Center for Advanced Manufacturing (CCAM) is a partnership founded by the Commonwealth of Virginia, University of Virginia, Virginia Tech, Rolls-Royce and other partners. The vision for CCAM, which is located at Crosspointe in Prince George County Virginia, is to become a world-class research facility delivering improved aerospace design and manufacturing technologies.[85]

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[83] Aerospace Industries Association, December 2008, pages 22-33.
[84] http://www.calvertnet.k12.md.us/departments/instruction/stem/documents/PLTW_Forging_II_062608.pdf, accessed May 20, 2011.
[85] http://www.seas.virginia.edu/research/centers.php, accessed May 20, 2011.

12. Conclusions and Implications

A strengths, weaknesses, opportunities and threats (SWOT) analysis provides a summary of workforce challenges and assets for aviation and aerospace in Virginia. The key weaknesses facing the aviation and aerospace workforce are its aging workers, a shortage of skilled workers, and a shortage of workers with security clearances. All three of these weaknesses point to the need in the pipeline to inform and direct potential workers to the occupations and skill levels that are in greatest demand.

The workforce opportunities facing Virginia's aviation and aerospace industry reflect the focus needed in demand occupations. Regional differences in industry mix require a local assessment of demand occupations and communication of skill/occupational needs to educators and job seekers to bolster the supply chain of workers. Notwithstanding regional variation, critical occupations for aviation and aerospace include mechanics, pilots, and engineers. Moreover, technological change impacts all occupations and continues to provide opportunities for upskilling incumbent workers. Finally, while aviation and aerospace occupations run the full gamut of skill requirements, half of all occupations in the aerospace in the state require STEM disciples, which underscore the opportunity to emphasize these disciplines in elementary and secondary schools.

Virginia Aviation and Aerospace Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

Strengths • Proximity to the nation's capital ensures a competitive advantage in workforce • Strong military presence provides a pipeline of pilots • The presence of highly ranked higher education institutions and a favorable quality of life attracts many workers to the Commonwealth	**Weaknesses** • Virginia, like most regions, is facing an aging workforce • Virginia needs to increase its security clearance awards as well as reduce the time to make awards • Shortage of skilled workers
Opportunities • Critical occupations are forecast for mechanics, maintenance, pilots, and engineers • Half of all occupations in aerospace in the state are in STEM disciplines • Technological changes provide opportunities to learn • The pipeline needs to be aligned with local demand occupations based on industry and occupation forecasts	**Threats** • Virginia is home to only one flight school (Liberty University) • Neighboring regions that have strong import history for talent are North Carolina, Maryland and the District of Columbia • Competition for STEM talent - Many industries outside aviation and aerospace require a strong STEM base such as defense, information technology (IT), health care, and professional business services • Regulatory changes consume resources

Threats to the aviation and aerospace workforce generally fall under the rubric of competition for talent and resources. The aviation and aerospace industry will be competing for individuals with STEM disciplines because they are also important to many other industries such as defense, health care, and information technology. Competition for talented workers also crosses state lines with surrounding states attracting some potential aviation and aerospace workers that were residents in Virginia. Another threat to a prepared aviation and

aerospace workforce is the fact that strict regulatory changes, including those for flying safety, are consuming so many resources that funds are more limited for training. Finally, in terms of the pipeline for pilots, Virginia has only one flight school.

Some of Virginia's strengths offset its weaknesses and threats. The strong military presence in the state provides a pipeline of pilots that offsets the lack of supply from having only one flight school. The Commonwealth's proximity to the nation's capital is a strong draw for workers, particularly in the northern part of the state because of its favorable quality of life. Finally, Virginia's highly ranked higher education institutions provide a strong pipeline of emerging workers for the aviation and aerospace industry.

12.1. Workforce Indicators

Regions can better align their organic mix of workers to the needs of local businesses by first tracking key workforce indicators that follow market trends and then implementing response strategies across the worker pipeline. Mapping demand occupations to meet real-time needs by employers helps regions become flexible and responsive.

The key workforce metrics that came from this study that are suggested as indicators for aviation and aerospace workforce planning are:

- employment projections by region,
- skill threshold demand by region, and
- demand occupations by region.

The relative impact from these workforce indicators, when taken together, is the gradual lifting of the skills needed to meet future business growth, including strengthening the knowledge of workers around safe travel practices and closing the retiring worker gap with skilled labor.

12.2. Bridging Policy to Practice

To effectively implement a best practices model, policies are recommended to further align workforce needs in the market. The jobs/economic development bills and degree attainment bill that came out of the 2010-2011 Virginia legislative session will shape the creation of new jobs and increase the quality of these jobs through degree attainment.[86] However, further emphasis on educational attainment in STEM occupations is a smart strategy for Virginia. STEM will benefit not only the Commonwealth from its return on investment but also the state's aviation and aerospace clusters and jobseekers.

[86] Recently enacted legislation in the Commonwealth impacting workforce alignment initiatives is summarized in Appendix C.

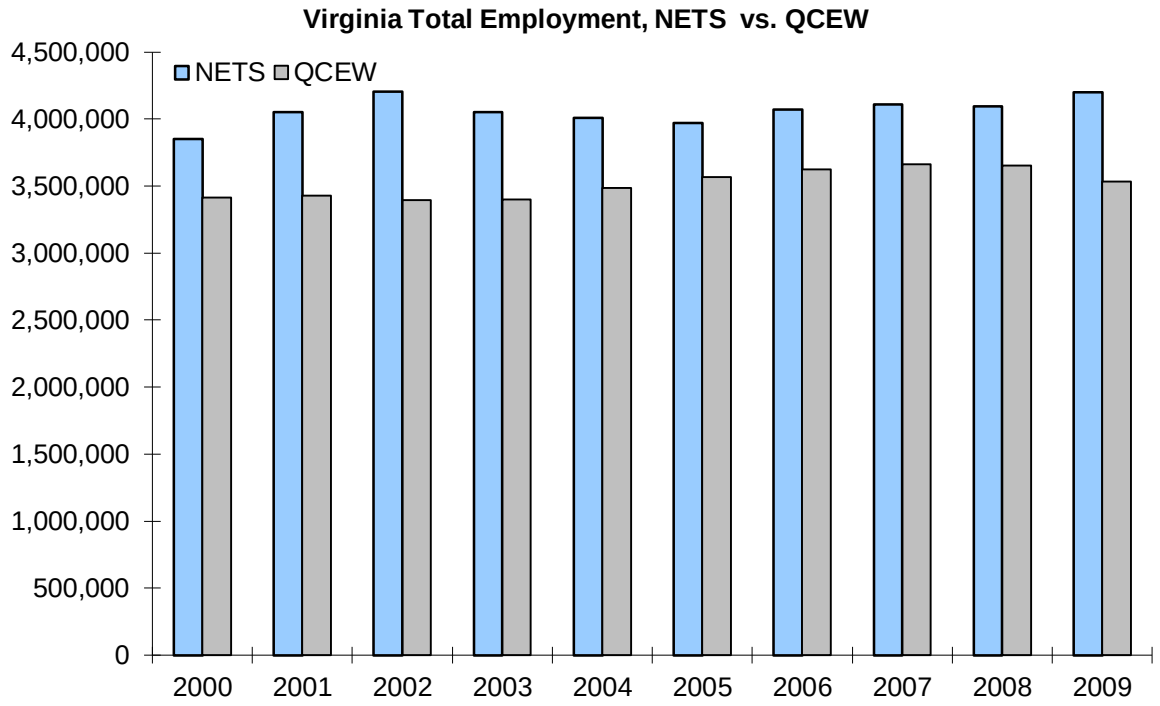
Appendix A: NETS Data

The National Establishment Time-Series (NETS) database was developed by Walls & Associates in California based on the Dun and Bradstreet (D&B) database. Chmura has acquired the NETS data for the state of Virginia since 1992 to supplement the Quarterly Census of Employment and Wages (QCEW) database.

As previously mentioned, the NETS database supplements the QCEW in several ways:

- It is survey-based and thus contains more small business proprietors that are not required to pay unemployment insurance.[87]
- It provides firm-specific and industry-specific sales.
- It identifies when a company has either entered Virginia from another state or exited the state.

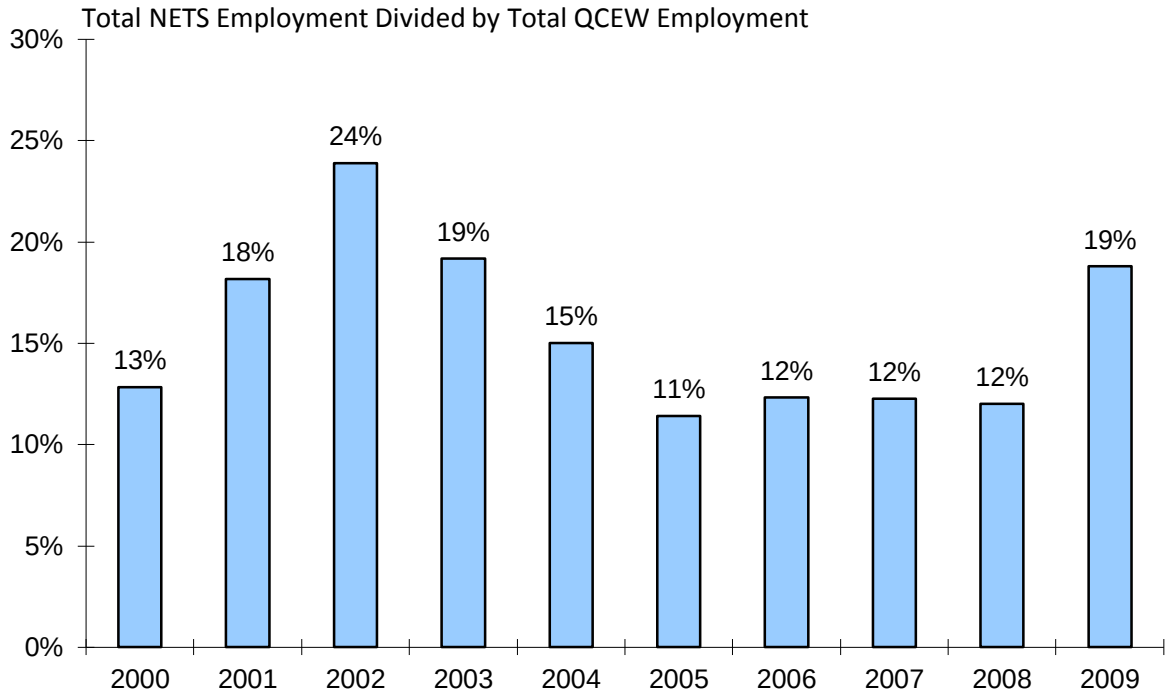
At the state level, NETS employment is, on average, 15% higher than employment data from QCEW, with a peak of 24% in 2002 and a low of 12% from 2006-2008 (see the following charts). At the state level, the difference is much higher during recessions than economic expansions. This pattern is consistent with the hypothesis that the differences between NETS and QCEW are mainly proprietors. More people are laid off during recessions and start their own small businesses—thus the larger number of employees in NETS.



Source: Chmura Economics & Analytics

[87] The NETS database captures additional employment, especially proprietor employment and partners in small businesses. QCEW only tracks employment that is covered by the unemployment insurance program. As a result, many proprietors (such as partners in small firms) are not included in the QCEW database. NETS database aims to include all business establishments in the country, including proprietors.

Virginia Total Employment, Difference Between NETS and QCEW



Source: Chmura Economics & Analytics

To illustrate further that NETS data captures more proprietor employment in Virginia, the following table compares NETS employment with QCEW employment by firm size. Not surprisingly, for firms in the embryonic stage (employment < 10), the NETS database identifies more employment than the QCEW database. For firms categorized as small (employment between 10 and 250), the NETS database captures 5.5% more employment than QCEW. On the opposite end, the NETS database recorded less employment for those firms in medium (employment between 250 and 1,000) or larger firms (employment > 1,000).

NETS vs. QCEW by Establishment Size (2009)			
Stage	NETS Employment	QCEW Employment	NETS/QCEW
Embryonic	1,231,216	484,904	153.9%
Small	1,985,656	1,881,985	5.5%
Medium	527,265	591,739	-10.9%
Large	455,147	576,212	-21.0%
Total All Industries in Virginia	4,199,284	3,534,840	18.8%
Aviation and Aerospace	28,125	29,606	-5.0%
Source: Chmura Economics & Analytics			

Appendix B: Survey Instrument

1. What workforce issues are critical for your organization? [check all that apply]

   - ☐ Lack of qualified employees for job openings…Which occupations in particular? _____
   - ☐ Pending retirements among skilled employees…Which occupations in particular? _____
   - ☐ High turnover rates
   - ☐ Escalating compensation requirements (including benefit packages; for all employees, incumbents as well as new workers)
   - ☐ Lack of regional training support for technical positions…Please elaborate: _____
   - ☐ Other: _____
   - ☐ We have no critical workforce issues

2. In which of the following categories do you see trends that will impact your workforce planning? If so, how? [check all that apply]

   - ☐ Technological: _____
   - ☐ Regulatory: _____
   - ☐ Customer requirements: _____
   - ☐ Economic: _____
   - ☐ Other: _____
   - ☐ None

3. For the following skills, please indicate which are in shortage among your organization's new hires:

Skill	Sufficient Supply	In Short Supply	Not Applicable	Don't Know/Other
Verbal and written skills				
Data management				
STEM[88]				
Motor Skills				
Adaptability				
Troubleshooting				
Critical Thinking				
Software development				
Productivity				
Work ethic				

[88] Science, technology, engineering, and mathematics skills

Decision making skills				
Program management skills				

4. Please list any skills not listed above or required certifications that are in short supply to meet your workforce needs:

5. Does your organization have difficulty retaining employees?
   - ☐ Yes…..Which occupations? _____
   - ☐ No [SKIP TO 7]
   - ☐ Other [SKIP TO 7]

6. For those employees your organization has trouble retaining, what reasons have these individuals given for leaving your organization? [check all that apply]
   - ☐ Working elsewhere for a higher salary
   - ☐ Working elsewhere for better benefits
   - ☐ Professional growth
   - ☐ Wanting to live in a different area
   - ☐ Changing field of work
   - ☐ Hours (amount or timing of)
   - ☐ Other: _____

7. Please estimate the current number of employees in your organization
   Full-time _____
   Part-time: _____
   Seasonal: _____

8. How do you expect your organization's employment will change over the next 12 months:
   - ☐ No Change
   - ☐ Decrease…..By about how many employees? _____
   - ☐ Increase…..By about how many employees? _____
   - ☐ Don't know

9. Over the next three years, how do you expect your organization's employment will change?
   - ☐ No change
   - ☐ Decrease…..By about how many employees? _____
   - ☐ Increase…..By about how many employees? _____
   - ☐ Don't know

10. Please list the occupations (up to five) that have the biggest potential impact on the success of your business, and then answer the related questions.

Occupation Title	This occupation is in sufficient supply for my organization in both quantity and quality.	How many vacancies in this occupation currently exist in your organization?
	True/False/Other	

	True/False/Other	
	True/False/Other	
	True/False/Other	
	True/False/Other	

11. Do you have recruitment programs for prospective employees?
    - ☐ Yes…..What programs? _____
    - ☐ No
    - ☐ Other

12. Do you have training programs for existing employees?
    - ☐ Yes…..What programs? _____
    - ☐ No
    - ☐ Other

13. For classification purposes, which of the following best defines the function of your organization?

    - ☐ Navigational, Measuring, Electromedical, and Control Instruments Manufacturing
    - ☐ Aerospace Product and Parts Manufacturing
    - ☐ Air Transportation (including airlines, both passenger and freight)
    - ☐ Airport Operations
    - ☐ FBO
    - ☐ Aircraft Maintenance
    - ☐ Flight School
    - ☐ Satellite Telecommunications
    - ☐ Space Research and Technology (Public)
    - ☐ Other: _____

14. Do you have any final thoughts you'd like to share with us regarding workforce skills in the aviation and aerospace industries in Virginia or training and education programs for the same?

Thank you for your cooperation.

Appendix C: Virginia 2011 Legislation

Recently enacted legislation in the Commonwealth impacting workforce alignment initiatives are summarized below:

1. **Jobs and Economic Development Legislation**[89] – a number of bills were signed in 2011 that address job creation and economic development.
    a. SB1326/ HB1447 – Creates a Research and Development Tax Credit for start ups and early stage firms in targeted industries, especially those companies accessing research and development services through Virginia colleges and universities to strengthen our business competitiveness.
    b. SB1379/HB1982 – Adjusts criteria for the Governor's Development Opportunity Fund. Criteria to be used in awarding grants and loans from the Governor's Development Opportunity Fund includes job creation, private capital investment, and anticipated additional state tax revenue expected to accrue to the state and affected localities as a result of the capital investment and jobs created.
    c. SB1485/ B2324 – Bolsters the Commonwealth Research and Commercialization Fund to create a comprehensive structure to grow Virginia's innovation economy.
    d. SB999/HB1822 – Local Defense Production Zone creates a separate classification of machinery and tools designed and used directly in manufacturing or processing materials, components, or equipment for national defense. Localities are authorized to create Local Defense Production Zones and to tax such machinery and tools at a rate that is less than the rate generally applicable to machinery and tools.
    e. SB1408 – Allows counties to give unprofitable businesses an exemption on business, professional, occupational license (BPOL) tax beginning on or after January 1, 2012.

2. **The Virginia Higher Education Opportunity Act of 2011 SB1459/HB2510**
    This act influences three areas: greater economic opportunity and impact; reform-based investment; and affordable access for all capable and committed Virginia students.
    a. This act provides a roadmap for achieving an additional 100,000 undergraduate (associate's and bachelor's) degrees for Virginians over the next 15 years.
    b. It focuses additional degree attainment in high-demand, high-income fields (e.g., STEM, healthcare) that are pathways to top jobs in the 21st Century economy.

[89] Source: http://www.governor.virginia.gov/News/viewRelease.cfm?id=74