Aerospace Workforce Industry Supply and Demand in Georgia

Final Report

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UNIVERSITY SYSTEM OF GEORGIA
270 WASHINGTON STREET, S.W.
ATLANTA, GA 30334

PREPARED BY
GEORGIA INSTITUTE OF TECHNOLOGY
CITY PLANNING PROGRAM AND
ECONOMIC DEVELOPMENT INSTITUTE
760 SPRING STREET, NW
ATLANTA, GEORGIA 30332

AUTHORS
William J. Drummond
Robert Lann
Jan L. Youtie

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Executive Summary

The Office of Economic Development (OED) of the University System of Georgia (USG) asked Georgia Tech to investigate the extent to which current and future needs of the aerospace industry can be enhanced by the type or level of talent produced by the state's higher educational system. We define aerospace as the manufacturing of aerospace products and parts and navigation systems as well as services associated with air transportation.

Summary of Findings

- More than 1.2 million employees worked in core aerospace industries (manufacturing and services sectors) in the U.S. and nearly 60,400 in Georgia in 2006. Aerospace comprised 1.1 percent of the workforce in the nation and 1.8 percent of the workforce in the state. Employment in core aerospace industries is projected to grow by 9 percent nationally and 9.4 percent in Georgia by 2014. Aerospace industries accounted for roughly 2 percent of Georgia's 2005 gross domestic product (GDP) compared to less than 1 percent of the national GDP.

- Aerospace related industries accounted for 1.1 million U.S. workers and 13,425 Georgia workers in 2006. Adding core and related employment, we estimate that there will be nearly 80,000 core- and related-aerospace workers in Georgia by 2014 that will account for 2.1 percent of the state's private-sector workforce.

- From an employment perspective, the state is more specialized in core aerospace sectors than the nation but not substantially so. Georgia is projected to be rather more competitive than the nation in its ability to add aerospace manufacturing jobs through 2014, but its other core components are not expected to do as well as the nation.

- In terms of innovation in the aerospace industry, 71 patents were issued to Georgia inventors or assigned to Georgia-based organizations in the 1990 to 2007 (September) timeframe. Georgia ranks 18th in aerospace patents issued to inventors even though it ranks fifth in core employment.

- Current job openings in aerospace that require some college education encompass aerospace engineering, other engineering, business, and computing/information technology (IT). These positions tend to have more substantial technological intensity and experience requirements than we have seen in other fields.

- Georgia graduated some 1900 students annually in core aerospace concentration areas in the 2003 to 2005 time period. This places the state among the leaders in aerospace graduates, second to Texas among aerospace-intensive benchmark states. These graduates were produced out of 18 higher educational institutions in Georgia, with six turning out at least 25 graduates per year. The state has a distinctive concentration of aerospace engineering and Airframe Mechanics and Aircraft Maintenance Technology/Technician graduates. Georgia is rather weak in pilot/flight engineering and avionics specializations.

- Projections of long-term demand for aerospace workers estimate that Georgia will need 1,250 workers annually.

- When comparing long-term demand to supply of graduates, we did not see many occupations with substantial shortfalls. Only occupational classifications related to pilots/flight engineers and aerospace engineering and operations technicians exhibited long-term short-falls.

- Georgia's substantial quantity of aerospace graduates at present belies that human capital insufficiencies may emerge as the state moves forward to develop the aerospace cluster and as current aerospace employers continue to grow. Hence, the recommendation below (not listed in priority order as all are considered important).

Top Recommendations

- Add an avionics degree program to redress the state's supply shortage in this area and in light of the transition the industry is making to computer-based systems. This will most likely be a two-year degree although additional resources at the bachelor's and higher levels may also be needed.

- Offer a program that supports the need for education in defense acquisition and contracting, drawing on discussions with WRALC and Defense Acquisition University's curriculum and at least one University System institution in the local region – most likely Macon State College – to serve as a foundation for such a course of study.

- Strengthen the state's position in innovation in the aerospace field by providing support for the addition of a research center that focuses on the post-composite materials area. The Aerospace Innovation Center could play a role through outreach, education, and research sponsorship.

- Maintain support for refreshment of facilities and equipment necessary in aerospace training including simulation machines, aircraft, computer-based systems, composite samples, and the like.

- Incorporate opportunities to integrate academic and experience opportunities with Warner Robins Air Logistics Center (WRALC) and with private industry in light of the need the industry has for experienced workers. Examples include: internships, coops/part-time jobs, student projects, seminar programs, formal partnerships, involvement of students and business leadership in curricula design, executive programs for today's aerospace professionals, and adjunct positions provided for industry executives to teach in university classes.

- Develop individualized professional development curricula that are deliverable in a timely manner to support lifelong learning.

Acknowledgements

The project team gratefully acknowledges the helpful support received from the University System of Georgia. We thank Phil Allen, Director of Georgia LEADS and Joy Hymel, Assistant Vice Chancellor, Office of Economic Development, University System of Georgia for their assistance with data acquisition and conceptual ideas regarding the place of aerospace in the university system's economic development horizon. Nicolas Fuhrman, Director of the Georgia Aerospace Innovation Center kindly provided us with information about the aerospace workforce initiatives in which that center is involved including the Middle Georgia Work-Ready Aerospace Partnership Solutions Summit. We also greatly appreciate the assistance of University System of Georgia faculty members and corporate executives we interviewed in the course of conducting this project. Significant research assistance was provided by Philip Douglas Allen Jr. and Yun Sang Lee. Final responsibility for the analyses and conclusions contained in this report rests with the authors.

Chapter

1

Introduction

The aerospace industry has been identified by the Governor's Commission for a New Georgia as one of the top six strategic industry clusters targeted for further growth within the state. The aerospace industry has traditionally been viewed as consisting of two main segments: aerospace manufacturing and air transportation services. Both segments are prominent in Georgia's aerospace industry. Manufacture of private aircrafts, defense contractors and major air force installations and other defense-related facility locations, and air transportation services have a strong presence in the state.

The industry is undergoing considerable change due to factors such as increases in federal defense spending; emergent global competition; consolidation among aerospace companies; outsourcing of functions such as maintenance, repair, and overhaul (MRO); and transitions to greater use of computers and composite materials. In addition, there have been greater concerns about homeland security; shocks to the travel industry; the rise of low cost carriers; and growing air traffic management needs. All of these changes have considerable implications for the types of skills needed by current and prospective workers in these industries. The impending retirement of many engineering and technical workers further intensifies these workforce needs. (Commission on the Future of the Aerospace Industry 2002; US Department of Commerce 2005; Aerospace Industries Association, 2006)

Given the importance of the aerospace industry to the state's economic development strategy, the Office of Economic Development (OED) of the University System of Georgia (USG) is interested to understand the extent to which there may be current or future aerospace industry needs that are unmet by the type or level of talent coming out of the state's higher educational system. It is this concern that we address in this report.

Definition of Aerospace

There is no standard definition of the aerospace industry. The Commission on the Future of the United States Aerospace Industry defines the industry as "the sum of those activities needed to develop, operate, and/or use aerospace capabilities, including the activities of commercial enterprises and government—from general aviation to space exploration, and from civil transport to national security." (Commission on the Future of the Aerospace Industry 2002, p. xxi)

We collected definitions from six regional (i.e. city or state) target industry and cluster initiatives focused on aerospace in the 2000s. These are presented in Appendix 1. Taken together, these initiatives reference 45 different North American Industrial Classification System (NAICS) codes.[1]

Manufacturing Definitions

Some of these classifications are directly related to aerospace such as 3364 – Aerospace Products and Parts Manufacturing. The breakdown of this industry into its 6-digit components is as follows:

- 336411 Aircraft Manufacturing
- 336412 Aircraft Engine and Engine Parts Manufacturing
- 336413 Other Aircraft Parts and Auxiliary Equipment Manufacturing
- 336414 Guided Missile and Space Vehicle Manufacturing
- 336415 Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
- 336419 Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing

NAICS 334511 is another manufacturing industry often used to define the industry in studies commissioned by other states and some cities. The title for this industry is Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing and it can encompass firms not in the aerospace industry as its title indicates. Pieces of many other manufacturing industries produce products that are used by the aerospace industry but it is very difficult to differentiate companies that serve the industry from companies that do not. In general, it is best not to include manufacturing industries that only partially belong to the aerospace industry because statistics based on such industries would be unduly influenced by the non-aerospace activities. Despite this, many studies conducted in other states have stretched the definition of aerospace manufacturing to include such industries as Steel Investment Foundries; Iron and Steel Forging; Electroplating, Plating, Polishing, Anodizing, and Coloring; Ammunition Manufacturing; Optical, Instrument and Lens Manufacturing; Metalworking Machinery Manufacturing; Engine, Turbine, and Power Transmission Equipment Manufacturing; and Metal Stamping. Clearly many firms in these industries manufacture products for industries other than aerospace.

Non-manufacturing Definitions

In terms of definitions of non-manufacturing sectors, NAICS 481 is Air Transportation and NAICS 4881 is Support Activities for Air Transportation, and both are service-related components of the aerospace industry. Not all studies reviewed in this project include these two service components. Some studies were only interested in the manufacture of aerospace products and not in their use, therefore, they did not include 481 or 4881. Studies that did include these classifications were generally in states with large airports such as we have in Georgia with the Hartsfield-Jackson International Airport and other airport facilities.

Many studies also tried to incorporate segments of NAICS 51– Information Services, and NAICS 54 – Professional, Scientific, and Technical Services. However, it is not possible to determine how much of these service industries serve the aerospace industry without surveying. Because these service industries tend to have high average weekly wages and

[1] The North American Industrial Classification System (NAICS) derived in the mid 1990s to replace the outdated Standard Industrial Classification (SIC) system of classifying businesses.

are considered to be high-tech, many states include them for these reasons and end up diluting their aerospace statistics with firms that do not serve the industry.

Our approach here was to draw on the NAICS classifications agreed to in the Commission for a New Georgia's Strategic Industries report. (Commission for a New Georgia, 2004) and incorporate further prominent NAICS codes that were commonly mentioned in other aerospace clustering/targeting initiatives. Based on the studies examined, the objective of this project, and a desire to not dilute our definition with industries that have only weak links to the aerospace industry, it was decided to include the following group of NAICS industries in our "core" aerospace industry definition. At the same time, we also want to acknowledge important industries that have important upstream or downstream relationships to these central classifications even as these industries – and their related occupations and educational program – may perform a cross-cutting function with importance to virtually all industries. As well, some of these classifications were referenced in earlier statewide cluster studies; for example, the Commission for a New Georgia included 3332, 3335, 3336, 3369, and 5417 in their definition of the state's aerospace industry.[2]

Definition Used in this Study

The definition used in this study is comprised of two parts:

Core: any academic program and occupational classification that is associated with the following core NAICS classifications for the aerospace sector:

- **3364 (Aerospace product and parts manufacturing);**
- **334511 (Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing);**
- **481 (Air transportation services);**
- **4881 (Support activities for air transportation).**

Related: the following NAICS classifications:

- 3332 (Industrial machinery manufacturing);
- 3335 (Metalworking machinery manufacturing);
- 3336 (Engine, turbine, and power transmission equipment manufacturing);
- 3369 (Other transportation equipment manufacturing);
- 5417 (Scientific R&D services);
- 611512 (Flight training)

Most of the analysis of academic programs and occupational classifications will focus on the core industries. However we will examine the related industries in the context of our description of the aerospace industry relative to the broader Georgia economy. We should note that although NAICS 927 (government space research and technology) can be

[2] The Commission for a New Georgia used the following definition:

- 333200Industrial Machinery Mfg
- 333500Metalworking Machinery Mfg
- 333600Engine, Turbine, and Power Transmission Equipment Mfg
- 336400Aerospace Product and Parts Mfg
- 336900Other Transportation Equipment Mfg
- 541700Scientific Research and Development Services

considered within the boundaries of the aerospace industry, none of this activity exists in Georgia, so it is not profiled in this study.

History and Approach

The University System of Georgia has partnered with Georgia Tech since 1997 to develop a systematic methodology for assessing the supply of graduates relative to the projected demand for these graduates in the workplace. Previous studies have assessed demand for employees in various occupations at the national, state, and substate regional levels. We have also assembled information on the supply of graduates from both public and private postsecondary institutions in Georgia. We have broadly measured shortfalls across a range of occupations requiring various levels of college education. These studies have pioneered methods for tracking and estimating intra- and inter-state migration of university graduates as they move from their school environment to taking their first job based on the acquisition of matched graduate data from the Georgia Department of Labor. In addition, we have focused on the talent needs of particular occupations such as those related to bioscience. Previous studies also have measured the value of higher education based on a new education-related measurement approach. (Drummond and Youtie 1997, Drummond and Youtie 1999, Drummond and Youtie 2001, Drummond and Youtie 2003a, Drummond and Youtie 2003b). In 2005 we conducted an analysis of the logistics industry, which is one of the Commission for a New Georgia's Strategic Industries. (Youtie et al, This knowledge is drawn upon to address the unique challenge of measuring talent needs in the aerospace industry.

Objective

The primary aim of this project is to assess current and future needs for educational programs to serve knowledge workers in the aerospace industry. More specifically, the objectives are to

- Understand the workforce development needs of the aerospace industry in Georgia
- Determine what jobs, current and future, are involved in this industry
- Assess the current strengths and weaknesses of USG academic programs – and other relevant postsecondary educational programs – that serve to provide the necessary workforce for this industry
- Suggest new economic development opportunities in Georgia as they relate to the aerospace industry
- Make recommendations that address the workforce needs of the aerospace industry

Method and Report Organization

Aerospace Industry Overview

The aerospace industry analysis is designed to assess the size of the industry and Georgia's competitive position relative to the nation. We utilize employment data from the U.S. Bureau of Labor Statistics and Georgia Department of Labor to gauge the size of the aerospace industry, its share of total employment in the U.S. and Georgia, projected growth to 2014, and the competitive position of Georgia relative to the nation. Chapter 2 presents the results of this analysis.

Current Demand

Web sites of aerospace companies and other sources are reviewed and data on job advertisements and their characteristics considered. Type of job, experience requirements, certifications, and particularly educational requirements are analyzed and presented in Chapter 3.

Academic Supply

Graduates of postsecondary institution specializations in Georgia and across the nation have been probed to assess Georgia's educational strengths and weaknesses in aerospace programs. Chapter 4 presents this information for graduates of public and private institutions in 2005, which we obtained from the Integrated Postsecondary Educational Dataset (IPEDS) of the National Center of Educational Statistics (NCES).

Projected Demand and Shortfall Analysis

Occupational employment projections in the 2004-to-2014 time period are matched with postsecondary institution graduate specializations to identify significant areas of unmet need or shortfalls in Georgia. Results are presented in Chapter 5.

Recommendations

We conducted indepth interviews with aerospace company executives and academic professionals. These interviews along with the results of the above analyses contributed to the recommendations presented in Chapter 6.

Chapter
2

Aerospace and Georgia's Competitive Position

The aerospace industry is particularly important to Georgia's economy. The state's airports, military installations, geographic positioning, and other characteristics have attracted manufacturing and service firms that generated nearly 2 percent of Georgia's gross domestic product (GDP) in 2005.[3] This is particularly significant because 2005 was a downturn period for Georgia's commercial air transportation industry, including Delta Airlines. Current figures are likely to show that the industry makes a higher contribution. Still, this figure is more than the national statistics of less than 1 percent of GDP. It suggests that **Georgia is more economically dependent on the aerospace industry than are other states,** possibly in part because of these infrastructure assets.

Overview of the U.S. Aerospace Industry

The last comprehensive, blue-ribbon commission report on the state of the U.S. aerospace industry was published in November 2002 by the Commission on the Future of the United States Aerospace Industry. The report examined every aspect of the industry including production, research and development, domestic and international travel and freight, and workforce issues. Being published a little over a year after 9/11, it was influenced by the problems suffered by the nation's air transportation industry and subsequently by aerospace manufacturing.

Studies since then have documented a rebounding aerospace industry as well as further consolidation of the industry and growing competition from abroad. This section examines the state of the industry using recent statistics from the Aerospace Industry Association (AIA) and elements from the November 2002 comprehensive report. It is important to note that AIA focuses on the manufacturing sector of the aerospace industry.

Aerospace Industry Performance

The AIA publishes a data compilation of the aerospace industry each year with the most recent (2006) report showing a fast growing industry. In a news release from December 2006, the association said that 2006 total aerospace industry sales should set a record for the third year in a row, totaling $184.4 billion in 2006. AIA's estimate for 2007 is $195.4

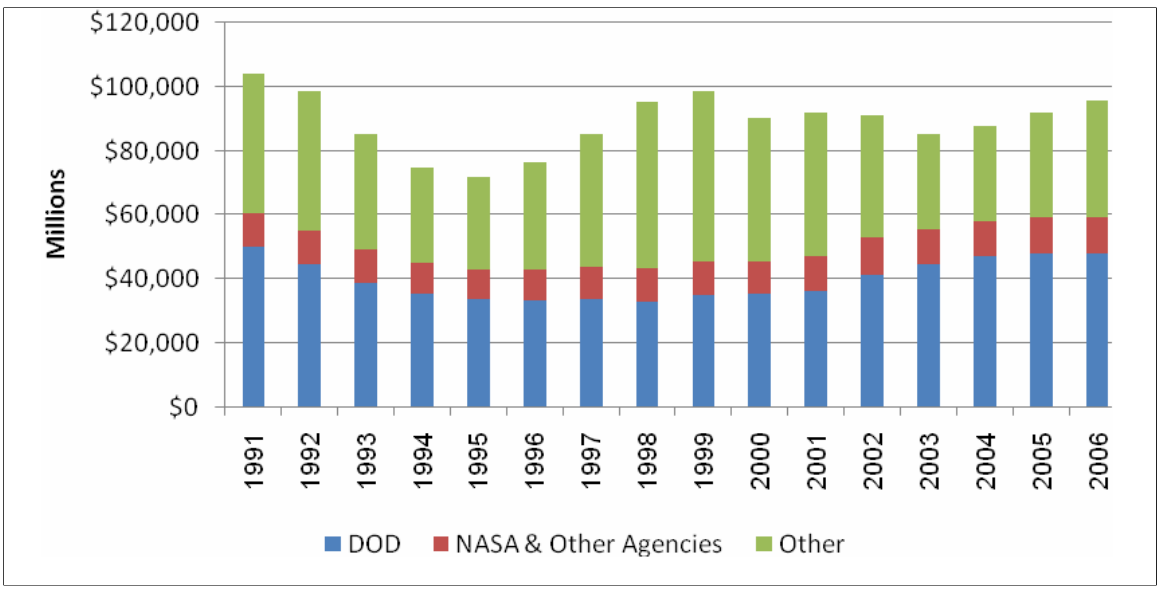
[3] This estimate of the aerospace industry's share of GDP is comprised of two sectors: other transportation equipment manufacturing and air transportation service. We must use these broad sectors because GDP estimates are not available at the state level in more detailed classifications. Although other transportation equipment manufacturing may include some non-aerospace components, we judge it to be largely a measure of aerospace manufacturing, in part because motor vehicle related manufacturing is accounted for in a separate industry sector in the GDP estimates. Source: US Bureau of Economic Analysis, http://www.bea.gov/regional/gsp/, accessed September 19, 2007.

billion. However, these are in current dollars and therefore, not deflated to real dollars. In terms of real dollars, using AIA's composite deflator (1987 = 100), 2006 is estimated at $115.1 billion, well below the 1991 figure of $124.9 billion.

AIA has defined the aerospace industry based on a combination of NAICS industry and product codes. Product codes can be up to ten-digits and were developed by the U.S. Census Bureau for mining and manufacturing industries. However, very few databases have information at this level, so it is difficult to use product codes in defining an industry. Appendix A, has the complete list of NAICS industry and product codes that AIA uses to define the aerospace industry. Still, it can be concluded that AIA focuses on aerospace manufacturing as opposed to air transportation services (although the two sectors are not unrelated in practice).

Figure 2.1 shows U.S. aerospace industry sales by major customer group, in real dollars, from 1991 through 2006 (estimated). The federal government continues to be the major customer of this industry with nearly 62 percent in total customer sales to the Department of Defense, NASA, and other government agencies. Since September 11, 2001, sales to commercial customers have fallen, but sales to the federal government have increased due to security concerns and the Iraq and Afghanistan conflicts. AIA estimates another $19.2 billion in sales of related products and services in 2006 (not shown in Figure 2.1).

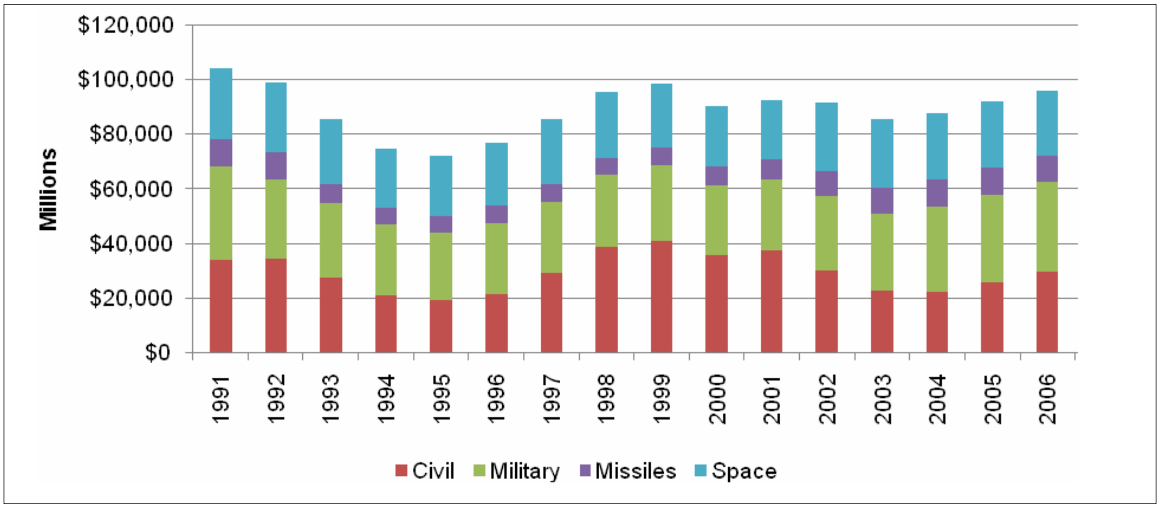
Figure 2.1. US Aerospace Manufacturing Sales by Customer



Source: Aerospace Industry Association

Figure 2.2 shows U.S. aerospace industry sales (in real dollars) by major product group: civil, military, missiles, and space. The military, missiles, and space product groups include figures for research, development, test, and evaluation.

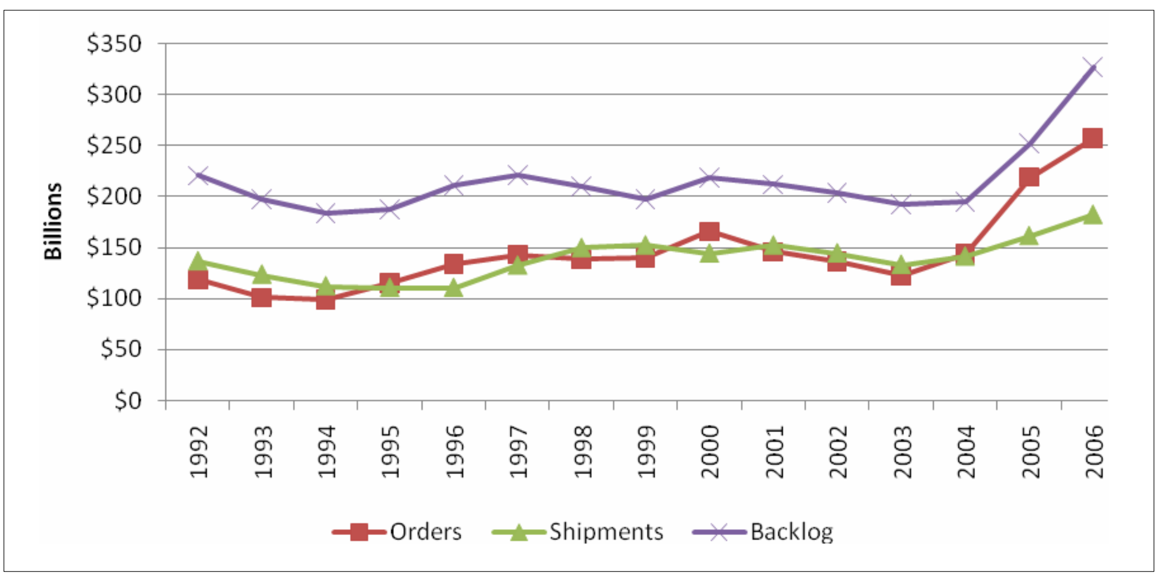
Figure 2.2. US Aerospace Manufacturing Sales by Product Group



Source: Aerospace Industry Association

A good indicator of strength in the near future is data on net new orders and backlog of unfilled orders. These data are collected by the United States Census Bureau on a monthly basis and show a dramatic upshot in both net new sales and backlog over the last couple of years, as shown in Figure 2.3 below, in current dollars.

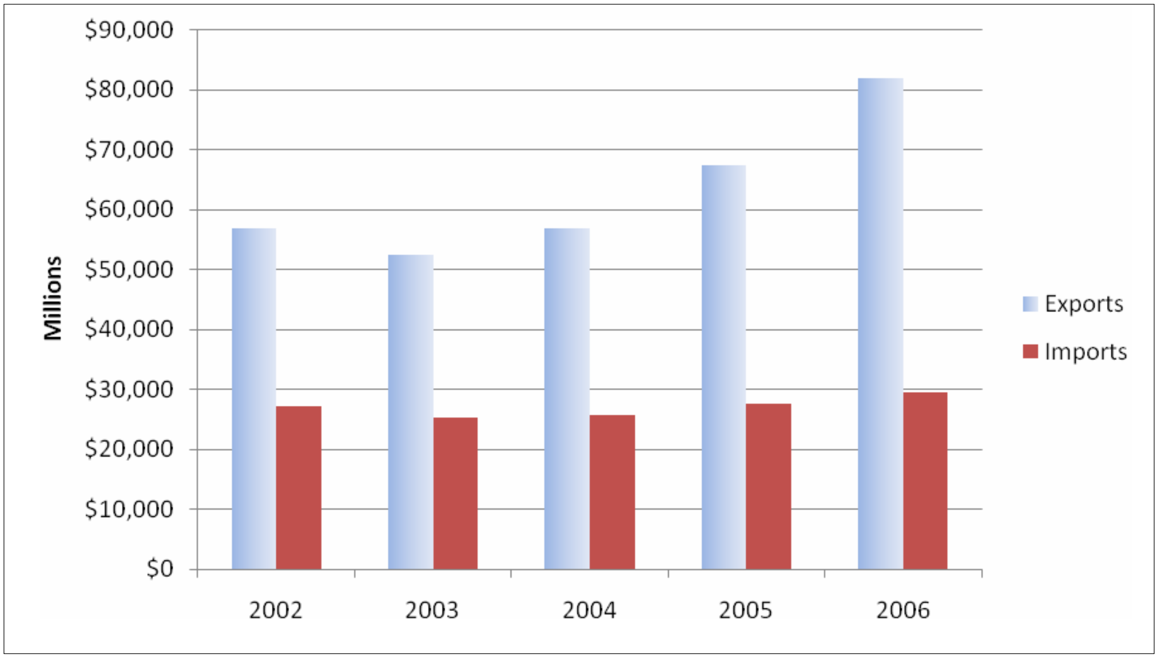
Figure 2.3. Orders, Shipments, and Backlog



Source: Aerospace Industry Association web site; Bureau of the Census, "Manufacturers Shipments, Inventories, and Orders," Series M3 monthly.

The aerospace industry also shows very strong export sales. Rather than contributing to the country's imbalance in foreign trade, this industry continues to show a strong positive trade balance. Figure 2.4 shows the most recent trade figures for the industry from 2002 through 2006 (preliminary), in current dollars. Strong export sales have helped to create an estimated $52 billion in trade surplus for this industry.

Figure 2.4. Aerospace Manufacturing Exports and Imports



Source: Aerospace Industry Association, based on data from the U.S. Department of Commerce and AIA estimates.

Industry Structure

States with significant aerospace sectors, especially those largely dependent on Department of Defense (DOD) contracts, know the cyclical nature of this industry. Data on defense outlays show that over the past half century, the industry has been riding a 10-year up and 10-year down roller coaster of defense funding. It can be difficult for an industry to maintain itself, especially its workforce, when it follows such cyclical influences.

Throughout these bust cycles, the industry has gone through a consolidation. During the last such cycle in the 1990s, over 50 companies consolidated into today's big five: Lockheed Martin, Boeing, Raytheon, Northrop Grumman, and General Dynamics. In a report by the U.S. Department of Commerce's International Trade Administration, it is stated that global production of large civil aircraft (LCA) with 100 or more seats is now dominated by two manufacturers: Boeing (United States) and Airbus (European Union).

Global production of regional jets with fewer than 100 seats is dominated by two companies: Bombardier (Canada) and Embraer (Brazil). RJ orders and deliveries have grown rapidly since 1992 when only two regional jets were delivered. In 2003 there were well over 300 delivered. These smaller jets fit a growing niche market.

Although existing production and assembly operations of regional jets is not found in the United States, the ITA report notes that up to 70 percent of the hardware on Embraer's jets comes from U.S. suppliers. U.S.-based airlines that purchase Embraer's jets are American Eagle, Continental Express, GE Capital, Mesa Air, U.S. Airways, and JetBlue

Airways. Bombardier, on the other hand, has production facilities in three U.S. states: Kansas (Wichita), Arizona (Tucson), and West Virginia (Bridgeport).

Another recent report claims that consolidation of the airlines industry after 9/11 has concentrated buying power into fewer airlines and thus caused downward pressures on costs, reducing margins for aircraft manufactures and causing consolidation throughout the supply chain.

Global Supply Chain

The global supply chain for the aerospace industry is made up of tens of thousands of companies worldwide. However, a handful of major suppliers in a few countries dominate this segment of the industry. Many of these major suppliers are located in the United States and Europe but Russia, Japan, South Korea, and China also have a number of major suppliers.

There are eight major suppliers in the U.S. that predominately manufacture large structures or subassemblies, or components such as avionics or communication equipment. These companies are: The Carlyle Group/Vought Industries, Eaton Corporation, Goodrich Corporation, Harris Corporation, Honeywell International, Inc., Parker Hannifin Corporation, Rockwell Collins, Inc., and United Technologies Corporation/Hamilton Sundstrand. Some used to be divisions of prime aerospace corporations but were spun off or sold. It should also be noted that U.S. suppliers are no longer completely dependent on U.S. prime aerospace manufacturers for sales, but have diversified their client base and sell throughout the world.

One trend that may be influencing the growth in a global supply chain is the use of offsets. These are agreements between a procuring foreign government and U.S. aircraft manufacturers which require some amount of parts to be produced by firms in the procuring country. In this way, some of the parts manufacturing that may have been done in the U.S. is moved to the procuring county, thus creating a more global supply chain. Offsets are difficult to evaluate in terms of their potential harm to U.S. aerospace manufacturing because it may be that a sale with an offset agreement would not have occurred without the offset agreement.

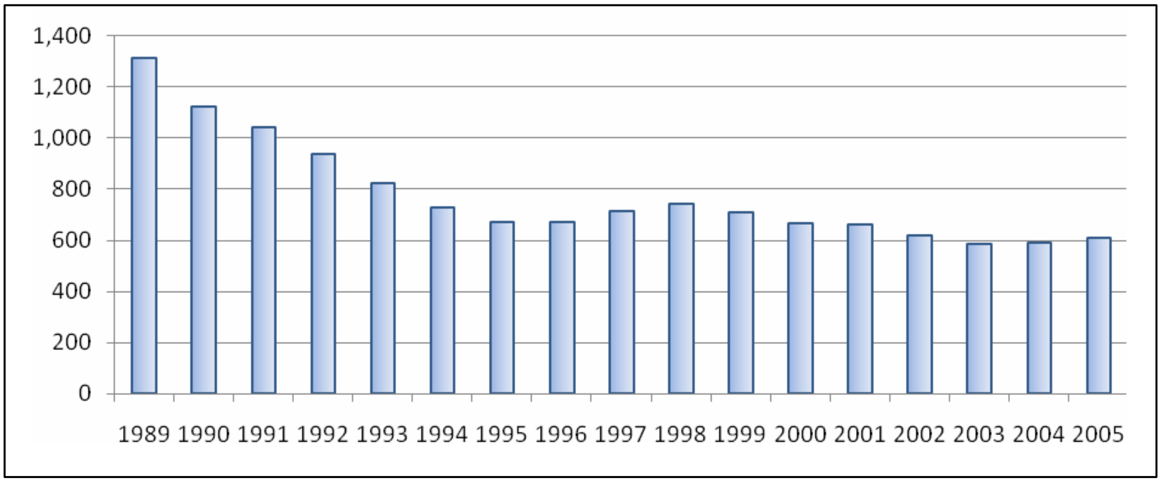
Aerospace Workforce Issues

In the 2002 commission report on the state of the U.S. aerospace industry, workforce issues were discussed in length. Several threats to sustaining the U.S. aerospace workforce were identified in the report, including the cyclical nature of the industry, global competition, offsets, the aging of the workforce, and a failure to attract and retain workers.

Total national aerospace employment (based on AIA's definition) peaked in 1989 at 1,314,000 and fell to only 612,000 by 2005. (See Figure 2.5.) Much of the drop in aerospace jobs in the 1990s is attributed to the reduction in defense budgets and after 2001 to the problems encountered by the commercial airline industry due to the events of 9/11. Contractions of the industry, both federal and commercial, resulted in consolidation which further reduced the workforce. The industry went from about 50 firms to just the "big 5" found today. Consolidation of the aircraft manufacturers has also caused parts manufacturers to consolidate, further exacerbating the problem. With these contractions and consolidations, many skilled engineers and technical experts left for other industries causing a drain in aerospace intellectual capital.

Global competition in aerospace manufacturing has increased dramatically. The U.S. market share has been reduced since the 1980s and much of it has been lost to Europe, primarily to Airbus. While U.S. employment has fallen, jobs in the European Union have risen. As mentioned earlier, regional jet manufacturing is dominated by firms in Canada and Brazil, and China's aerospace industry is growing rapidly.

Figure 2.5. US Aerospace Industry Employment



Source: Aerospace Industry Association estimates and the U.S. Bureau of Labor Statistics, 2007

Offset agreements, mentioned earlier, may also be contributing to losses in U.S. aerospace industry employment. However, if the sales with offset agreements would not have occurred without the agreements, then it can be said that offsets still have a positive influence on U.S. aerospace industry employment. But, this is, of course, difficult to determine, especially as competition in aircraft production increases.

The 2002 commission report claims that the industry's workforce is aging and reports that by some estimates as much as 27 percent of aerospace workers can retire by 2008. The average age of production workers in this industry is reported to be 44 in commercial, 53 in defense, and 51 at the National Aeronautics and Space Administration (NASA). Another statistic shows that the proportion of workers 30 or younger has dropped by almost two-thirds between 1987 and 1999. Some firms are trying to combat this decline through knowledge management programs that aim at capturing workers knowledge and skills before retirement.

Analysis of Georgia's Aerospace Industry and Competitive Position

In an earlier section, this study presented its definition of the aerospace industry after reviewing definitions used by other states, associations, and some cities. As shown earlier, this study defines a "core" set of industries and a "related" set of industries. Most of the analyses in this section will center on the core industries as these are of most interest to the objectives of this study.

Georgia ranks in the top 10 aerospace-industry states. Table 2.1 shows the top ten states, in rank order, with respect to total core industry employment. The top state is California and Georgia ranks fifth with 61,592 and 60,371 jobs in 2005 and 2006, respectively. Among the top ten states, only California, Georgia, and Illinois saw a decline in core industry jobs. The state with the largest percentage increase from 2005 to 2006 is

Washington at 8.6 percent. For the nation, core aerospace industry jobs grew by 3.19 percent.

Table 2.1. Core Aerospace Industry Jobs - Top 10 States

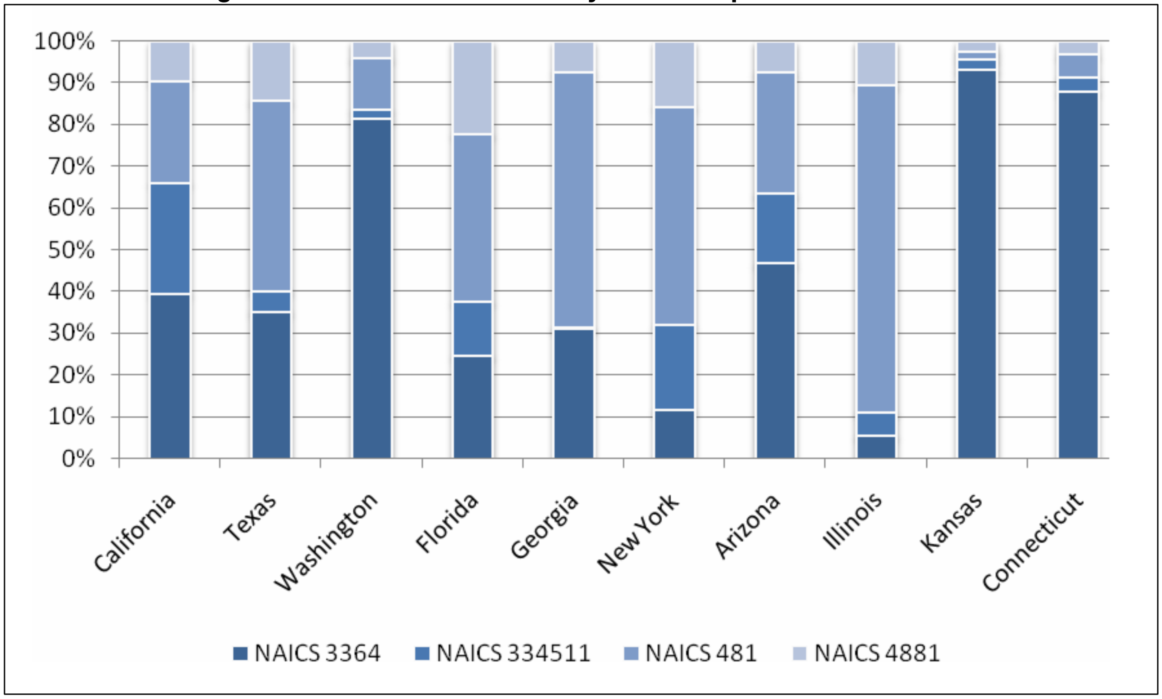
Rank	State	Jobs 2005	Jobs 2006	Percent Change
1	California	185,817	183,534	-1.23%
2	Texas	136,231	138,714	1.82%
3	Washington	82,755	89,872	8.60%
4	Florida	73,601	74,201	0.82%
5	Georgia	61,592	60,371	-1.98%
6	New York	56,334	58,227	3.36%
7	Arizona	55,267	57,052	3.23%
8	Illinois	46,662	45,527	-2.43%
9	Kansas	39,534	40,902	3.46%
10	Connecticut	34,372	35,188	2.37%
	U.S. Totals	1,225,809	1,264,872	3.19%

Source: U.S. Bureau of Labor Statistics, 2007.

Total core industry jobs are a measure of the overall size of each state's aerospace industry. The makeup of that industry is revealed by examining the distribution of jobs by the four NAICS components that comprise the core. Figure 2.6 below, shows the distribution of jobs across these four NAICS industries: 3364 – Aerospace manufacturing and parts, 334511 – Search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing, 481 – Air transportation, and 4881 – Support activities for air transportation.

These four NAICS industries can be grouped into manufacturing (3364 and 334511) and air transportation (481 and 4881). From this perspective, it makes sense that Georgia's core manufacturing percentage is relatively low (31 percent), with the busiest airport in the world at Atlanta's Hartsfield-Jackson International Airport. On the other hand, Washington is dominated by its manufacturing base at about 82 percent. This is also found for Kansas (home of manufacturing facilities of Beach, LearJet, Cessna, Bombardier, and others) and Connecticut (home of manufacturing facilities of Sikorsky, Pratt and Whitney, and others).

Figure 2.6. Distribution of Jobs by Core Component



Source: U.S. Bureau of Labor Statistics, 2007

Another useful metric is the location quotient (LQ) which measures a state's relative concentration of a particular industry. Typically, the percentage of total jobs in an industry in a state is compared to the same ratio for the U.S., to create the LQ. (See Box 1 for the formula.) If an industry has, say, 2 percent of total jobs in a state and that same percentage prevails for the U.S. economy, then the LQ is 1.0 (state percentage divided by the U.S. percentage). Therefore, a location quotient larger than 1.0 indicates the industry is more concentrated in the state (or any region) than in the U.S.; less than 1.0 indicates just the opposite.

LQs are typically used in economic development to assess whether an industry is basic or non-basic but they can be applied to a variety of situations and have been used in recent years to assess occupational employment strengths and weaknesses. (Bendavid-Val 1991; Markusen and Schrock 2001). An LQ above one is typically interpreted as an indicator of specialization and human capital advantage. An LQ below one may be interpreted as an under-representation of human capital relative to the nation.

Box 1. Location Quotients

$$\frac{e_{ir} / \sum e_{ir}}{E_i / \sum E_i}$$

e_{ir} = employment in some group (i) in some region (r)

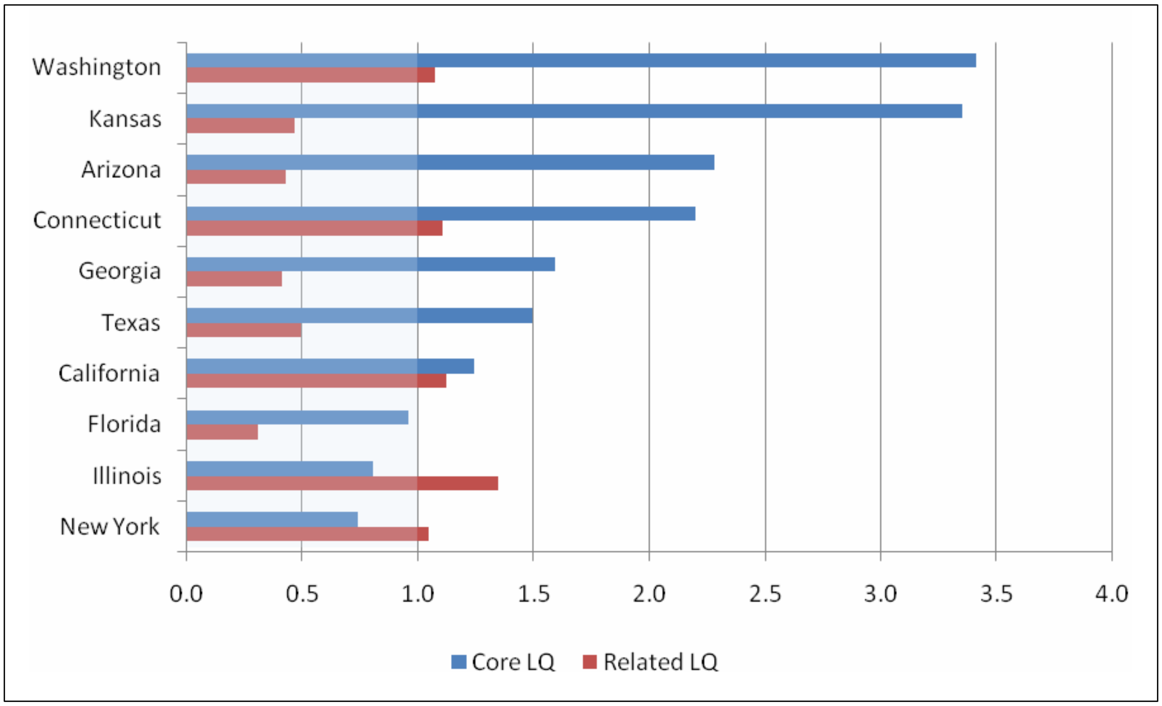
Σe_{ir} = total employment in the region

E_i = national employment in some group (i)

ΣE_i = total national employment

Figure 2.7 shows LQs by state for each core industry and relative industry segment. The LQs are in rank order by core industry segment. By far Washington has the largest LQ for its core industry, followed by Kansas, Arizona, Connecticut, and Georgia, in that order. Every top-ten state, except Florida, Illinois, and New York have a location quotient larger than 1.0 for its core industry. Only a few states in Figure 2.7 have LQs greater than 1.0 for the related industry sector. NAICS 5417 – Scientific, research, and development services, serves a very broad set of industries. Only about 2 percent of its output goes to NAICS 3364, so it is not in any way dependent on the aerospace industry. What it does supply to NAICS 3364 is only about 1.9 percent of what NAICS 3364 purchases as intermediate inputs. Given the tenuous connections of the related industries to the core industries, no conclusions can be drawn about the relationship of related and core LQs from the statistics in Figure 2.7.

Figure 2.7. Location Quotients for Core and Related Segments



Source: U.S. Bureau of Labor Statistics, 2007

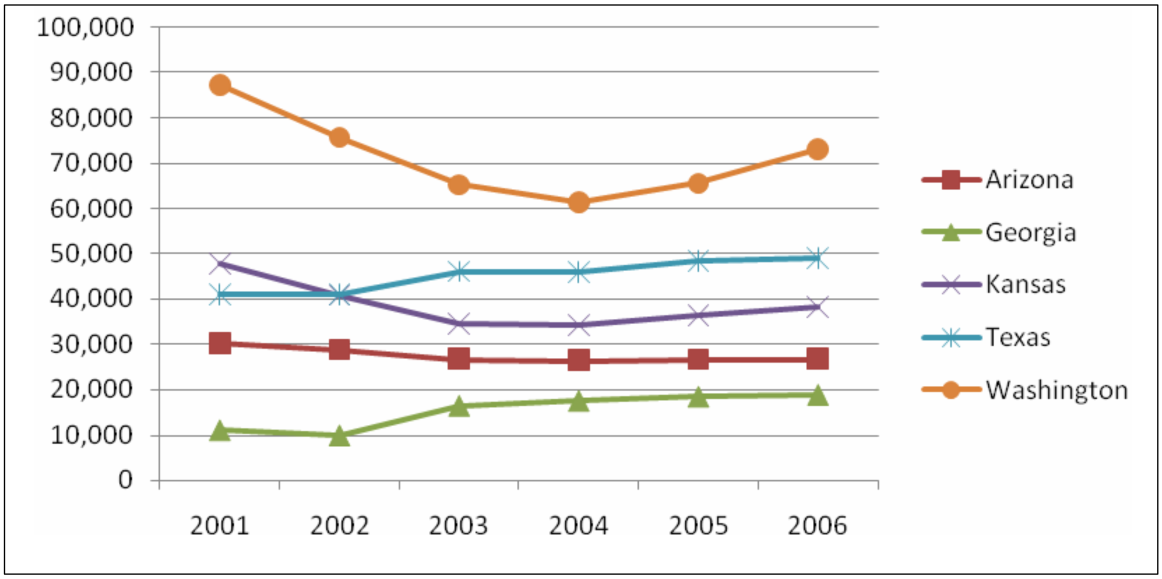
Key States for Comparison

From these analyses, the project team selected Kansas, Washington, Arizona, and Texas as key states for comparison to Georgia. Although Connecticut has a higher location quotient than Texas, the balance between manufacturing and air transportation in Texas closely resembles that found in Georgia, where Connecticut's does not (refer to Figure 2.6).

Performance by Core Subsector

Figure 2.8 shows each state's employment numbers for the 2001 to 2006 period for its aerospace manufacturing sector, NAICS 3364. Washington experienced a large decrease in its jobs from 2001 through 2004, mostly because of its dependence on commercial aircraft production which was very negatively impacted after 9/11. Washington has seen a strong renewal of job growth since 2004 as have each of the other states with the exception of Arizona which has grown at less than 1 percent in the last two years of the period. Georgia and Texas both showed an increase in each of the first two years after 2001, where the other three states did not. Perhaps the strong defense component of these states' aerospace manufacturing sectors kept them growing as defense spending rose after 9/11.

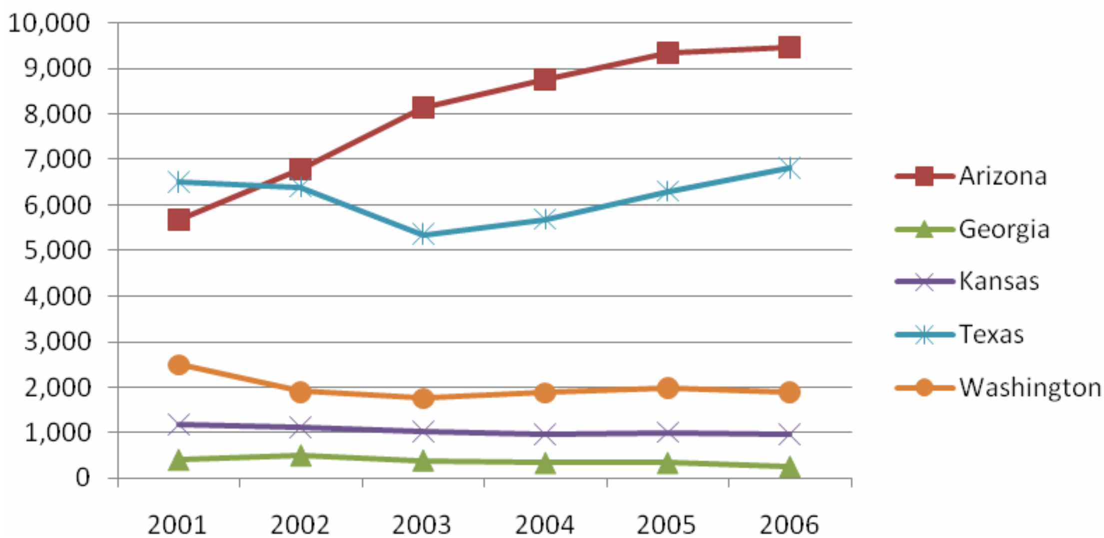
Figure 2.8. NAICS 3364 Jobs by Key State



Source: U.S. Bureau of Labor Statistics, 2007

Figure 2.9 shows each state's employment numbers for the 2001 to 2006 period for its NAICS 334511 industry. This industry is a key supplier industry to 336411 – aircraft manufacturing. Based on the chart in Figure 2.9, it is apparent that Arizona has been very successful at retaining and recruiting this industry, adding 3,814 jobs from 2001 through 2006. Among the other states, only Texas has shown strong growth over the last three years. Whether the growth in this industry in Arizona and Texas is related to the industry's sales to aircraft manufacturing cannot be determined here. However, the small size of the Georgia component may point to an opportunity for recruitment.

Figure 2.9. NAICS 334511 Jobs by Key State



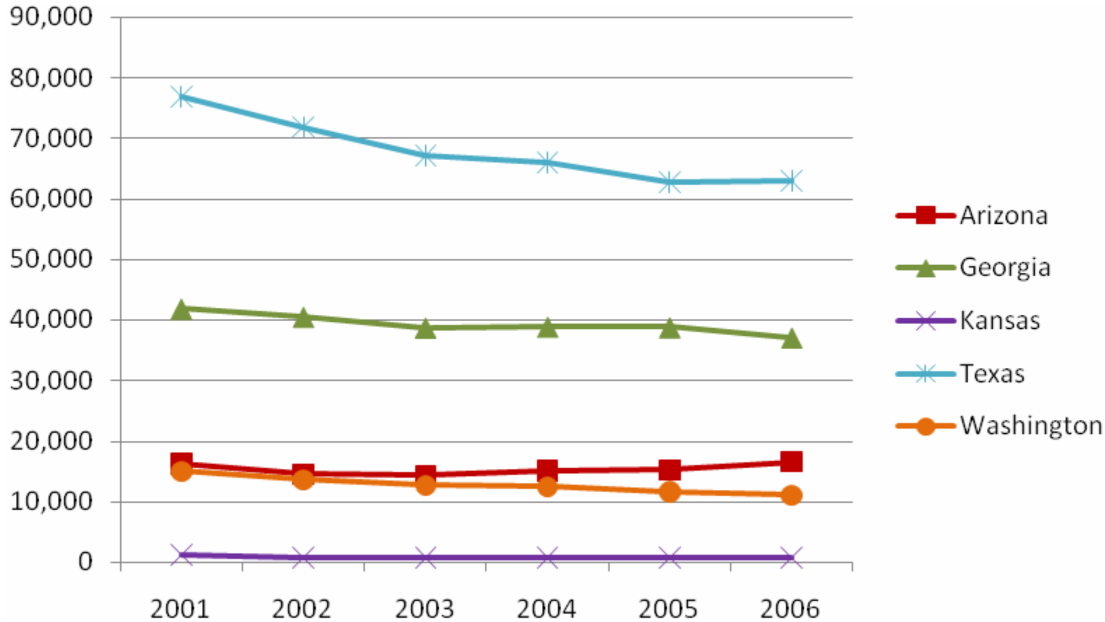
Source: U.S. Bureau of Labor Statistics, 2007

Figure 2.10 shows each state's employment numbers for the 2001 to 2006 period for its NAICS 481 industry. The air transportation industry is made up of passenger and freight air carriers, therefore, states with large or numerous commercial airports will typically have a large number of jobs in this industry. The following six-digit NAICS industries comprise NAICS 481:

- 481111Scheduled Passenger Air Transportation
- 481112Scheduled Freight Air Transportation
- 481211Nonscheduled Chartered Passenger Air Transportation
- 481212Nonscheduled Chartered Freight Air Transportation
- 481219Other Nonscheduled Air Transportation

Although Georgia has only one large international airport in Atlanta (the state has Savannah International but it is a much smaller airport with only about 2.5 percent of the passenger traffic of Atlanta's airport), its job numbers are impressive. Texas with sizable airports in Dallas/Ft. Worth, Houston, Austin, San Antonio, and El Paso, has far more jobs.

Figure 2.10. NAICS 481 Jobs by Key State



Source: U.S. Bureau of Labor Statistics

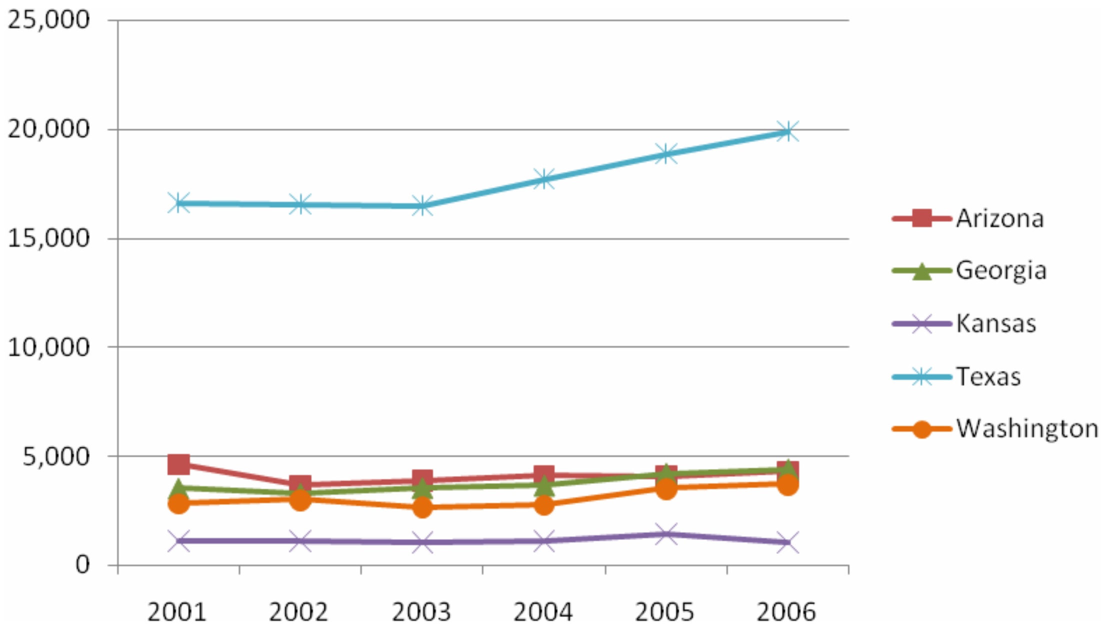
According to the latest domestic passenger data from the Bureau of Transportation Statistics (TransStats database) the volume of domestic passengers by origin provides the same ranking as the jobs shown in Figure 2.10. In terms of air freight, Texas also ranks on top of these five states, with Georgia, Washington, Arizona, and Kansas following, in that order. With the exception of Arizona, all states shown in Figure 2.10 experience declines in employment after 2001, due to the impact of 9/11.

Figure 2.11 shows each state's employment numbers for the 2001 to 2006 period for its NAICS 4881 industry. This segment of the aerospace industry covers firms and facilities that provide support to air transportation. There are three six-digit industries that fall under NAICS 4881:

■488111Air Traffic Control
■488119Other Airport Operations
■488190Other Support Activities for Air Transportation

Clearly Texas is again on top with four and a half times the number of jobs as Georgia. This difference in air transportation support jobs between Georgia and Texas is much larger than found above for NAICS 481.

Figure 2.11. NAICS 4881 Jobs by Key State

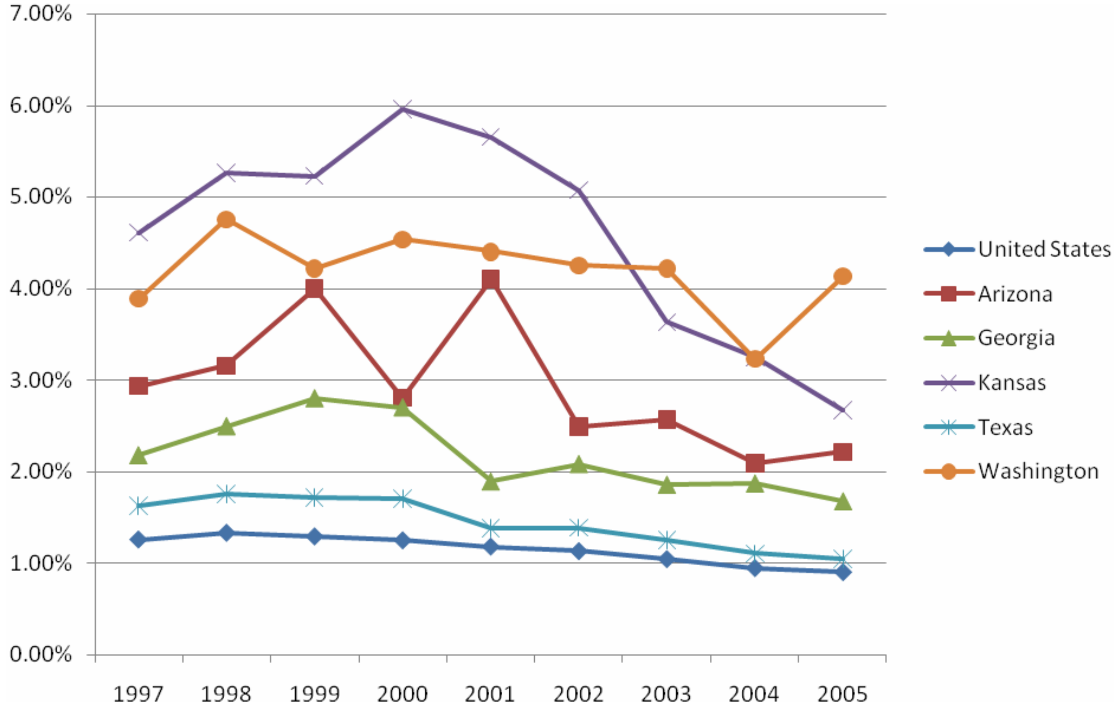


Source: U.S. Bureau of Labor Statistics

We have also provided a comparison of these states in terms of the percent of the state's economy, i.e., GDP, that the aerospace industry represents. These percentages are shown in Figure 2.12 along with benchmark values for the U.S. Each percentage is based upon two industries that most closely represent the aerospace industry – other transportation equipment manufacturing and air transportation. The former includes more than just aircraft production and parts but it does not include automobile manufacture and parts. Unfortunately, more precise GDP estimates are not available.

All state GDP percentages are above the U.S. percentages but Texas' values are only slightly above the national figures. It is difficult to say much more about these percentages because of the mix of non-aerospace industries in these percentages. Also, the importance of each of the two industry segments differs from state to state. For Georgia, air transportation's contribution to GDP has been falling since 2003 while the contribution of other transportation equipment manufacturing has been rising. However, air transportation's contribution is still greater at about 55 percent of the two combined. We note that the last measurement (2005) was taken when Georgia's air transportation services industry was at its trough in terms of its economic vitality. GDP percentages reported for 2007 may well present a more robust perspective on this sector.

Figure 2.12. Percentage of Gross Domestic Product Accounted for by the Aerospace Industry: Georgia and Benchmark States



Source: US Bureau of Economic Analysis

Georgia's Aerospace Industry

The state's aerospace manufacturing industry is mostly dependent on defense contracts which go primarily to Lockheed Martin in Cobb County and Boeing in Houston County. In previous sections, Georgia's aerospace industry was compared to other states and several statistics were compiled to provide insight into their differences. In this section, the state's aerospace industry will be examined in more detail with data that is available for Georgia but could not be obtained from the other states.

Figure 2.13 below breaks down statewide jobs in NAICS 3364 into its six-digit parts. As the chart shows, the state has no presence in guided missile and space vehicle manufacturing and very little in parts and propulsion units. The other three segments are related to aircraft production and/or parts. Figure 2.14 shows average weekly wages for each of these components in the state for 2006. The average weekly wage for all of manufacturing in the state is $849 and for all jobs, both private sector and government, is $776. Clearly, aerospace manufacturing jobs are high-wage jobs and should be promoted as much as possible. NAICS 336412 and 336413 are not as desirable from an average wage standpoint, but these industries contribute to the overall cluster and strengthen the main industry – 336411 – by having a strong presence in the state. The state lacks a strong presence of the guided missile and space vehicle manufacturing industry. The prospect of expanding this industry's presence cannot be determined in this research, but further investigation of the industry may be warranted.

Figure 2.13. NAICS 3364 Breakdown for Georgia-2006

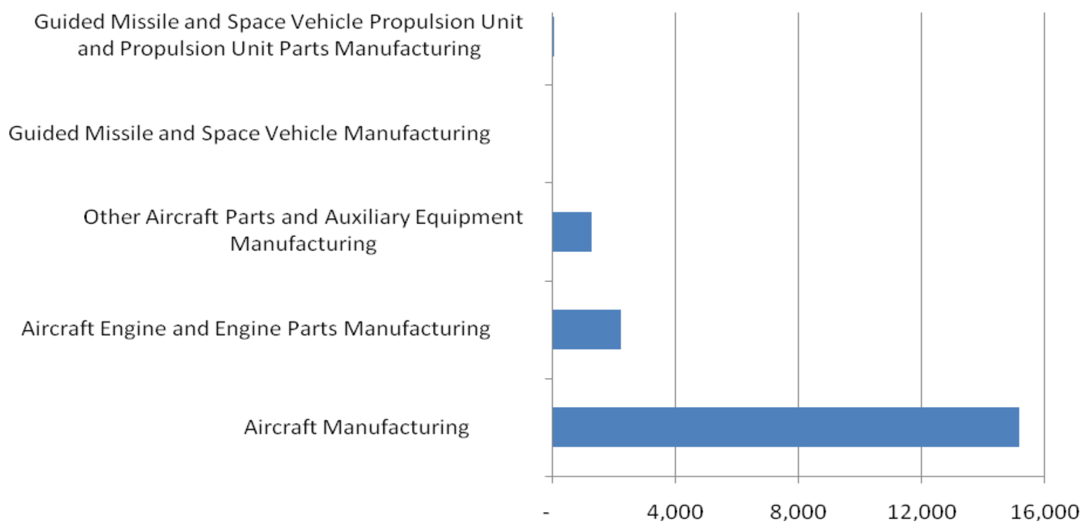
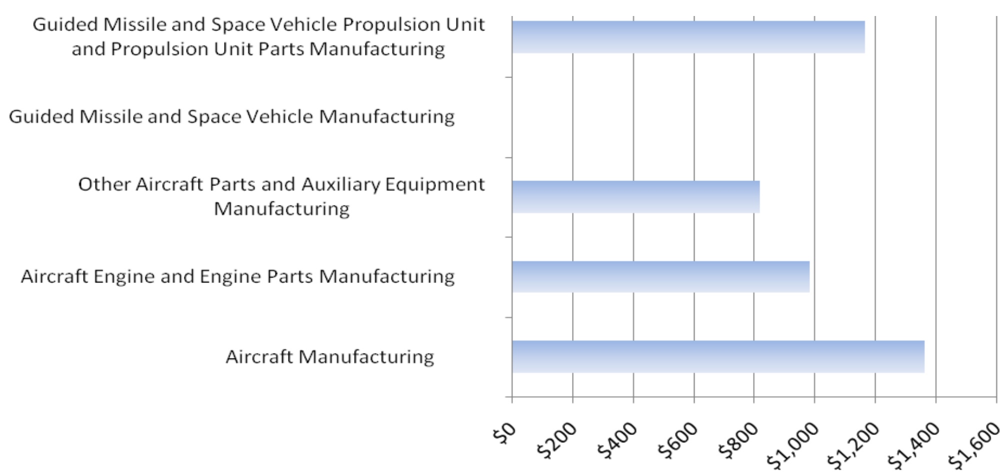


Figure 2.14. Average Weekly Wages by Component: Georgia 2006



Source: US Bureau of Labor Statistics, 2007.

Earlier, the concept of a location quotient was introduced and values were calculated for the core and related industry segments for each of the top ten aerospace states. Georgia's aerospace industry components can be broken down into smaller pieces and location quotients can be calculated for each piece to provide a more detailed look at the state's strengths. Table 2.2 shows the location quotients and average weekly wages for each six-digit industry in the core aerospace segment.

Table 2.2: Georgia Location Quotients by Detailed Core Industry and Average Weekly Wages for Georgia and the U.S.

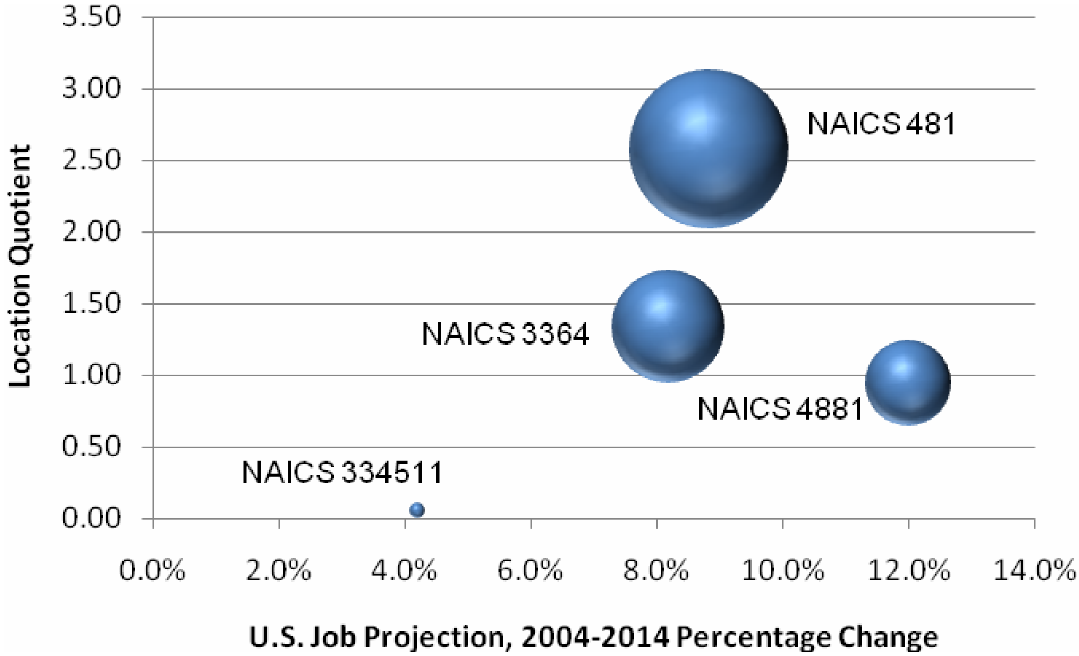
NAICS Code	Title	LQ	Georgia AWW	U.S. AWW
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Mfg	0.04	$977	$1,671
336411	Aircraft Manufacturing	2.29	$1,382	$1,626
336412	Aircraft Engine and Engine Parts Manufacturing	0.90	$917	$1,371
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing	0.47	$815	$1,116
336414	Guided Missile and Space Vehicle Manufacturing	0.00	$0	$1,883
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	0.14	$1,340	$1,347
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	0.00	$0	$1,476
481111	Scheduled Passenger Air Transportation	2.88	$1,004	$1,044
481112	Scheduled Freight Air Transportation	0.82	$837	$1,032
481211	Nonscheduled Chartered Passenger Air Transportation	0.85	$861	$1,162
481212	Nonscheduled Chartered Freight Air Transportation	0.29	$1,079	$1,019
481219	Other Nonscheduled Air Transportation	0.05	$1,746	$1,020
488111	Air Traffic Control	2.07	$685	$1,188
488119	Other Airport Operations	0.79	$549	$514
488190	Other Support Activities for Air Transportation	1.04	$838	$895

Source: Georgia Department of Labor and the U.S. Bureau of Labor Statistics

The importance of Atlanta's airport is evident in the passenger-related NAICS 481111 and the air traffic control industry. Average weekly wages in Georgia are mostly below the U.S. averages except for NAICS 481212, 481219, and 481119. The high location quotient for aircraft manufacturing (2.29) and the low location quotients for its supplier industries in the 3364 industry – 336412 and 336413 – indicate potential room for growth in these two industries. It does not necessarily mean that new firms in these industries can only be recruited based on the potential to sell to the state's aerospace manufacturing firms. The availability of a trained and specialized aerospace workforce is also an important recruitment tool.

Another way to gauge the value of these industries is through a bubble chart that compares the location quotient to U.S. employment projections. Industries with high location quotients and high projections for job growth are strong industries that should be nurtured to expand in the state. Figure 2.15 below shows such a chart after aggregating six-digit industries to the same level found in the job growth projections. The size of each bubble indicates the relative size of each industry in the state, based on jobs in 2006.

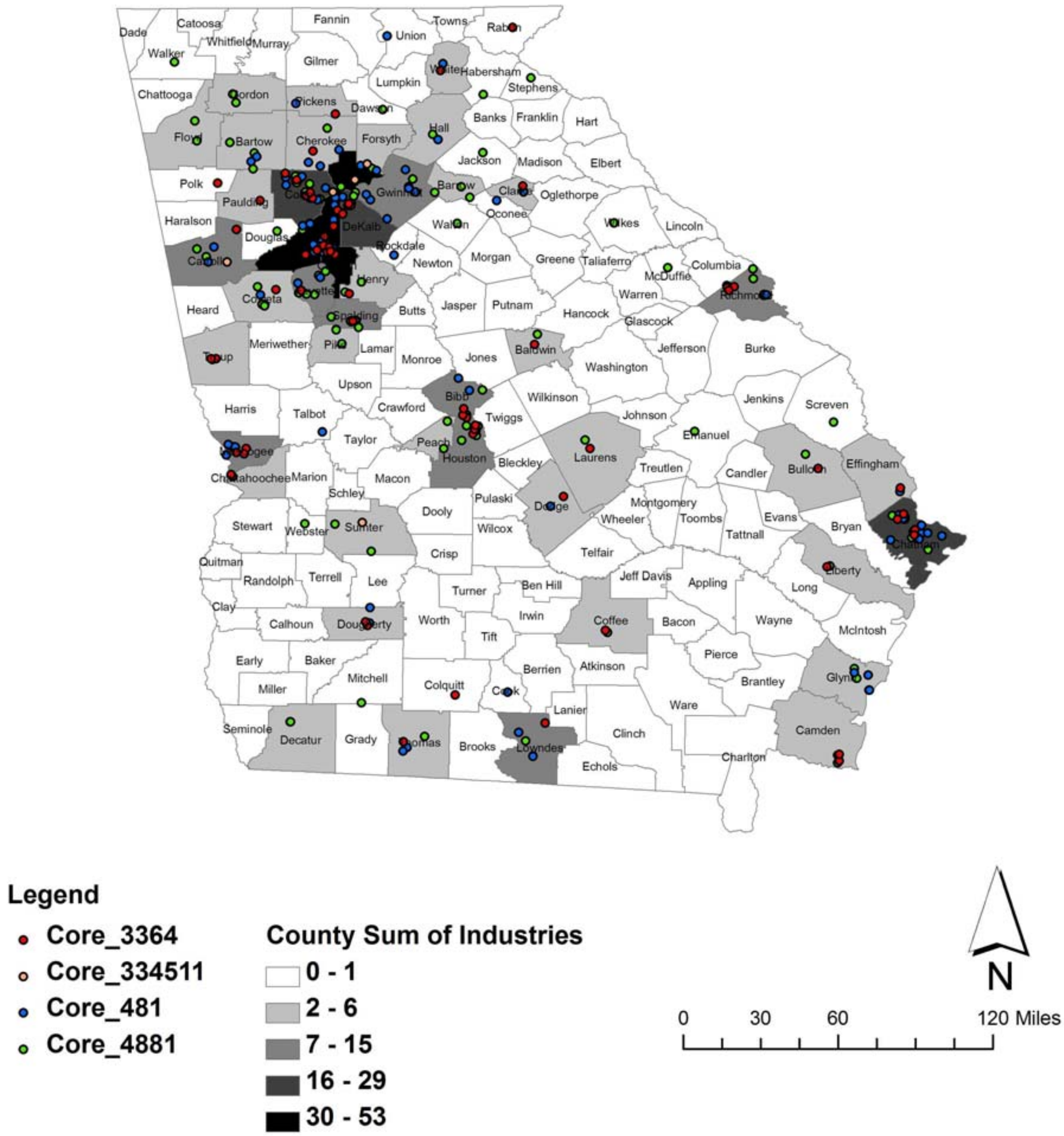
Figure 2.15 US Employment Projections and Location Quotients by Aerospace Industry Segments



Source: US Bureau of Labor Statistics, 2007

The location of the state's aerospace establishments is of interest in identifying geographic concentrations. Figure 2.16 provides a map of the state showing the location of all the core aerospace establishments in the state. Each subgroup is color coded and exact locations are not always possible because of limitations in the address information researchers acquired. Based on the map, there appear to be sizable concentrations of core establishments in the Columbus, Macon, and Savannah areas, as well the Atlanta metropolitan area.

Figure 2.16. Location of Core Aerospace Establishments in Georgia.



Upstream Industries to NAICS 3364

Using the supplier-industry information from the national input-output use matrix (mentioned above), the following table shows all supplier industries to 3364 that provide at least 1 percent of the industries requirements of intermediate products and services. As the table shows, two components of NAICS 3364 – 336412 and 336413 – are suppliers to 336411. NAICS 334511 provides a little over 10 percent of the industries requirements, which is why it was included in this study's aerospace definition.

The information in Table 2.3 can be used to examine the presence of key suppliers to the aerospace manufacturing industry in the state. However, the main suppliers are from the core aerospace segment which has been thoroughly examined above. These three manufacturing industries – 334511, 336412, 336413 – all have a presence in the state. Others, such as wholesale and management of companies and enterprises, rank high in nearly all manufacturing industry use tables and therefore, are of little value for further examination.

Whether it makes sense to pursue recruitment of more companies in these three supplier manufacturing industries based on the demand from 336411 cannot be determined without examining whether the firms in these three supplier industries indeed sell to firms in the purchasing industry (336411). However, even if supplier firms are not greatly supporting the demand from firms in the purchasing industry, the workforce in these industries is a valuable part of the "cluster" of aerospace companies in the state. Firms tend to locate where they can find skilled labor with the experience they need. The pool of aerospace manufacturing workers in the state, which number over 18,500, represent an attractive pool of labor for new or expanding firms.

Table 2.3. Top 10 Suppliers to NAICS 336411 - National Use Matrix

I-O Code	Title	Percentage
336413	Other aircraft parts and equipment	22.5%
336412	Aircraft engine and engine parts manufacturing	16.1%
334511	Search, detection, and navigation instruments	10.3%
420000	Wholesale trade	5.5%
33441A	All other electronic component manufacturing	3.6%
550000	Management of companies and enterprises	2.7%
334413	Semiconductors and related device manufacturing	2.5%
334220	Broadcast and wireless communications equipment	1.8%
32619A	Plastics plumbing fixtures and all other plastics products	1.6%
481000	Air transportation	1.4%
332910	Metal valve manufacturing	1.3%
541300	Architectural and engineering services	1.3%
33451A	Watch, clock, and other measuring and controlling device manufacturing	1.2%
541100	Legal services	1.1%
52A000	Monetary authorities and depository credit intermediation	1.0%

Source: U.S. Department of Commerce, Bureau of Economic Analysis Web site

Innovation in the Aerospace Industry

The aerospace industry is very technology driven. Although supply chains are the predominant factor of the positioning of the industry, there is still considerable patenting activity around it as well. The Commission on the Future of the US Aerospace Industry (2002, Chapter 9) notes that ongoing innovation is critical to the development and strength of the industry.

Patenting is among the most common measure of innovation. Even acknowledging weaknesses in the use of patents as a measure of innovation, such as that patents are only one measure of innovation and that not all patents are commercialized, still patents represent an independent measure of innovations that are new, non-obvious, and have the possibility of being utilized in application. The US patent classification system has a class specifically devoted to the industry: **US Class 244, Aeronautics and Astronautics**. Although the aerospace industry may draw from other patent classes, Class 244 is a good proxy for innovation as measured by patents, in this industry. Patent class 244 alone accounted for 1.1 percent of all utility patents at the US Patent and Trade Office (USPTO) from 1990-2007 (September). This figure is higher than the overall share of the industry based on GDP in 2005, suggesting that innovation is important to the industry.

Georgia appears to be undersubscribed in terms of patents in US Class 244. The state has 71 patents granted in this class in the time period 1990-2007 (September). Patents awarded in Class 244 account for 0.8 percent of all Georgia patent awards. So the state's innovation-related position in the aerospace industry is much lower than its position in the industry based on GDP. The titles of these patents are listed in Appendix 2.

One limiting factor in Georgia's aerospace patent situation is the lack of private sector R&D activities. Of the 71 patents granted in Class 244 with a Georgia connection in the time period 1990 to 2007 (September), virtually all of these patents were the result of the work of Georgia-based inventors. However, only 20 were granted to "assignees" or organizations to which ownership of the patent was assigned at the time the patent was granted. Of these patents, nine were granted to Georgia Tech and two were granted to Gulfstream Aerospace Corporation in Savannah. The remaining nine patents were granted to nine different companies.

This lower ranking of Georgia in terms of Aerospace related patents in Class 244 is further observed in Table 2.5. Table 2.5 shows the number of patents based on residence of the first-named inventor listed on the patent grant for the years 2001 through 2005. The list is headed by California, Washington, and Texas. Georgia ranked 18th in terms of patents in this list, despite its fifth-place ranking on core aerospace-related employment. These data suggest that the innovation area provides an opportunity for strengthening of Georgia's aerospace positioning.

Table 2.4. Granted Patents in US Class 244, Aeronautics and Astronautics by Location of the first-named Inventor by State: 2001 to 2005.

State/Territory	2001	2002	2003	2004	2005	Total
California	94	89	91	74	62	410
Washington	29	23	30	44	49	175
Texas	23	30	25	17	11	106
Arizona	15	20	15	19	19	88
Florida	9	10	11	11	10	51
New York	10	7	10	11	12	50
New Jersey	9	10	8	10	9	46
Connecticut	10	11	7	8	7	43
Virginia	7	8	7	11	7	40
Ohio	18	7	6	5	3	39
Maryland	6	13	8	5	5	37
Missouri	4	4	6	13	8	35
Massachusetts	10	3	14	2	4	33
Pennsylvania	5	3	10	10	3	31
Colorado	5	8	10	3	4	30
Alabama	5	4	4	5	7	25
Illinois	5	2	2	8	6	23
Georgia	2	5	3	4	3	17
North Carolina	5	3	2	4	3	17
Kansas	3	2	2	4	4	15
Indiana	5	1	3	2	1	12
Utah	3	2	0	4	2	11
Michigan	3	6	0	1	0	10
Minnesota	0	2	3	3	2	10
New Hampshire	0	1	4	2	3	10
Iowa	0	1	4	0	1	6
Nevada	1	1	1	0	3	6
New Mexico	3	2	0	0	0	5
Wisconsin	3	0	0	1	1	5
Arkansas	2	2	0	0	0	4
District of Columbia	1	2	0	1	0	4
Kentucky	1	1	0	1	1	4
Oklahoma	2	0	1	0	1	4
Hawaii	1	1	1	0	0	3
Louisiana	0	0	0	1	2	3
Maine	1	2	0	0	0	3
Oregon	0	1	1	0	1	3
Rhode Island	0	2	0	1	0	3
Tennessee	2	1	0	0	0	3
West Virginia	1	1	0	0	1	3
Alaska	1	0	1	0	0	2
Idaho	0	0	1	0	1	2
South Carolina	0	0	0	2	0	2
Wyoming	0	0	1	1	0	2

State/Territory	2001	2002	2003	2004	2005	Total
Delaware	1	0	0	0	0	1
Mississippi	1	0	0	0	0	1
Montana	1	0	0	0	0	1
North Dakota	0	0	0	0	1	1
Nebraska	0	0	1	0	0	1
Puerto Rico	0	0	1	0	0	1
Vermont	0	1	0	0	0	1
Total US	307	292	294	288	257	1438

Source: U.S. Bureau of Labor Statistics, 2007

Summary

Georgia is a solid player in the aerospace sector and there is room to build on that strength. The state is somewhat more specialized in aerospace than the nation but not substantially so. Georgia is projected to be rather more competitive than the nation in its ability to add aerospace jobs through 2014. The state may be bucking slower national trends because of its advantageous position to population growth centers, particularly those in the Southeast from Virginia, the Carolinas, Florida, and west beyond the Mississippi.

National growth rates, which are less robust than those projected for Georgia, may presume that aerospace is becoming more efficient and therefore needs less low end employment. One strategy to counter this trend may be to focus on the high end management level positions. If the state is perceived to be good at managing aerospace and developing and adopting relevant technologies, more companies may be attracted to Georgia. This high end strategy calls for a good educational underpinning.

Chapter
3

Aerospace Firms and Demand for Knowledge Workers in Georgia

This chapter will examine the current demand for aerospace services, with a particular emphasis on employment implications. As we indicated in Chapter 1, there is no single aerospace industry. As a result, there is no simple relevant analytic approach. We will uncover the demand for aerospace through several methods, with this chapter focusing on present needs for college-educated knowledge workers in the aerospace field.

Measuring Current Demand

We measure current demand for aerospace-related employment by developing an inventory of job advertisements for open positions in Georgia. We use the following sources of data for this analysis: (1) job advertisements registered on the Web pages of firms in our core industrial classifications (3364, 334511, 481, 4881) with 20 or more employees, (2) 70 additional relevant job titles in monster.com with open positions in Georgia that were not already advertised on the firms' individual sites. All data were collected in July and early August of 2007.

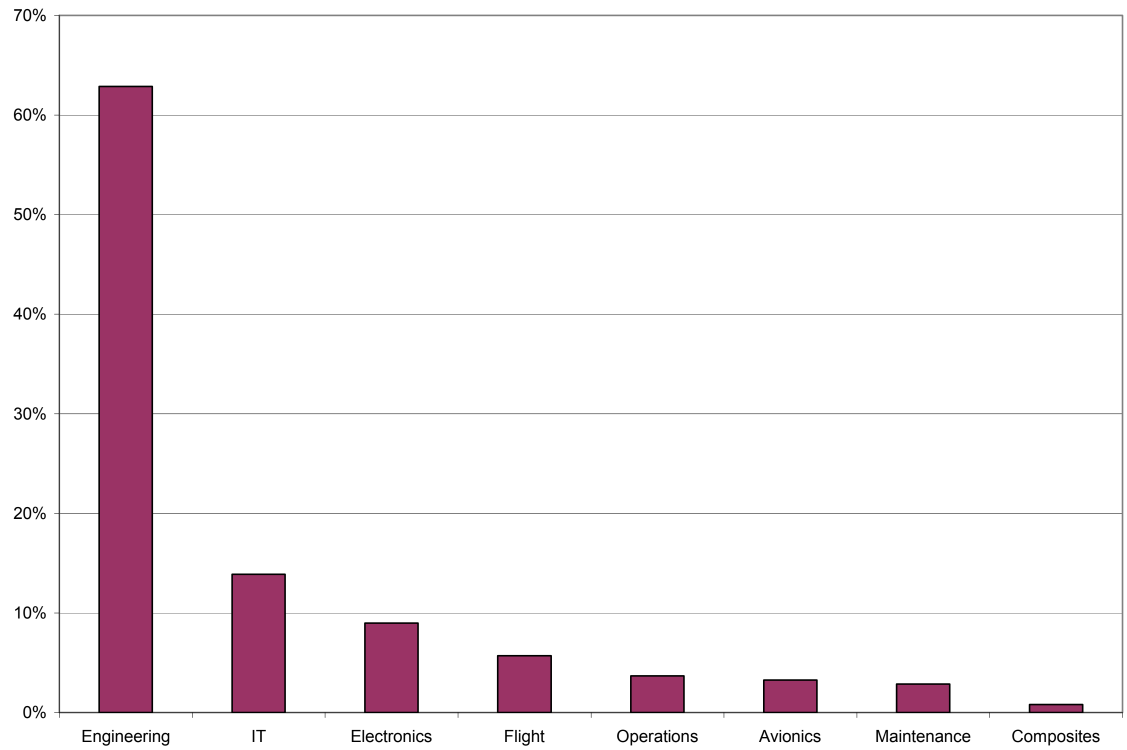
There were 245 advertisements from 26 companies for aerospace-oriented positions in Georgia that required at least some postsecondary education. We set this educational bar because we wanted to focus on the jobs most relevant to USG programs. This includes some postsecondary education such as two-year degrees and certifications. However, it excludes openings for cross-cutting positions found in most industries such as human resources and positions that lack an educational requirement beyond the high school level such as security guard. At the same time, some advertisements did not specify an educational requirement, but really appeared to require at least some college, so we did include these in our database. The 100 companies are listed in Appendix 3 and specific job titles in Appendix 4.

These advertisements are illustrative but by no means do they constitute all aerospace-related jobs in Georgia for college-educated workers. Some positions are filled through word-of-mouth or unadvertised searches for talent. This is particularly the case for the highest level of jobs requiring the most experience. Nevertheless this knowledge base is helpful in illuminating the types of knowledge workers for which the aerospace industry is advertising today.

Occupational Category

Company advertisements for aerospace positions requiring some postsecondary education were classified into occupational categories based on their job title and job description. Sixty-three percent of the advertised positions involved engineering. About 14 percent involved information technology, and 9 percent dealt with electronics. Occupations involving flight, operations, avionics, and maintenance were also advertised. In short most of the positions in our occupational database were for jobs that require some technical capabilities. (See Figure 3.1.)

Figure 3.1. Nearly Two-thirds of the Aerospace Related Job Openings Involve Engineering



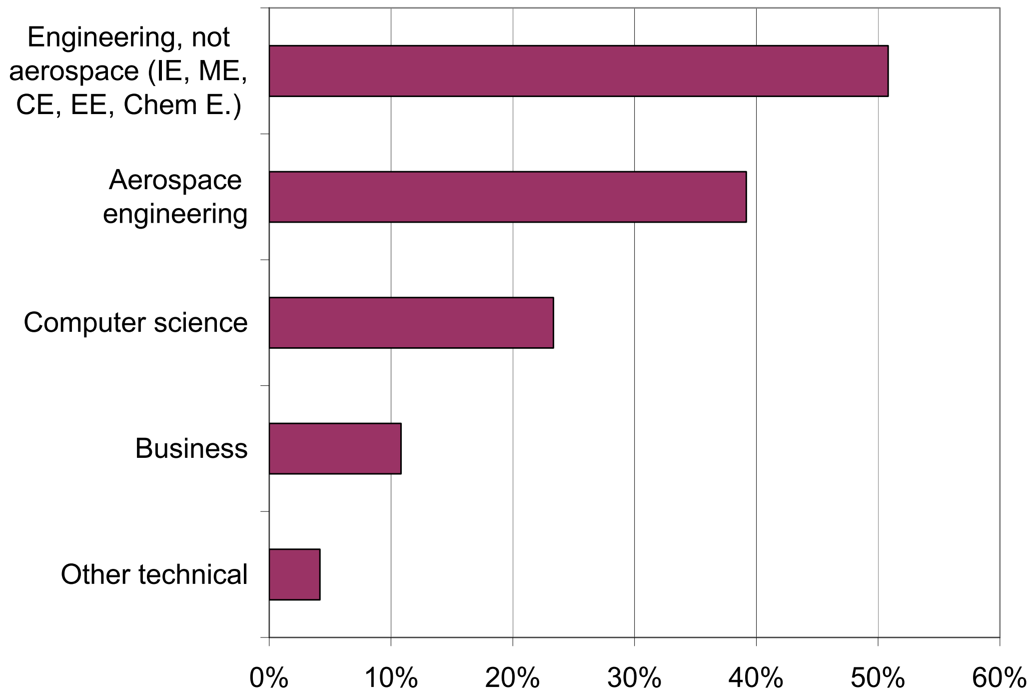
Source: Georgia Tech Survey of 245 aerospace-related openings, July/August 2007.

Educational Level and Major Area

A formal education requirement was the primary criterion for selection of the job advertisements in our database so it is not surprising that such a requirement would be predominant. The large majority – 87 percent – of our job openings had bachelor's degree requirements. Two year degrees were referenced in 7 percent of the job advertisements. Masters degrees were uncommon, with only one position having this requirement.

We further examined the types of majors that aerospace companies indicated in their job advertisements. Although many advertisements do not specify a major area of concentration in their requirements, nearly 50 percent of the advertisements did list one or more majors or academic concentrations that they expect. Some of these advertisements specified only one specialization. Others listed as many as four. The areas of academic concentration fell into four categories: aerospace engineering – 39 percent of job advertisements that list a major requirement; other types of engineering (e.g., industrial, mechanical, civil) – 51 percent; computer science – 23 percent; and business – 11 percent. These percentages exceed 100 percent because of the multiple major references in many of the job advertisements. These percentages show that although there is some demand for aerospace-related business functions, there is strong demand for specific technical capabilities.

Figure 3.2. Experience Requirements in College-Level Aerospace-Related Job Advertisements



Source: Georgia Tech Survey of 245 aerospace-related openings, July/August 2007.

Table 3.1. shows detailed academic specialization requirements in recent aerospace-related job advertisements. The most common detailed specialization requirements were computer science degrees, aerospace specializations, finance, and accounting.

Table 3.1. Engineering, Information Technology, and Business Academic Specialization Requirements
(specializations with 2 or more references are listed below)

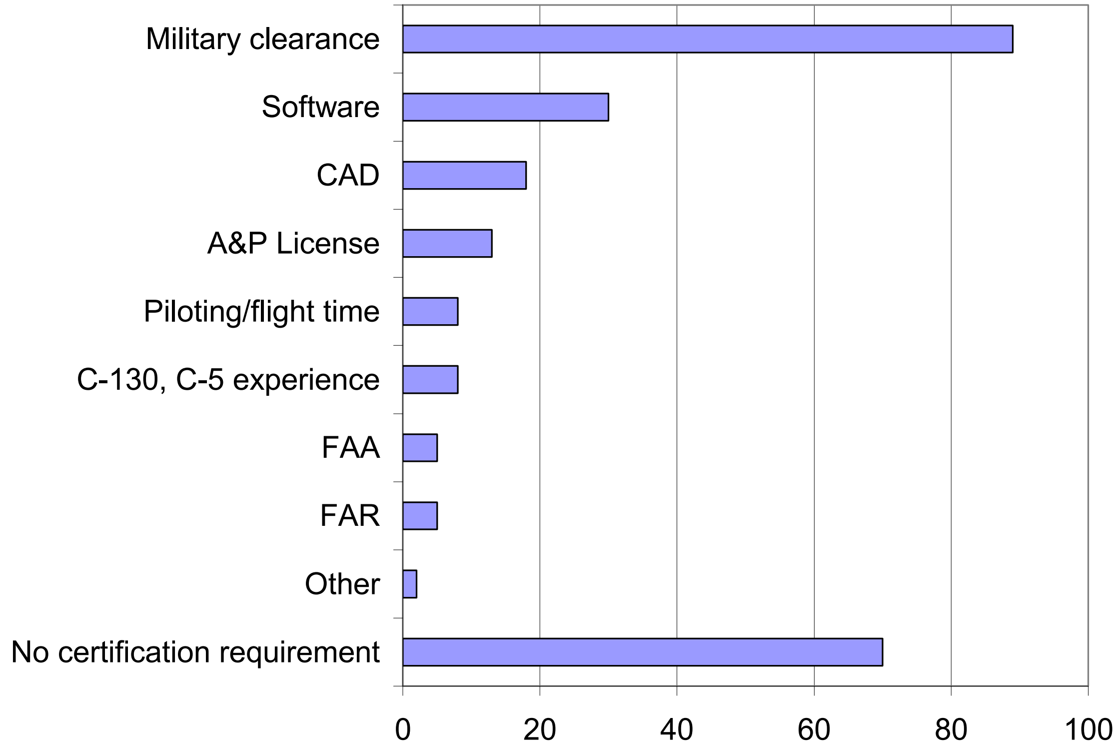
Academic Specialization	Number of Advertisements
Aerospace Engineering	47
Electrical Engineering	45
Mechanical Engineering	30
Computer Science	26
Civil Engineering	12
Industrial Engineering	12
Business	6
Chemical Engineering	4
Finance	3
Mathematics	3
Statistics	3
Management	2
Electronics	2
Doesn't specify	125

Source: Georgia Tech Survey of 245 aerospace-related openings, July/August 2007.

Certification Requirements

Certifications are especially important in this industry. More than 70 percent of all current job openings called for some type of certification. **Military clearance was required in 36 percent of all jobs** and more than half of all jobs with some type of certification. Also common were proven skills in certain programming languages or computer aided design (CAD) software. Airframe & PowerPlant (A&P) licenses were a requirement for 5 percent of all openings. Also mentioned were flight time requirements, experience with certain types of airplanes, other FAA certifications (i.e., medical, structural), Federal Aviation Regulation certifications, and the like. Specific certifications required are shown in Appendix 5.

Figure 3.3. Certification Requirements in College-Level Aerospace-Related Job Advertisements
(Numbers of Advertisements are Shown)



Source: Georgia Tech Survey of 245 aerospace-related openings, July/August 2007.

Experience

Aerospace is a field that requires college-educated candidates to have industry experience. The level of experience specified in these aerospace-industry job openings tends to be higher than we have seen for other occupations. The mean experience requirement is 6 years. Twenty percent of all jobs required 5 years of experience and 42 percent had experience requirements of more than 5 years.

Experience levels differ based on the type of job being advertised. Engineering jobs were more likely to have higher experience requirements than jobs in the IT, business, or other technical occupations. (See Figure 3.5.)

Figure 3.4. Experience Requirements in College-Level Aerospace-Related Job Advertisements
(Numbers of Advertisements are Shown)

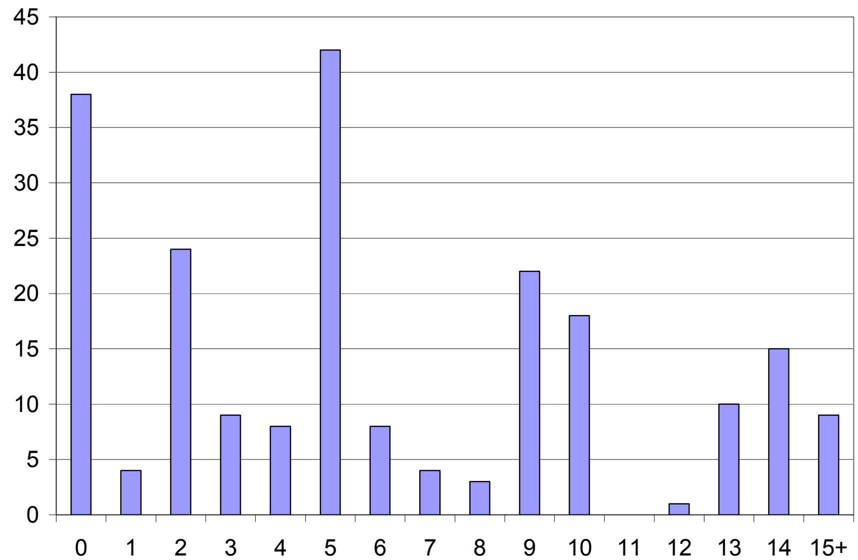
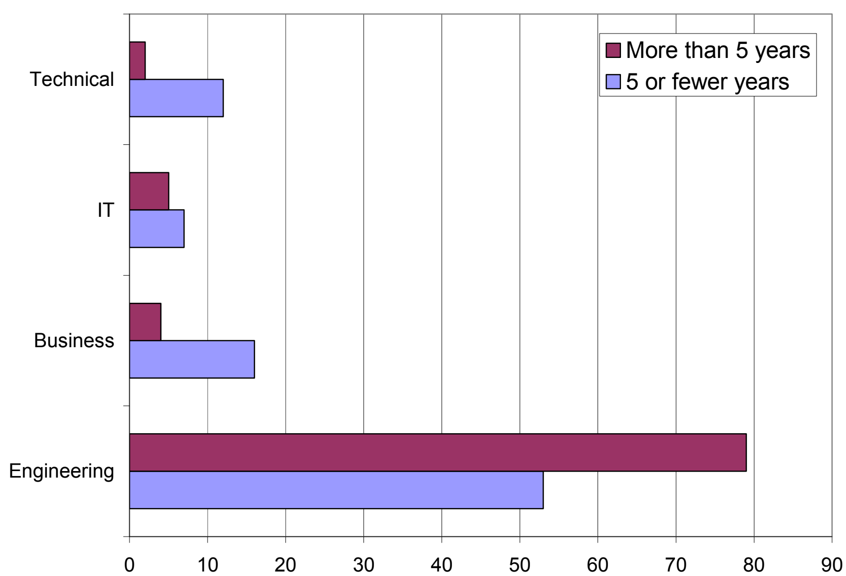


Figure 3.5. Experience Requirements in Aerospace Job Advertisements by Type of Job
(Numbers of Advertisements are Shown)



Source: Georgia Tech Survey of 380 aerospace-related openings, April/May 2005.

Summary

This chapter suggests that there is current demand for employment at the college level. We identified 245 position advertisements for college-level aerospace workers. Most of these advertisements require a bachelor's degree. Academic specializations called for in aerospace-related job advertisements tended to be highly technical in aerospace, other engineering or IT disciplines. Military clearance was specified in 36 percent of the positions and other certifications were also prominent. Most of these jobs had a strong emphasis on work experience, particularly for positions in engineering fields.

Chapter

4

Supply of Aerospace Graduates

There were some 250 aerospace-related job openings in Georgia that require postsecondary educational training. This chapter examines the offerings of the state's public and private postsecondary educational system to supply graduates for these job openings.

The academic major or primary field forms the basis for any analysis of the supply of aerospace graduates. Academic majors or primary fields of study that lead to degrees or certificates are constructed around what is called the classification of instructional programs (CIP). CIPs are hierarchically structured to organize similar fields of study into the same major grouping. This classification system has more than 660 CIPs. It is from this listing that we discern which CIPs are most directly germane to the aerospace industry.

What is a Aerospace Instructional Program

There is not a straightforward definition of what is an aerospace instructional program. Several CIPs have the term aerospace or airline in their titles, for example: 14.0201 - Aerospace, Aeronautical and Astronautical Engineering; 15.0801 - Aeronautical/Aerospace Engineering Technology/Technician; and 49.0102 - Airline/Commercial/Professional Pilot and Flight Crew. However, just focusing on these CIPs does not provide a sufficiently comprehensive view of educational program offerings. We used the job advertisement analysis in Chapter 3 to inform our definition of what constitutes a core instruction program for the aerospace industry. The advertisement analysis indicated that instructional programs should have a prominent technological content and, with the exception of engineering, be relatively narrowly focused on engineering. One rule was that educational programs in the miscellaneous catch-all categories were excluded. The final set of core aerospace programs includes 9 CIPs. (See Table 4.1) We acknowledge that there certainly are some important related occupations such as finance, human resources, management, and IT that have relevance to the industry, but these are broadly pertinent to most industries. Our aim in this section is to profile the most significant and directly relevant educational programs for the aerospace industry.

Table 4.1. Core Academic Majors for the Aerospace Industry

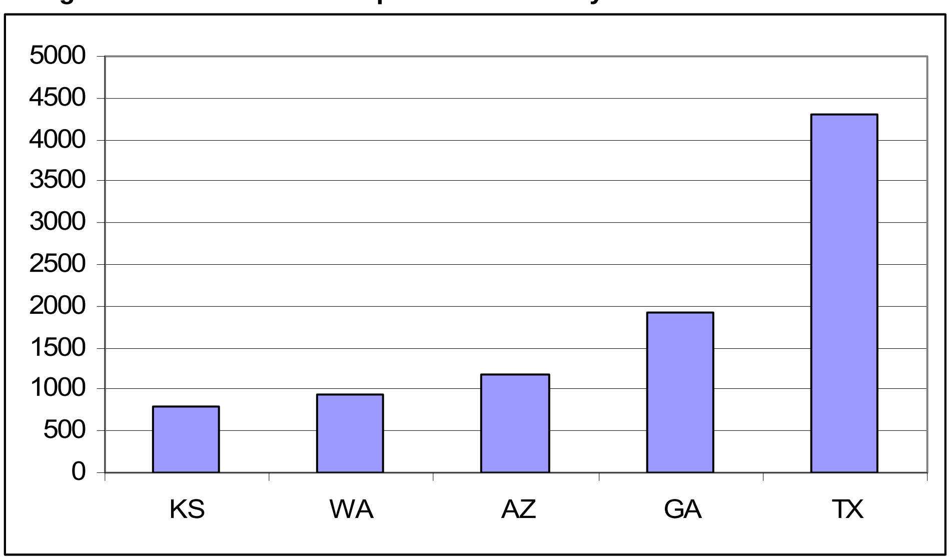
CIPCODE	CIP Description
14.0201	Aerospace, Aeronautical and Astronautical Engineering
14.1001	Electrical, Electronics and Communications Engineering
14.1901	Mechanical Engineering
14.3501	Industrial Engineering
15.0801	Aeronautical/Aerospace Engineering Technology/Technician
47.0607	Airframe Mechanics and Aircraft Maintenance Technology/Technician
47.0608	Aircraft Powerplant Technology/Technician
47.0609	Avionics Maintenance Technology/Technician
49.0102	Airline/Commercial/Professional Pilot and Flight Crew

Source: National Center for Educational Statistics and author analysis.

Top U.S. Aerospace Programs

We obtained information on graduates (or "completions" as the National Center for Education Statistics calls them) by CIP for all public and private postsecondary institutions in the country. We then procured the number of graduates by program in these CIPs for 2003, 2004, and 2005 and averaged the result. There were more than 61,260 graduates of aerospace programs in the United States annually averaged over the 2003-2005 time period. Relative to the aerospace-intensive benchmark states, Georgia has the second highest number of graduates, with Texas in the lead, having more than 4000 graduates in aerospace-related fields of study annually in the 2003 to 2005 time period.[4] (See Figure 4.1).

Figure 4.1. Number of Aerospace Graduates by Benchmark State



Source: National Center for Educational Statistics. Numbers of graduates are annual averages over the 2003-2005 time period.

[4] California has the largest number of aerospace graduates – more than 7000 annually over the 2003 to 2005 time period..

More than 600 programs graduated at least 25 students as an annual average during the 2003 to 2005 time frame. These programs are listed in Appendix 6. Figure 4.2 maps the location of all schools with over 250 annual aerospace grads. The magnitude of graduates in the aerospace programs at a particular institution is symbolized in proportionally-sized circles. The map shows that most of the large aerospace programs are located east of the Mississippi, in Florida, Michigan, New York, Pennsylvania, Alabama, Massachusetts, Ohio, Illinois, Georgia, and Indiana. West of the Mississippi, there are also clusters of aerospace graduates in California and Texas.

The top **Aerospace, Aeronautical and Astronautical Engineering** programs by annual average numbers of graduates over the 2003-2005 time period were:

■Georgia Tech (180 graduates)

■Purdue University (165 graduates).

■MIT (151 graduates)

■University of Colorado - Boulder (122 graduates)

■University of Michigan (121 graduates)

■Embry Riddle Aeronautical University-Daytona Beach (115 graduates)

The top **Aircraft Powerplant Technology/Technician** programs in aerospace by number of graduates were at:

■Community College of the Air Force – Alabama (624 graduates)

■Redstone College – Colorado (239 graduates)

■Michigan Institute of Aviation and Technology (169 graduates)

And the top **Avionics Maintenance Technology/Technician** programs in aerospace by number of graduates were at:

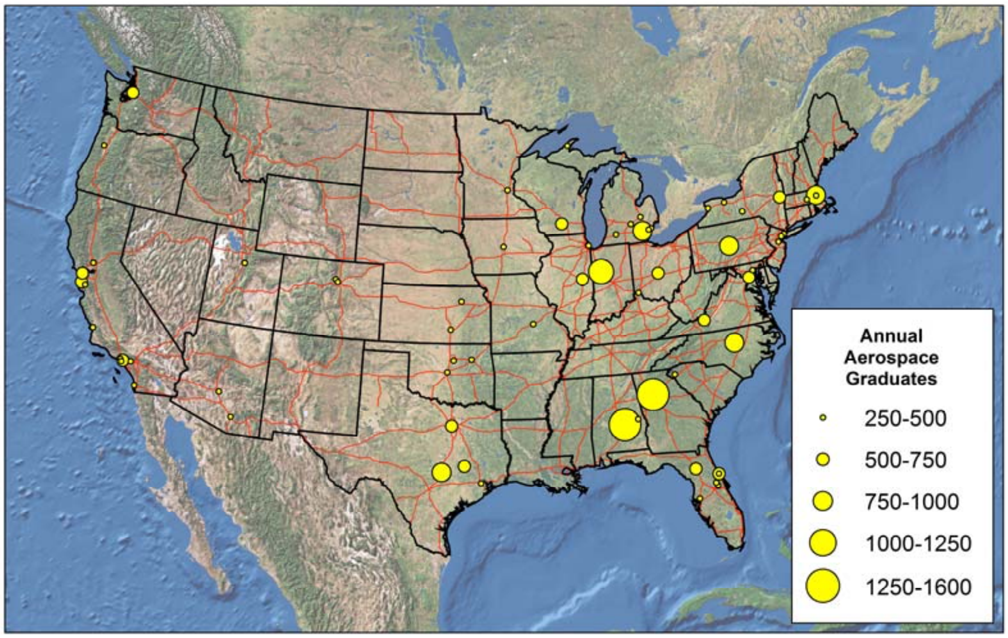
■Community College of the Air Force – Alabama (507 graduates)

■Metro Technology Centers – Oklahoma (256 graduates)

■Hallmark Institute of Technology – Texas (113 graduates)

Figure 4.2. Map of Large US Aerospace Educational Programs at Postsecondary Educational Institutions

(Circles Represent the Location of Institutions with Aerospace programs and are Proportionally Sized based on Average Number of Graduates in 2003-2005 time period)



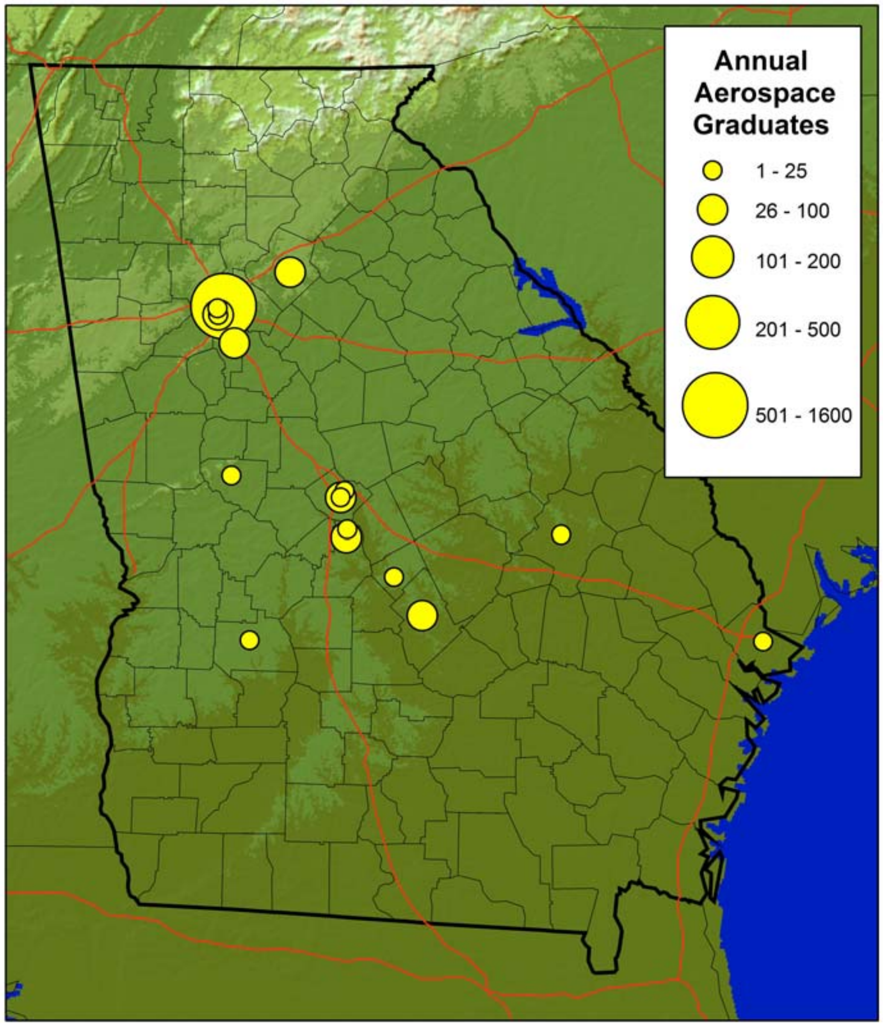
Source: National Center for Educational Statistics.

Georgia's Relative Position

Georgia averaged **more than 1900 graduates** in the core aerospace CIPs over the 2003-2005 time period. Georgia graduates in the core aerospace specializations came from 18 institutions across the state. Figure 4.3 displays these institutions geographically. Again, the proportionally-sized circles represent the magnitude of graduates in all aerospace programs at a particular institution. The map shows that most of the programs reside in Atlanta, but supply also can be seen throughout the state.

Figure 4.3. Map of Aerospace Education Programs in Georgia at Postsecondary Educational Institutions

(Circles Represent the Location of Institutions with Aerospace programs and are Proportionally Sized based on Number of Graduates)



Source: National Center for Educational Statistics.

The five largest programs that served a broad population (e.g., were not on a military base) were: Georgia Tech, Georgia Aviation & Technical College, Aviation Institute of Maintenance-Atlanta, Middle Georgia Technical College, Central Georgia Technical College, Clayton State University, and Atlanta Technical College. The particular aerospace-related majors offered by the major Georgia colleges and universities are further detailed in Table 4.2.

Table 4.2. Georgia Institutions, Aerospace Instruction Program, and Number of Graduates

Institution	CIP Description	Grads.**
Atlanta Technical College	Aircraft Powerplant Technology/Technician	60
Atlanta Technical College	Avionics Maintenance Technology/Technician	8
Atlanta Metropolitan College	Aircraft Powerplant Technology/Technician	1
Clark Atlanta University	Electrical, Electronics and Communications Engineering	1
Clayton State University	Airframe Mechanics and Aircraft Maintenance Technology/Technician	26
Clayton State University	Aircraft Powerplant Technology/Technician	15
East Georgia College	Airline/Commercial/Professional Pilot and Flight Crew	1
Georgia Institute of Technology-Main Campus	Aerospace, Aeronautical and Astronautical Engineering	180
Georgia Institute of Technology-Main Campus	Electrical, Electronics and Communications Engineering	608
Georgia Institute of Technology-Main Campus	Mechanical Engineering	468
Georgia Institute of Technology-Main Campus	Industrial Engineering (NEW)	280
Georgia Southwestern State University	Aircraft Powerplant Technology/Technician	1
Georgia Southwestern State University	Avionics Maintenance Technology/Technician	1
Middle Georgia Technical College	Airframe Mechanics and Aircraft Maintenance Technology/Technician	34
Middle Georgia Technical College	Aircraft Powerplant Technology/Technician	20
Central Georgia Technical College	Airframe Mechanics and Aircraft Maintenance Technology/Technician	33
Macon State College	Airframe Mechanics and Aircraft Maintenance Technology/Technician	1
Mercer University	Electrical, Electronics and Communications Engineering	13
Mercer University	Mechanical Engineering	1
Middle Georgia College*	Airframe Mechanics and Aircraft Maintenance Technology/Technician	1
Middle Georgia College*	Aircraft Powerplant Technology/Technician	1
Middle Georgia College*	Airline/Commercial/Professional Pilot and Flight Crew	4
Savannah Technical College	Airframe Mechanics and Aircraft Maintenance Technology/Technician	5
South Georgia Technical College	Airframe Mechanics and Aircraft Maintenance Technology/Technician	11
South Georgia Technical College	Aircraft Powerplant Technology/Technician	8
South Georgia Technical College	Avionics Maintenance Technology/Technician	4
Flint River Technical College	Airframe Mechanics and Aircraft Maintenance Technology/Technician	7
Georgia Military College-Warner Robins Campus	Aircraft Powerplant Technology/Technician	1
Aviation Institute of Maintenance-Atlanta	Airframe Mechanics and Aircraft Maintenance Technology/Technician	53
Georgia Aviation & Technical College*	Airframe Mechanics and Aircraft Maintenance Technology/Technician	53

Institution	CIP Description	Grads.**
Georgia Aviation & Technical College*	Aircraft Powerplant Technology/Technician	19
Georgia Aviation & Technical College*	Airline/Commercial/Professional Pilot and Flight Crew	18

*The number of graduates in this table reports separate statistics for the now consolidated aerospace programs of the Middle Georgia College and the Georgia Aviation & Technical College.
**The number of graduates represents an annualized average during the 2003-2005 time period.
Source: National Center for Educational Statistics.

The numbers of graduates do not tell us how competitive Georgia is in terms of its supply relative to the nation as a whole and benchmark states. Thus we have formulated a comparison with the average number of aerospace graduates for the nation. Areas in which Georgia is producing a higher concentration of graduates relative to the national system could be viewed as comprising the state's areas of specialization. Alternatively, areas in which the state is producing fewer graduates could be viewed as being under-represented. We computed LQs for each of the core primary fields of study, comparing Georgia and the benchmark aerospace-intensive states to the national average. Table 4.3 presents these results.

Georgia has great strength in engineering education in aerospace and industrial engineering. The LQ for Georgia Tech's aerospace engineering program is higher than that of the benchmark states. Likewise, although the electrical and mechanical engineering LQs are below one (hence suggesting Georgia is less competitive in terms of quantity in these areas relative to the nation), the LQ for industrial engineering is above two. Overall, these high LQs suggest that the state has a substantial human capital advantage on the engineering side of aerospace.

Technician-level aerospace majors also show areas of strength as well as opportunities for enhancement. Georgia's LQ for Airframe Mechanics and Aircraft Maintenance Technology/Technician in 2.65 and its LQ for Aircraft Powerplant Technology/TechnicianGeorgia is 1.70. These statistics suggest that the state is very competitive, if not a leader, in supplying graduates in these two primary fields. However, the important area of avionics registers an LQ of only 0.29, far below the figure of 1.29 for Texas. Expanding the states' avionics aerospace programs could help achieve enhanced preparation for this rising field. Moreover the category Airline/Commercial/Professional Pilot and Flight Crew displays an LQ of only 0.28 in Georgia which is the lowest of any of the benchmark states. Sometimes this major is found in bachelors and sometimes in technical degree programs.

Table 4.3. Georgia is Specialized in Engineering
(Location Quotient Analysis of Number of Graduates in Georgia and US CIPs, 2003)

CIP	CIPName	AZ	GA	KS	TX	WA
14.0201	Aerospace, Aeronautical and Astronautical Engineering	1.53	1.99	1.96	1.15	1.05
14.1001	Electrical, Electronics and Communications Engineering	0.77	0.90	0.87	1.39	0.76
14.1901	Mechanical Engineering	0.51	0.87	1.03	0.88	0.65
14.3501	Industrial Engineering (NEW)	1.08	2.29	1.72	1.57	0.36
15.0801	Aeronautical/Aerospace Engineering Technology/Technician	1.05			0.61	
47.0607	Airframe Mechanics and Aircraft Maintenance Technology/Technician	0.49	2.65	1.66	1.10	
47.0608	Aircraft Powerplant Technology/Technician	0.81	1.70	1.73	1.02	
47.0609	Avionics Maintenance Technology/Technician	0.25	0.29		1.26	0.01
49.0102	Airline/Commercial/Professional Pilot and Flight Crew	1.86	0.28	1.89	0.47	2.22
	Total for All Aerospace Programs	0.78	1.12	1.17	1.15	0.76

Source: National Center for Educational Statistics.

The LQ's in this table that are below one may not automatically mean that Georgia should add more aerospace educational programs. However, they may indicate a possible bottleneck for future expansion of the aerospace cluster in the state. Considerable growth in the demand for aerospace-related employees would probably require employers to recruit from schools in nearby states for avionics technicians, for example.

Summary

Georgia is a leader in education for the aerospace industry. Georgia graduated some 1900 students in core aerospace concentration areas a year in the 2003-2005 time period. Seventeen higher educational institutions in Georgia were found to operate programs that produce these graduates, with six demonstrating the capacity to turn out at least 25 graduates per year.

Location quotients were employed to measure the state's relative specialization in aerospace compared to the national academic system. The analysis showed that aerospace and industrial engineering, aerospace engineering technology, and airframe mechanics and maintenance were found to be strengths for the state, while avionics technology and pilot/flight crew training were found to be a weakness. These results suggest that the state is in good shape with respect to having sufficient supply of graduates to grow its aerospace cluster, with the exception of the avionics area.

Chapter

5

Future Demand, Graduates, and Shortfalls

The ability to expand a sector such as aerospace has become increasingly dependent on having the right talent available to support this expansion. The USG has examined the extent to which mismatches between the demand for knowledge workers and the supply of university graduates exist in various occupations for more than 10 years. Supply-demand analysis can be used to help address large gaps between supply and demand arising when industry structure transforms, consumer tastes change, demand for products or services shifts, and/or technological advances occur. Labor mobility restrictions, rapid pace of change, and regional industrial concentrations can challenge industries on the rise to find the skills they need. Because of the lead time necessary in developing or expanding educational programs, it can be helpful to foresee potential gaps in demand for various types of jobs.

This chapter uses long-term projections of employment in occupations in the aerospace cluster and links these projections to present levels of graduates from aerospace major fields of study in the state's postsecondary educational institutions. The analysis seeks to identify any long-range mismatches between projected demand for certain types of workers and current supply of graduates. It does not take into account any changes that may occur in demand as a result of new and highly successful economic development business recruitment strategies which expand the cluster in unexpected directions. In addition, because aerospace does not have a clear-cut occupational and industry definition, we cannot pinpoint the extent to which out-of-state labor may migrate to Georgia to adopt open positions in aerospace firms. At the same time, some number of Georgia graduates also leave the state for other employment locations; Drummond and Youtie (2001) found that 72 percent of graduates in the 1993 to 1997 time period were found in the Georgia workforce database in 1998. The analysis does give us an initial look at any long-range employment disparities in the aerospace cluster that could limit Georgia's economic development recruitment strategy.

What are Aerospace Occupations?

As in the case of the industry and supply analysis, no widely held definition of what is and what is not an aerospace occupation exists. The 2000 Standard Occupational Classification (SOC) system published by the U.S. Bureau of Labor Statistics is used in all dissemination of occupational employment projections and analyses. All workers are classified into one of over 780 occupations. To facilitate classification, occupations are combined to form 23 major groups, 96 minor groups, and 449 broad occupations. Each broad occupation includes detailed occupation(s) requiring similar job duties, skills, education, or experience.

To define aerospace occupations, we used the national standard SOC-CIP Crosswalk database which relates occupations to the major educational programs that provide higher education graduates for those occupations. This is a complex many-to-many relationship, since an occupation can be served by more than one program, and a program can serve more than one occupation. We defined a set of nine core occupations, excluding managers, teachers, and cost estimators. Table 5.1 presents the resulting list of occupations. **All of these occupations expect some type of university or college degree (with the exception of commercial pilots).**

Table 5.1. Aerospace Occupations and Type of Educational Requirement

SOC	SOCTITLE	Educational Requirement
17-2011	Aerospace Engineers	Bachelor's degree
17-2071	Electrical Engineers	Bachelor's degree
17-2072	Electronics Engineers, Except Computer	Bachelor's degree
17-2112	Industrial Engineers	Bachelor's degree
17-2141	Mechanical Engineers	Bachelor's degree
17-3021	Aerospace Engineering and Operations Technicians	Associate degree
49-2091	Avionics Technicians	Post-secondary vocational training
49-3011	Aircraft Mechanics and Service Technicians	Post-secondary vocational training
51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	Long-term on-the-job training
53-2011	Airline Pilots, Copilots, and Flight Engineers	Bachelor's degree
53-2012	Commercial Pilots	Long-term on-the-job training

Source: U.S. Bureau of Labor Statistics, Standard Occupational Classification.

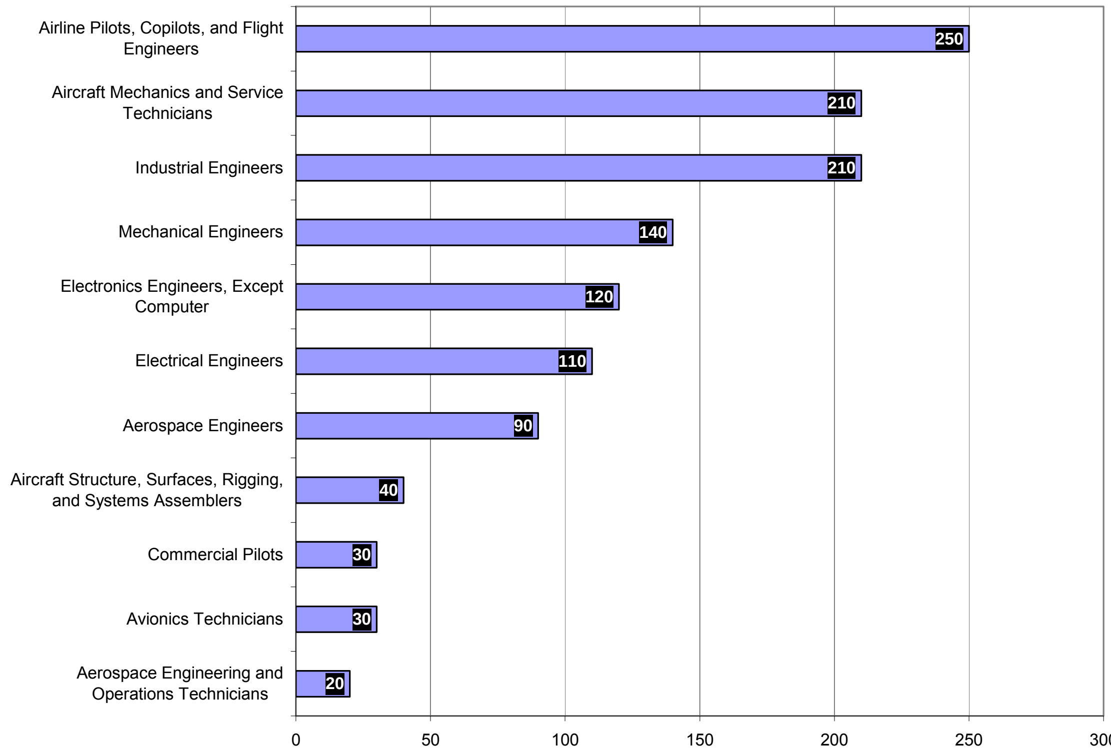
Long-Term Demand

The Georgia Department of Labor projects that from 2004 to 2014 the state will need 1,250 workers annually in aerospace occupations. These numbers indicate that there will be considerable growth in aerospace-related knowledge occupations over this 10 year period. Figure 5.1 breaks down the number of annual openings by the various aerospace occupations. The top core occupations with at least 200 annual openings per year include:

- Airline Pilots, Copilots, and Flight Engineers
- Aircraft Mechanics and Service Technicians
- Industrial Engineers

Also important are Civil Engineers, Electronics Engineers, and Electrical Engineers which are projected to have more than 100 openings a year. **More than 70 percent of these occupations customarily require a bachelor's degree**.

Figure 5.1. Annual Openings in Core Aerospace Occupations: 2004-2014



Source: Georgia Department of Labor

Shortfall Analysis

As a rough measure of the extent to which there are short falls in aerospace occupations, we compared these projected annual openings to the number of graduates that Georgia's postsecondary educational institutions produced annually in the 2003 to 2005 time frame. Graduates of each program are allocated to related occupations by calculating an allocation factor for each program-to-occupation relationship based on the SOC-CIP Crosswalk. The allocation factor is the number of openings in the occupation divided by the total number of openings in all occupations related to the program. Once all programs are allocated, the number of graduates coming from all related programs is summed for each occupation. For some occupations the number of allocated graduates may exceed the number of openings. When this is the case the "excess" graduates are then re-assigned to their original programs, in proportion to the size of the program. The process is repeated until the largest number of "excess" graduates is less than ten; for the current supply demand analysis three rounds of allocation were sufficient. The results are presented in Table 5.2.

The results do not show substantial numbers of shortfalls. The only shortfalls are evidenced with respect to Pilots and Flight Engineers, and the Aerospace Engineering and Operations Technicians classification.

Despite the lack of gross numbers of unfilled occupations projected particularly in the core occupations, we emphasize that there are limitations to this analysis. In particular, it does not take into account the state's economic development strategy. To the extent that the state succeeds in expanding its already-significant cluster in this area, this success will not be reflected in these projections which are based on standard demographic, business, and economic trends.

Table 5.2. Annual Openings, Graduates, and Shortfall in Aerospace Occupations

SOCTITLE	Annual Openings	Graduates	Shortfall
Airline Pilots, Copilots, and Flight Engineers	250	21	229
Industrial Engineers	210	210	0
Aircraft Mechanics and Service Technicians	210	210	0
Mechanical Engineers	140	140	0
Electronics Engineers, Except Computer	120	120	0
Electrical Engineers	110	110	0
Aerospace Engineers	90	90	0
Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	40	40	0
Commercial Pilots	30	3	27
Avionics Technicians	30	30	0
Aerospace Engineering and Operations Technicians	20	0	20

Source: National Center for Educational Statistics and the Georgia Department of Labor.

Chapter

6

Recommendations

This study has shown that in quantitative terms, Georgia has one of the strongest foundations in the country in the aerospace educational area on which to build. The state's educational supply is unmatched across most areas and few aerospace occupations appeared to have significant shortfalls when comparing projected job openings against graduates of existing higher educational programs. Therefore most of our recommendations involve the need for strengthening aspects of the aerospace cluster and its ability to prepare for future needs for innovation in the industry.

This section also portrays a "qualitative" analysis undertaken to acquire further information in support of the development of recommendations regarding Georgia's postsecondary educational programs. More than 10 indepth interviews with corporate executives in aerospace firms, administrators at WRALC, and university faculty and administrators were conducted in July through September 2007. We also interviewed directors of aerospace and avionics educational associations to obtain a perspective on best practices relative to the implications of our quantitative data in Chapter 5.

During the interviews with industry, academic and association leaders in the aerospace industry, no academic practices in aerospace and aviation higher education could be identified as best practices. Programs might be mentioned by one interviewee, but without corroboration, this study's researchers can only cite the practices below as ones that could be explored further by educators in these industry areas. These practices relate to two postsecondary educational programs observed to have quantitative supply gaps in Georgia:

- Avionics Maintenance Technology/Technician. A program that prepares individuals to apply technical knowledge and skills to repair, service, and maintain all types of aircraft operating, control, and electronic systems. Includes instruction in flight instrumentation, aircraft communications and homing systems, radar and other sensory systems, navigation aids, and specialized systems for various types of civilian and military aircraft.

- Aeronautical/Aerospace Engineering Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing, manufacturing and testing aircraft, spacecraft and their systems. Includes instruction in aircraft/spacecraft systems technology, design and development testing, prototype and operational testing, inspection and maintenance procedures, instrument calibration, test equipment operation and maintenance, and report preparation.

Table 6.1. Aerospace Educational Practices

Practice	Institution	Contact for more information
Avionics Maintenance Technology/Technician		
• Associate to baccalaureate cooperative program based on partnership between Air Force and local universities. Web based virtual education center for distance learning.	Community College of the Air Force www.au.af.mil/au/ccaf/	Dr. Bruce Murphy, Chief Academic Officer (334) 953-5613
• Oklahoma City Aviation/Aerospace Education Alliance (confederation of public education institutions involved in training and academic degree programs in the field of aviation and aerospace) • Modern aviation career campus • High school and short-term adult programs (in addition to full-time programs)	Metro Technology Centers www.metrotech.org	James D. Branscum, Ed.D., Superintendent (405) 605-4420
• 14 month (accelerated) program for Associates Degree.	Hallmark Institute of Aeronautics www.hallmarkinstitute.edu	Doretta J. Moreno, Director of Training dmoreno@hallmarkinstitute.com (210) 826-1000
• Equipment (turbine, helicopters, etc.) • Industry partners program	Wyotech www.wyotech.edu	Frank Stryjewski , President (888) 577-7559
Aeronautical/Aerospace Engineering Technology/Technician		
• Modern, state-of-the-art laboratories and classrooms • Collaborative areas for student projects	Purdue University (Department of Aviation Technology) www.tech.purdue.edu	Dr. Thomas Q. Carney tcarney@purdue.edu (765) 494-5782
• Technologies and teaching infrastructure including PIA's owned $20 million aircraft via corporate donation	Pittsburgh Institute of Aeronautics www.pia.edu	John Graham III, President (412) 346-2100
• Multiple levels of program offerings ranging from aviation maintenance certification (2 weeks) to avionics technology (7 months) to aviation maintenance technology (14 months) to aviation maintenance professional (21 months) to associates in science degree	National Aviation Academy www.naa.edu	Mac Elliott, Chairman and CEO (727) 531-2080 ext: 10

Source: Author analysis of Web sites

Drawing on the information in this study, we propose a set of recommendations for postsecondary education in Georgia for strengthening aspects of the aerospace cluster, and its ability to prepare for future needs for innovation in the industry. These recommendations are shown below (not in priority order as all are judged to be important).

Add an Avionics Degree Program

The field of avionics is emerging in importance as the aerospace industry continues to transition to computer systems. Georgia has limited educational program offerings in this area at the postsecondary level. This is one of the few areas in which Georgia is not a national leader.

We recommend that the USG provide support for an avionics program in the state. This would likely be a two-year degree program although additional resources at the bachelor's and higher levels could also be important. A two-year degree program would require the hiring of at least one new faculty member. In addition, educational infrastructure would be required to ensure that there are sufficient computer-based gauges and other systems available for avionics educational programs at the two-year and bachelor's and higher levels. As the technology changes, these programs must keep up with the computer-based requirements.

Support the Need for Military-related Education

More than one-third of current job openings in the aerospace industry require a military clearance. This is an indication of the importance of bases such as Warner Robins Air Logistics Center to the state's aerospace industry.

We recommend that the University System of Georgia support degree programs in coordination with the base. There is a particular need for degree programs that provide an education in defense acquisition and contracting. Although the base does hire general business graduates to perform this function, it usually has to furnish further extensive training of these graduates through the Defense Acquisition University. A Georgia-based curriculum that focuses on defense contracting would speed and facilitate this training process for the base. It would save the base time and money in bringing on graduates who can perform priority management and acquisition functions upon graduation.

We propose that the state engage in discussions with the WRALC to obtain copies of the Defense Acquisition University's curriculum to serve as a foundation for such a course of study. This offering is likely to be most productive if it is structured as a major in a business or management program at a postsecondary educational institution proximate to the base such as Macon State College. We further recommend that this program include a cooperative (coop) education element. This is taking place to some degree but greater support for coop experiences on the base will reduce the time before recent graduates are fully productive at the base.

Develop Post-composite Capabilities and Offerings

Another major transition impacting the aerospace industry is the movement from traditional aluminum and steel alloy materials to composites and eventually to post-composites. Georgia does have aerospace-related educational programs in this field. However, it is particularly important for the state's educational institutions to sustain capabilities in this area. Next-generation materials are being developed and these have important implications for the aerospace industry.

We propose that the state encourage and support the establishment of a center to research and provide training in post-composite materials of importance to the aerospace industry. Such a research center focused on post-composite advances would attract PhD students to conduct state-of-the-art research. It would also allow undergrads to participate in coop opportunities to gain experience in this areas. Moreover, it would provide research opportunities for undergraduates. From an economic development viewpoint, such a center could yield commercializable products and incubate new spinoff firms around the next generation of aerospace and related materials. This type of a center is important for the state's positioning in the aerospace industry particularly given its relatively lower patent position compared to the nation and to its competition in other aerospace-intensive states. It will also likely have spillover impacts in upgrading materials important to other of the state's strategic industries. There is a potential role for the Aerospace Innovation Center in terms of research sponsorship, educational, and outreach activities as well as for linkage to university technology transfer programs to facilitate commercialization.

Maintain Refreshment of Educational Infrastructure

Georgia has a strong base of aerospace-related educational programs. However it is important for the state to maintain the quality of these programs. Maintenance involves investment not only in human capital such as professors and instructors, but also in upgrading equipment and facilities. Equipment and facilities are especially important in providing education in the aerospace area because it is a highly technology intensive industry. The technological nature of the aerospace industry is underscored in the current job openings analysis which demonstrated the large number of positions with technological requirements.

The state should provide for refreshment and upgrading of its equipment and facilities in its technology-intensive aerospace educational programs. Equipment and facilities necessary for aerospace-related training range from composite samples to computer-based gauges and systems to safety equipment to laboratory equipment to simulators and to aircraft available for flight training. We recommend that the state develop a mechanism for providing for this refreshment for educational infrastructure.

Promote Opportunities to Gain Industry Experience

Because the aerospace industry places such a premium on work experience, it is important that there be a proficient base of workers in the state with this background. Industry executives emphasized the need for the following efforts to integrate academic and experience requirements: internships, coops/part-time jobs, student projects, seminar programs, formal partnerships, involvement of students and business leadership in curricula design, executive programs for today's aerospace professionals, and adjunct positions provided for industry executives to teach in university classes. The need for work experience does suggest that the state should ensure that appropriate educational investments are placed near aerospace industry geographic clusters in the Atlanta area, near Warner Robins, and Savannah.

Develop Individualized Professional Development Curricula

One of the key recommendations of the Commission on the Future of the United States Aerospace Industry is “that emphasis must be placed on the concepts of ‘lifelong learning’ and ‘individualized instruction.’ It is likely that individuals now entering the workforce will hold five or more jobs in their lifetime and the education system must be prepared to deliver training and education to meet these changing skill requirements and meet labor market needs.” (Commission on the Future of the Aerospace Industry 2002, p. 8-8)

The ICAPP program has done well in developing industry-oriented educational programs. However, more needs to be done in the professional development area to have ready offerings that can be delivered on-line or in a timely manner to meet the skill upgrading requirements of the aerospace industry. There is a particular prevalence of certifications around aerospace education that could be addressed through professional development Addressing this need is not as straightforward as reviewing Web sites and developing a centralized database of University System offerings. Some classes lend themselves to professional development offerings better than others. Laboratory-intensive classes are obviously difficult to offer on-line for example.

We recommend that the distance learning and ICAPP liaison functions at the universities begin to make personal contact with the appropriate aerospace instructors to develop relationships for flexible and customized training programs that could be proactively offered to private industry. While this is already being done to some degree, greater resources need to be provided to support these efforts.

Conclusion

Georgia’s geographic position and existing industries give it great potential for developing a world-class aerospace industry. The state’s higher educational system can greatly enhance the knowledge segment of the industry through its programmatic offerings and quality graduates.

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Appendices

Appendix 1. Definitions of Aerospace Industry in State Cluster and Target Industry Studies

NAICS	TITLE	CITY	STATE	YEAR
331512 (P)	Steel Investment Foundries	Denver	CO	2006
331524	Aluminum Foundries (except Die-Casting)	Denver	CO	2006
331528 (P)	Other Nonferrous Foundries (except Die-Casting)	Denver	CO	2006
332111 (P)	Iron and Steel Forging	Denver	CO	2006
332313 (P)	Plate Work Mfg	Denver	CO	2006
332813 (P)	Electroplating, Plating, Polishing, Anodizing, and Coloring	Denver	CO	2006
332993	Ammunition (except Small Arms) Mfg	Denver	CO	2006
333314	Optical Instrument and Lens Mfg	Denver	CO	2006
334220 (P)	Radio and Television Broadcasting and Wireless Communications Equipment Mfg	Denver	CO	2006
334511	Search, Detection, Navig., Guid., Aero., and Nautical System and Instr. Mfg	Denver	CO	2006
336414	Guided Missile and Space Vehicle Mfg	Denver	CO	2006
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Mfg	Denver	CO	2006
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Mfg	Denver	CO	2006
339113 (P)	Surgical Appliance and Supplies Mfg	Denver	CO	2006
423860	Trans. Equipment and Supplies (except Motor Vehicle) Merchant Wholesalers	Denver	CO	2006
517212	Cellular and Other Wireless Telecommunications	Denver	CO	2006
517410	Satellite Telecommunications	Denver	CO	2006
517510	Cable and Other Program Distribution	Denver	CO	2006
927110	Space Research and Technology	Denver	CO	2006
33641	Aerospace Product and Parts Mfg	San Antonio	TX	2002
42386	Trans. Equipment and Supplies (except Motor Vehicle) Merchant Wholesalers	San Antonio	TX	2002
48111	Scheduled Air Transportation	San Antonio	TX	2002
48121	Nonscheduled Air Transportation	San Antonio	TX	2002
48811	Airport Operations	San Antonio	TX	2002
48819	Other Support Activities for Air Transportation	San Antonio	TX	2002
336411	Aircraft Mfg		AL	2003
336412	Aircraft Engine and Engine Parts Mfg		AL	2003
336413	Other Aircraft Parts and Auxiliary Equipment Mfg		AL	2003
336414	Guided Missile and Space Vehicle Mfg		AL	2003

336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Mfg	AL	2003
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Mfg	AL	2003
336992	Military Armored Vehicle, Tank, and Tank Component Mfg	AL	2003
541330	Engineering Services	AL	2003
541511	Custom Computer Programming Services	AL	2003
541512	Computer Systems Design Services	AL	2003
541519	Other Computer Related Services	AL	2003
541710	Research and Development in the Physical, Engineering, and Life Sciences	AL	2003
333200	Industrial Machinery Mfg	GA	2004
333500	Metalworking Machinery Mfg	GA	2004
333600	Engine, Turbine, and Power Transmission Equipment Mfg	GA	2004
336400	Aerospace Product and Parts Mfg	GA	2004
336900	Other Transportation Equipment Mfg	GA	2004
541700	Scientific Research and Development Services	GA	2004
3364	Aerospace Product and Parts Mfg	MD	2004
9271	Space Research and Technology	MD	2004
54171	Research and Development in the Physical, Engineering, and Life Sciences	MD	2004
334511	Search, Detection, Navig., Guid., Aero., and Nautical System and Instr. Mfg	MD	2004
488111	Air Traffic Control	MD	2004
541512	Computer Systems Design Services	MD	2004
332116	Metal Stamping	OK	2005
334511	Search, Detection, Navig., Guid., Aero., and Nautical System and Instr. Mfg	OK	2005
336411	Aircraft Mfg	OK	2005
336412	Aircraft Engine and Engine Parts Mfg	OK	2005
336413	Other Aircraft Parts and Auxiliary Equipment Mfg	OK	2005
488111	Air Traffic Control	OK	2005
541512	Computer Systems Design Services	OK	2005
541710	Research and Development in the Physical, Engineering, and Life Sciences	OK	2005
611512	Flight Training	OK	2005
928110	National Security	OK	2005
481	Air Transportation	TX	2005
927	Space Research and Technology	TX	2005
4881	Support Activities for Air Transportation	TX	2005
54133	Engineering Services	TX	2005

334511	Search, Detection, Navig., Guid., Aero., and Nautical System and Instr. Mfg	TX	2005
336411	Aircraft Mfg	TX	2005
336412	Aircraft Engine and Engine Parts Mfg	TX	2005
336413	Other Aircraft Parts and Auxiliary Equipment Mfg	TX	2005
336414	Guided Missile and Space Vehicle Mfg	TX	2005
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Mfg	TX	2005
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Mfg	TX	2005

Source: Author analysis of Web sites

Appendix 2. List of Patents in US Class 244 (Aeronautics or Astronautics) by Georgia Inventors or Assignees: 1990-2007

PAT. NO.	Title
7,234,667	Modular aerospace plane
7,195,198	Helicopter blade emergency detachment system
7,159,823	Rapid deployment of troops and cargo
7,104,498	Channel-wing system for thrust deflection and force/moment generation
6,997,415	Method and arrangement for aircraft fuel dispersion
6,990,885	Missile interceptor
6,974,106	V/STOL biplane
6,906,537	System for controlling the temperature of an aircraft airfoil component
6,860,449	Hybrid flying wing
6,848,649	V/STOL biplane aircraft
6,817,579	Passenger transport module system for supersonic aircraft
6,776,373	Aircraft escape cabin
6,772,086	Process to determine impact location
6,769,493	Liquid dispensing lighter-than-air airship system
6,745,979	Spacecraft and aerospace plane having scissors wings
6,736,409	Drinking straw prepared from flattened polymeric tubular conduit, method of making same and dispenser
6,715,791	Air bag tether system comprising multiple segments cut in alignment with fabric warp of fill
6,715,717	Method and apparatus for inducing controlled vortices to reduce afterbody drag
6,698,684	Supersonic aircraft with spike for controlling and reducing sonic boom
6,669,137	Air vehicle having rotor/scissors wing
6,644,598	Modification of fluid flow about bodies and surfaces through virtual aero-shaping of airfoils with synthetic jet actuators
6,608,262	Aircraft load cell shoring
6,601,795	Air vehicle having scissors wings
6,510,805	Aerial reforestation system
6,464,171	Leading edge channel for enhancement of lift/drag ratio and reduction of sonic boom
6,460,810	Semiautonomous flight director
6,450,451	Multi-pane window portable defogging device
6,446,909	Reciprocating chemical muscle(RCM) and method for using same
6,412,732	Apparatus and method for enhancement of aerodynamic performance by using pulse excitation control
6,332,105	Neural network based automatic limit prediction and avoidance system and method
6,318,677	Method and apparatus for generating a stable leading-edge lifting-vortex controller
6,311,106	Automatic flat rate setting system for freight feeder aircraft and method of setting of engine flat rate
6,241,190	Towplate positive lock device
6,227,096	Universal warhead adapter, and missile and method incorporating same
6,142,425	Apparatus and method for aerodynamic blowing control using smart materials
6,102,332	High capacity air transport system and method

PAT. NO.	Title
6,092,919	System and method for adaptive control of uncertain nonlinear processes
6,082,671	Entomopter and method for using same
6,050,527	Flow control device to eliminate cavity resonance
5,979,829	In-flight evacuation system
5,967,463	Air foil having valve
5,957,413	Modifications of fluid flow about bodies and surfaces with synthetic jet actuators
5,947,419	Aerial cargo container
5,890,441	Horizontal and vertical take off and landing unmanned aerial vehicle
5,842,666	Laminar supersonic transport aircraft
5,794,887	Stagnation point vortex controller
5,791,601	Apparatus and method for aerodynamic blowing control using smart materials
5,755,405	Parachute promotion
5,711,651	Blade vortex interaction noise reduction techniques for a rotorcraft
5,678,175	Satellite system using equatorial and polar orbit relays
5,673,872	Apparatus for energy transformation and conservation
5,588,800	Blade vortex interaction noise reduction techniques for a rotorcraft
5,520,355	Three wing circular planform body
5,485,958	Mechanism for operating a cascade of variable pitch vanes
5,435,503	Real time missile guidance system
5,427,330	Sphereroll
5,390,877	Vectorable nozzle for aircraft
5,362,014	Ejectable lightweight foam protective covers for fiber optic data link systems
5,274,314	Adaptive friction compensator
5,260,702	Aircraft information system
5,240,759	Aircraft fuel mat
5,205,710	Helicopter blade crack detection system
5,155,788	Optical fiber disposed in and decoupled from a reinforcing member
5,150,864	Variable camber control of airfoil
5,065,958	Helicopter soft snow landing aid
D319,041	Delta rotor wing aircraft
5,035,169	Guided vehicle system
5,033,389	System for guiding a vehicle from a rest position to a target
4,964,591	Projectile having nonelectric infrared heat tracking device
4,948,071	Deployment system for parachute
4,913,380	Fuel system for Canard aircraft

Source: US Patent and Trade Office

Appendix 3. Selected Companies in Georgia with Advertised Aerospace-related Positions Requiring Some Postsecondary Education

Company	Number of Advertisements
Air Force Material Command	3
Air Force Reserve Headquarters	1
AirTran	8
Aramark	1
Atlantic Southeast Airlines	3
DataPath	2
Delta	25
EMS Technologies	1
Engility Corporation	1
Federal Aviation Administration	2
Gulfstream – Brunswick	1
Gulfstream – Savannah	52
Hilton Head	2
Intelsat	2
ISPA	2
L-3 Communications	1
Lockheed Martin	102
MTC Services	2
Northrop Grumman	20
Pro Staff	3
Raytheon - Albany	1
Rolls Royce - Savannah	1
Volt Engineering Services	1
Vought Aircraft Industries	1
World Airways	5
Yoh Engineering	2
Grand Total	245

Source: Georgia Tech Survey of 245 aerospace-related openings, July/August 2007.

Appendix 4. Titles of Advertised Aerospace-related Positions Requiring Some Postsecondary Education

Title	Number of Advertisements
Advertising Specialist	1
Aeronautical Engineer Sr	5
Aeronautical Engineer Stf	1
Aerospace Engineer (Avionics/Electrical)	1
Aerospace Simulation Engineer	1
Air Force Operations Research Policy Analyst	1
Aircraft Electrical Worker	1
Aircraft Loads and Dynamics Technical Specialist III	1
Aircraft Performance Engineer	2
Aircraft Stress Analysis Engineer	1
Aircraft Stress Analysis Engineering Mgr	1
Assembly Supv	1
Aviation Cabin Service Duty Manager	1
Aviation Maintance Controller	1
Aviation Scheduler	1
Avionics/Electrical Tech II	2
Avionics/Electrical Tech Lead	1
Chemical Engineer	1
College Student Tech	1
College Student Tech Sr	2
Comp Systems Architect Sr Stf	1
Composite Structural Designer	1
Composites M&P Engineer	1
Computer Sys Analyst Sr	1
Computer Systems Architect Sr Stf	1
Computer Tech Spt Analyst Asc	1
Co-Op - Enabling Technologies	1
Co-Op - Operations Support Engineering	1
Co-Op Demand Planning	1
Co-Op Engine Maintanence Operations	1
Co-Op Engineer Engine Maintanence	1
Co-Op Engineering Ops Support	1
Co-Op Planning	1
Corporate Travel Coordinator	1
Crew Planer	1
Customer Service Recruiter	1
Diversity Workforce Specialist	1
Electric Periferal Design Engineer	1
Electric Systems Technical Specialist III	1
Electrical Engineer	2
Electrical/Avionics Experience Writer	1
Electronics / Avionics Engineer	1
Electronics Engineer	2
Electronics Engineer Asc	2
Electronics Engineer Sr	1
Electronics Engineer Stf	1

Title	Number of Advertisements
Electronics hardware Engineer	1
Embedded Firmware Engineer	1
Embedded S/W Engineer Asc	3
Embedded S/W Engineer Sr Stf	2
Embedded S/W Engineer Stf	4
Embedded Software Engineer	2
Embedded Software Engineer Mgr	1
Embedded Software Engineer Stf	1
Embedded S-W Engineer	2
Embedded S-W Engineer Sr	1
Engineer	3
Engineer - IFE Engineer	1
Engineer - IFE Reliability	1
Engineer II	1
Engineer II - Avionics Eng	1
Engineer II - Prelim Design Aero/Performance	1
Engineering Co-Op	1
Engineering Group Head I	1
Engineering Manager	1
Engineering Mgr - Flight Sciences	1
Engineering Technical Assistant	1
Engineering-Gen/Multidiscip 4	1
Field Engineer Sr	1
Field Service Engineer / Software Developer 3	1
Financial Manager, Sr.	1
Financial Specialist	1
Fleet Reliability Analyst	1
Flight Controls Engineer	1
Flight Controls Sys/Test Lead Engineer	1
Flight Engineer Simulator Instructor	1
Flight Operations Aircrew Staff	1
Flight operations Publications	1
Flight Operatns Aircrew Stf	2
Flight Tech IV	1
Flight Test Engineering Control Engineer	1
Flight Test instrumentation Engineer	2
General Engineer	1
General Manager - Fleet Programs	1
Heavy Maintance Planner	1
Industrial Engineering Mgr	2
Integration Test Technical Specialist	1
Internship-Aerospace Engineering	1
IS Disaster Rcvry Anlst Stf	1
Landing Gear & Doors Engineer	1
Lead Checking Engineer	1
Loads and Dynamics Engineer II	1
Maintainability Engineer II	1
Maintenance and Engineering Systems Specialist	1

Title	Number of Advertisements
Maintenance Representative II	1
Manager Coorporate Communications	1
Manager Labor Relations	1
Manager-Demand Planning	1
Materials & Processes Engineer/TSI	1
Materials Engineer Stf	1
Materials Sprt Team Mbr Stf	1
Mechanical Engineer Sr	1
Mechanical/Avionics Experience Writer	1
Mfg. Engineer I	2
Mfg. Engineer II	2
Military Oprtns Analyst Sr	1
Missile Elect Tech Assoc	2
Operations Engineer Sr Stf	1
Operations Research Analyst	1
PDT Lead I - System Integration NPD	1
PDT Lead II - Engineering Support NPD	1
Pilot Simulator Instructor	1
Principal Electronics Engineer	1
Principal IT System Engineer	1
Principal RF Engineer	1
Project Engineer	1
Project Engineer II	1
Propulsion Engineering Co-Op - Fleet Teams	1
Propulsion/thermodynamics/TSIII	2
QA Engineering Manager	1
QA Technical Specialist	1
Quality Engineer - Mission Assurance	1
Quality Engineer II	4
Quality Engineering Supervisor	1
Regulator Document Analyst	1
Safety Engineer Sr	1
Safety/Environmental Coord	1
Senior Safety Engineer	1
Software Development Engineer	6
Software Development Engineer 2	1
Software Development Engineer 3	1
Software Development Engineer	4
Software Engineer	1
Software Engineer 3	1
Specialist	2
Specialist, Flight Safety Investigations	1
Sr Logistics Specialist	1
Sr Project manager	1
Sr Technical Specialist	1
Sr. Project Analyst, Customer Services	1
Structural Design Engineer II	1
Student Tech Spec	1

Title	Number of Advertisements
Sys Engr-Field Tech Spt Sr	1
Sys Engr-Field Tech Spt Stf	1
Sys Integ Bsns Analyst Sr Stf	1
System Engineer II	1
System Engineer Sr Stf	1
Systems Engineer	2
Systems Engineer 5	1
Systems Engineer 6	1
Systems Engineer Asc	3
Systems Engineer Prin	2
Systems Engineer Sr	8
Systems Engineer Sr Stf	8
Systems Engineer Stf	9
Systems Engineering Mgr	1
Systems Engineering Sr Mgr	1
Technical Analyst	2
Technical Designer I - Dir	1
Technical Instructor	1
Technical Specialist I	2
Technical Specialist II	3
Technical Specialist III	3
Technical Specialist III - Airframe Stress Analyst	1
Technical Specialist III - Applied Aero	1
Technical Trainter	1
Technical Writer	1
Test Engineer	1
Tool Engineer Sr Stf	1
Training Curriculum Developer	1
Training Developer	1
Training specialist II	1
TSII - Airworthiness & Certification	1
Value Engineering Sr Mgr	1
Grand Total	245

Source: Georgia Tech Survey of 245 aerospace-related openings, July/August 2007.

Appendix 5. Certification Requirements and Preferences in Advertised Aerospace-related Positions

Certification Requirement	Number of Advertisements
10,000 hours CATIA v4	1
1000 hours C-5 Flight Engineer time, A&P License, Turboprop flight engineer license	1
1000 hours recent experience as a C-5 Flight Engineer	1
2.7 GPA	1
A&P License	11
A&P license or FCC preferred	1
A&P License, ASQ Certified	1
Ada and C++, Military Security Clearance	2
Ada on PowerPC, Military Security Clearance	1
Agilent VEE and Visual Basic programmin exp	1
AIMS Experience	1
Airline Exp	1
ASQ Certified	1
ATP Certification	1
AutoCad Exp	1
C and Ada programming, Military Security Clearance	2
C#, ASP.NET, and JAVA, Military Security Clearance	1
C/C++ on PowerPC, Military Security Clearance	2
C/C++ or ADA computer skills	1
C++ and trainer simulatorexperience	1
C++ Programming	2
C++, Military Security Clearance	1
C++, Simulation Experience	1
C++, Software modeling, Top Secret/Special Security Requirements	2
C-130 Aircraft Avionics systems troubleshooting	1
C-130 Aircraft Experience	1
C-130 Aircrew experience	1
C-130 Flight Certified within the last 5 years	2
C-5 Aircraft systems	1
C5 AMP/RERP experience	1
C5 System Troubleshooting	1
CAD and CATIA v5 experience	1
CAD experience	1
CAD/CAE programming	1
CADAM, and CATIA Experience	3
CATIA v4 and v5 experience	1
CATIA v4 experience	2
CATIA v5	1

Certification Requirement	Number of Advertisements
CATIA v5 and CAD experience	1
CATIA v5 and Fiberslim experience	1
Computer programming	1
CONOPS Development, Top Secret Military Clearance	1
Database Managemnet	1
Department of Defense Security Clearance	1
DoD IA C&A Process Guidance certification	1
EIT certfication	1
EMC, OSS, CRM and NMS experience	1
Engine cycle performance and FAR part 25/33	2
FAA class 3 medical	2
FAA Mechanic Certificate, A&P License	1
FAA Pilots License	1
FAA Structure Certification	1
FAII medical, C5 Flight engineer, 1000 flight experience	1
FAR 121	1
FAR and DOT Regulation exp	2
FAR Certified	1
FAR/JAR experience	1
FORTRAN and UNIX experience	1
FRACAS, Reliability Prediction and testing	1
High Voltage testing experience, Military Security Clearance	1
IMAT, ADAMSys, CGRO, LOOPIN	3
Java	1
Junior or Higher	2
Military Piloting Experience	1
Military Security Clearance	45
Military Security Clearance, Piloting experience	1
Operational Flight Experience	1
PATRAN, NASTRAN, and CATIA V4	2
PATRAN, NASTRAN, CATIA V4	1
Pilots License or Dispatcher License	1
PMP Certification	1
professional engineer license	3
PRP Security Clearance	1
SABRE and AIMS Experience	1
SAS, SQL, UNIX	1
Secret Military Clearance	4
Secret Military Clearance, ADA, C++, Visual Studio, .NET Environment, Perl, Java, SQL, ASP, Web Scripting and HTML	1
Senior	1
Simulink/MATLab and C++ Experience	1

Certification Requirement	Number of Advertisements
Software programming	1
System Security Engineering	1
Top Secret Clearance	1
Top Secret Military Clearance	5
Undergrad, Sophomore or later	1
UNIX, LINUX, Frontran experience	1
USM3D, GRIDGEN, TECPLOT, FLUENT, MGAERO experience	1
VISIO and ASATRAX Experience	1
Visual Basic, Visual C++, C#, , Delphi and Java	1
Visual Basic, Visual C++, C#, Delphi and Java	1
Visual Basics, C++, Delphi and Java	1

Source: Georgia Tech Survey of 245 aerospace-related openings, July/August 2007.

Appendix 6. Large U.S. Aerospace Programs by Number of Graduates (Completions) in 2003 (programs with at least 25 graduates in core CIPS)

Institution	Description	State	Grads.
Georgia Institute of Technology-Main Campus	Aerospace, Aeronautical and Astronautical Engineering	GA	180
Purdue University-Main Campus	Aerospace, Aeronautical and Astronautical Engineering	IN	165
Massachusetts Institute of Technology	Aerospace, Aeronautical and Astronautical Engineering	MA	151
University of Colorado at Boulder	Aerospace, Aeronautical and Astronautical Engineering	CO	122
University of Michigan-Ann Arbor	Aerospace, Aeronautical and Astronautical Engineering	MI	121
Embry Riddle Aeronautical University-Daytona Beach	Aerospace, Aeronautical and Astronautical Engineering	FL	115
Virginia Polytechnic Institute and State University	Aerospace, Aeronautical and Astronautical Engineering	VA	108
The University of Texas at Austin	Aerospace, Aeronautical and Astronautical Engineering	TX	102
United States Air Force Academy	Aerospace, Aeronautical and Astronautical Engineering	CO	102
Pennsylvania State University-Main Campus	Aerospace, Aeronautical and Astronautical Engineering	PA	94
University of Illinois at Urbana-Champaign	Aerospace, Aeronautical and Astronautical Engineering	IL	94
Texas A & M University	Aerospace, Aeronautical and Astronautical Engineering	TX	89
University of Maryland-College Park	Aerospace, Aeronautical and Astronautical Engineering	MD	87
University of Washington-Seattle Campus	Aerospace, Aeronautical and Astronautical Engineering	WA	74
Stanford University	Aerospace, Aeronautical and Astronautical Engineering	CA	70
University of Minnesota-Twin Cities	Aerospace, Aeronautical and Astronautical Engineering	MN	65
Iowa State University	Aerospace, Aeronautical and Astronautical Engineering	IA	62
University of Southern California	Aerospace, Aeronautical and Astronautical Engineering	CA	61
Embry Riddle Aeronautical University-Prescott	Aerospace, Aeronautical and Astronautical Engineering	AZ	60
California Polytechnic State University-San Luis Obispo	Aerospace, Aeronautical and Astronautical Engineering	CA	55
University of Florida	Aerospace, Aeronautical and Astronautical Engineering	FL	53
United States Naval Academy	Aerospace, Aeronautical and Astronautical Engineering	MD	52
University of California-Los Angeles	Aerospace, Aeronautical and Astronautical Engineering	CA	47
Wichita State University	Aerospace, Aeronautical and Astronautical Engineering	KS	46
North Carolina State University at Raleigh	Aerospace, Aeronautical and Astronautical Engineering	NC	45

Institution	Description	State	Grads.
Rensselaer Polytechnic Institute	Aerospace, Aeronautical and Astronautical Engineering	NY	44
Ohio State University-Main Campus	Aerospace, Aeronautical and Astronautical Engineering	OH	39
Auburn University Main Campus	Aerospace, Aeronautical and Astronautical Engineering	AL	39
Southeastern Oklahoma State University	Aerospace, Aeronautical and Astronautical Engineering	OK	38
University of Cincinnati-Main Campus	Aerospace, Aeronautical and Astronautical Engineering	OH	37
West Virginia University	Aerospace, Aeronautical and Astronautical Engineering	WV	36
Saint Louis University-Main Campus	Aerospace, Aeronautical and Astronautical Engineering	MO	34
University of Central Florida	Aerospace, Aeronautical and Astronautical Engineering	FL	33
University of Notre Dame	Aerospace, Aeronautical and Astronautical Engineering	IN	33
University of California-Davis	Aerospace, Aeronautical and Astronautical Engineering	CA	32
University of Arizona	Aerospace, Aeronautical and Astronautical Engineering	AZ	31
University of Missouri-Rolla	Aerospace, Aeronautical and Astronautical Engineering	MO	31
Illinois Institute of Technology	Aerospace, Aeronautical and Astronautical Engineering	IL	31
The University of Texas at Arlington	Aerospace, Aeronautical and Astronautical Engineering	TX	30
Florida Institute of Technology-Melbourne	Aerospace, Aeronautical and Astronautical Engineering	FL	29
Arizona State University at the Tempe Campus	Aerospace, Aeronautical and Astronautical Engineering	AZ	29
University of California-San Diego	Aerospace, Aeronautical and Astronautical Engineering	CA	29
SUNY at Buffalo	Aerospace, Aeronautical and Astronautical Engineering	NY	28
Boston University	Aerospace, Aeronautical and Astronautical Engineering	MA	28
University of Kansas Main Campus	Aerospace, Aeronautical and Astronautical Engineering	KS	26
Georgia Institute of Technology-Main Campus	Electrical, Electronics and Communications Engineering	GA	608
University of Southern California	Electrical, Electronics and Communications Engineering	CA	528
The University of Texas at Austin	Electrical, Electronics and Communications Engineering	TX	508
North Carolina State University at Raleigh	Electrical, Electronics and Communications Engineering	NC	432
Massachusetts Institute of Technology	Electrical, Electronics and Communications Engineering	MA	427

Institution	Description	State	Grads.
University of Illinois at Urbana-Champaign	Electrical, Electronics and Communications Engineering	IL	391
Stanford University	Electrical, Electronics and Communications Engineering	CA	376
University of California-Berkeley	Electrical, Electronics and Communications Engineering	CA	371
University of Florida	Electrical, Electronics and Communications Engineering	FL	354
Rensselaer Polytechnic Institute	Electrical, Electronics and Communications Engineering	NY	331
Purdue University-Main Campus	Electrical, Electronics and Communications Engineering	IN	327
The University of Texas at Arlington	Electrical, Electronics and Communications Engineering	TX	314
Pennsylvania State University-Main Campus	Electrical, Electronics and Communications Engineering	PA	299
Ohio State University-Main Campus	Electrical, Electronics and Communications Engineering	OH	291
University of Maryland-College Park	Electrical, Electronics and Communications Engineering	MD	282
University of Washington-Seattle Campus	Electrical, Electronics and Communications Engineering	WA	276
Arizona State University at the Tempe Campus	Electrical, Electronics and Communications Engineering	AZ	276
University of Michigan-Ann Arbor	Electrical, Electronics and Communications Engineering	MI	273
Virginia Polytechnic Institute and State University	Electrical, Electronics and Communications Engineering	VA	272
California State Polytechnic University-Pomona	Electrical, Electronics and Communications Engineering	CA	268
University of California-San Diego	Electrical, Electronics and Communications Engineering	CA	251
University of Wisconsin-Madison	Electrical, Electronics and Communications Engineering	WI	249
Cornell University	Electrical, Electronics and Communications Engineering	NY	247
University of California-Los Angeles	Electrical, Electronics and Communications Engineering	CA	242
San Jose State University	Electrical, Electronics and Communications Engineering	CA	238
Rutgers University-New Brunswick/Piscataway	Electrical, Electronics and Communications Engineering	NJ	231
The University of Texas at Dallas	Electrical, Electronics and Communications Engineering	TX	226
University of Colorado at Boulder	Electrical, Electronics and Communications Engineering	CO	213
University of Minnesota-Twin Cities	Electrical, Electronics and Communications Engineering	MN	202
Texas A & M University	Electrical, Electronics and Communications Engineering	TX	197
New Jersey Institute of Technology	Electrical, Electronics and Communications Engineering	NJ	193

Institution	Description	State	Grads.
University of Illinois at Chicago	Electrical, Electronics and Communications Engineering	IL	176
Johns Hopkins University	Electrical, Electronics and Communications Engineering	MD	169
SUNY at Buffalo	Electrical, Electronics and Communications Engineering	NY	166
Illinois Institute of Technology	Electrical, Electronics and Communications Engineering	IL	159
Michigan State University	Electrical, Electronics and Communications Engineering	MI	155
University of Houston	Electrical, Electronics and Communications Engineering	TX	151
University of California-Irvine	Electrical, Electronics and Communications Engineering	CA	150
University of Puerto Rico-Mayaguez	Electrical, Electronics and Communications Engineering	PR	150
University of Arizona	Electrical, Electronics and Communications Engineering	AZ	147
Southern Methodist University	Electrical, Electronics and Communications Engineering	TX	146
University of Central Florida	Electrical, Electronics and Communications Engineering	FL	146
University of South Florida	Electrical, Electronics and Communications Engineering	FL	145
Iowa State University	Electrical, Electronics and Communications Engineering	IA	143
University of Missouri-Rolla	Electrical, Electronics and Communications Engineering	MO	141
Columbia University in the City of New York	Electrical, Electronics and Communications Engineering	NY	141
Duke University	Electrical, Electronics and Communications Engineering	NC	133
Wichita State University	Electrical, Electronics and Communications Engineering	KS	131
California State University-Sacramento	Electrical, Electronics and Communications Engineering	CA	130
California Polytechnic State University-San Luis Obispo	Electrical, Electronics and Communications Engineering	CA	129
Michigan Technological University	Electrical, Electronics and Communications Engineering	MI	128
Southern Illinois University Carbondale	Electrical, Electronics and Communications Engineering	IL	127
Louisiana State University and Agricultural & Mechanical College	Electrical, Electronics and Communications Engineering	LA	126
Oregon State University	Electrical, Electronics and Communications Engineering	OR	126
Drexel University	Electrical, Electronics and Communications Engineering	PA	125
Oklahoma State University-Main Campus	Electrical, Electronics and Communications Engineering	OK	123
Brigham Young University	Electrical, Electronics and Communications Engineering	UT	120

Institution	Description	State	Grads.
Northeastern University	Electrical, Electronics and Communications Engineering	MA	119
Wright State University-Main Campus	Electrical, Electronics and Communications Engineering	OH	119
Auburn University Main Campus	Electrical, Electronics and Communications Engineering	AL	118
Clemson University	Electrical, Electronics and Communications Engineering	SC	117
University of California-Santa Barbara	Electrical, Electronics and Communications Engineering	CA	109
New Mexico State University-Main Campus	Electrical, Electronics and Communications Engineering	NM	109
CUNY City College	Electrical, Electronics and Communications Engineering	NY	108
Polytechnic University	Electrical, Electronics and Communications Engineering	NY	107
Princeton University	Electrical, Electronics and Communications Engineering	NJ	106
Worcester Polytechnic Institute	Electrical, Electronics and Communications Engineering	MA	106
Universidad Politecnica de Puerto Rico	Electrical, Electronics and Communications Engineering	PR	104
Wayne State University	Electrical, Electronics and Communications Engineering	MI	104
Portland State University	Electrical, Electronics and Communications Engineering	OR	102
San Diego State University	Electrical, Electronics and Communications Engineering	CA	102
The University of Texas at San Antonio	Electrical, Electronics and Communications Engineering	TX	102
University of Utah	Electrical, Electronics and Communications Engineering	UT	101
Utah State University	Electrical, Electronics and Communications Engineering	UT	99
Santa Clara University	Electrical, Electronics and Communications Engineering	CA	98
Stony Brook University	Electrical, Electronics and Communications Engineering	NY	96
Colorado State University	Electrical, Electronics and Communications Engineering	CO	95
University of Virginia-Main Campus	Electrical, Electronics and Communications Engineering	VA	95
Syracuse University	Electrical, Electronics and Communications Engineering	NY	94
SUNY at Binghamton	Electrical, Electronics and Communications Engineering	NY	92
Texas Tech University	Electrical, Electronics and Communications Engineering	TX	92
University of Michigan-Dearborn	Electrical, Electronics and Communications Engineering	MI	92
California State University-Long Beach	Electrical, Electronics and Communications Engineering	CA	91

Institution	Description	State	Grads.
University of Pittsburgh-Main Campus	Electrical, Electronics and Communications Engineering	PA	91
Boston University	Electrical, Electronics and Communications Engineering	MA	90
University of Massachusetts-Lowell	Electrical, Electronics and Communications Engineering	MA	89
University of New Mexico-Main Campus	Electrical, Electronics and Communications Engineering	NM	89
University of Oklahoma Norman Campus	Electrical, Electronics and Communications Engineering	OK	89
George Washington University	Electrical, Electronics and Communications Engineering	DC	89
University of Cincinnati-Main Campus	Electrical, Electronics and Communications Engineering	OH	85
Stevens Institute of Technology	Electrical, Electronics and Communications Engineering	NJ	85
The University of Texas at El Paso	Electrical, Electronics and Communications Engineering	TX	84
The University of Tennessee	Electrical, Electronics and Communications Engineering	TN	83
University of North Carolina at Charlotte	Electrical, Electronics and Communications Engineering	NC	81
Western Michigan University	Electrical, Electronics and Communications Engineering	MI	81
Mississippi State University	Electrical, Electronics and Communications Engineering	MS	80
Rochester Institute of Technology	Electrical, Electronics and Communications Engineering	NY	80
University of Missouri-Columbia	Electrical, Electronics and Communications Engineering	MO	77
Rice University	Electrical, Electronics and Communications Engineering	TX	76
University of Alabama at Birmingham	Electrical, Electronics and Communications Engineering	AL	76
University of Kentucky	Electrical, Electronics and Communications Engineering	KY	75
Northern Illinois University	Electrical, Electronics and Communications Engineering	IL	72
University of Toledo	Electrical, Electronics and Communications Engineering	OH	72
University of South Carolina-Columbia	Electrical, Electronics and Communications Engineering	SC	72
North Dakota State University-Main Campus	Electrical, Electronics and Communications Engineering	ND	71
Kettering University	Electrical, Electronics and Communications Engineering	MI	71
California Institute of Technology	Electrical, Electronics and Communications Engineering	CA	71
Tennessee Technological University	Electrical, Electronics and Communications Engineering	TN	70

Institution	Description	State	Grads.
Ohio University-Main Campus	Electrical, Electronics and Communications Engineering	OH	69
George Mason University	Electrical, Electronics and Communications Engineering	VA	69
Oakland University	Electrical, Electronics and Communications Engineering	MI	69
Kansas State University	Electrical, Electronics and Communications Engineering	KS	68
University of Nebraska at Lincoln	Electrical, Electronics and Communications Engineering	NE	67
Florida International University	Electrical, Electronics and Communications Engineering	FL	65
California State University-Los Angeles	Electrical, Electronics and Communications Engineering	CA	64
West Virginia University	Electrical, Electronics and Communications Engineering	WV	64
Cleveland State University	Electrical, Electronics and Communications Engineering	OH	63
University of Pennsylvania	Electrical, Electronics and Communications Engineering	PA	63
Tufts University	Electrical, Electronics and Communications Engineering	MA	62
North Carolina A & T State University	Electrical, Electronics and Communications Engineering	NC	62
Southern Illinois University Edwardsville	Electrical, Electronics and Communications Engineering	IL	62
Northwestern University	Electrical, Electronics and Communications Engineering	IL	61
California State University-Northridge	Electrical, Electronics and Communications Engineering	CA	61
University of Louisville	Electrical, Electronics and Communications Engineering	KY	61
University of Idaho	Electrical, Electronics and Communications Engineering	ID	59
Vanderbilt University	Electrical, Electronics and Communications Engineering	TN	58
Morgan State University	Electrical, Electronics and Communications Engineering	MD	58
Florida Atlantic University	Electrical, Electronics and Communications Engineering	FL	57
California State University-Fullerton	Electrical, Electronics and Communications Engineering	CA	56
University of Delaware	Electrical, Electronics and Communications Engineering	DE	56
Washington State University	Electrical, Electronics and Communications Engineering	WA	56
Villanova University	Electrical, Electronics and Communications Engineering	PA	55
University of Connecticut	Electrical, Electronics and Communications Engineering	CT	54

Institution	Description	State	Grads.
Herzing College	Electrical, Electronics and Communications Engineering	AL	54
Florida Institute of Technology-Melbourne	Electrical, Electronics and Communications Engineering	FL	54
Fairleigh Dickinson University-Metropolitan Campus	Electrical, Electronics and Communications Engineering	NJ	53
University of Arkansas Main Campus	Electrical, Electronics and Communications Engineering	AR	53
University of California-Riverside	Electrical, Electronics and Communications Engineering	CA	52
University of Alabama in Huntsville	Electrical, Electronics and Communications Engineering	AL	52
University of Dayton	Electrical, Electronics and Communications Engineering	OH	52
Clarkson University	Electrical, Electronics and Communications Engineering	NY	52
University of Wisconsin-Milwaukee	Electrical, Electronics and Communications Engineering	WI	51
University of California-Davis	Electrical, Electronics and Communications Engineering	CA	51
University of Hawaii at Manoa	Electrical, Electronics and Communications Engineering	HI	51
Indiana University-Purdue University-Indianapolis	Electrical, Electronics and Communications Engineering	IN	51
Lawrence Technological University	Electrical, Electronics and Communications Engineering	MI	51
University of Rochester	Electrical, Electronics and Communications Engineering	NY	50
Lehigh University	Electrical, Electronics and Communications Engineering	PA	49
Temple University	Electrical, Electronics and Communications Engineering	PA	48
University of Louisiana at Lafayette	Electrical, Electronics and Communications Engineering	LA	48
Milwaukee School of Engineering	Electrical, Electronics and Communications Engineering	WI	47
University of Kansas Main Campus	Electrical, Electronics and Communications Engineering	KS	47

Source: National Center for Educational Statistics.