FLYING INTO THE FUTURE WITH

AEROSPACE & DEFENSE

RESEARCH PREPARED FOR

The Advanced Manufacturing Jobs and Innovation Accelerator Challenge
Innovations in Advanced Materials and Metals Manufacturing Project
and The Greater Portland Export Initiative

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"*The Meeting 2011*"; oil on canvas 60x36", © 2014 Donna Steger

"The Meeting 2011" depicts an early morning performance meeting, held at the Oregon National Guard's Oregon Sustainment Maintenance Site (O.S.M.S) at Camp Withycombe in Clackamas, Oregon.

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PREFACE[1]

The federal government has awarded a grant in support of advanced manufacturing and advanced materials to five counties in Northwest Oregon and Southwest Washington: Multnomah, Clackamas, Washington, Clark and Cowlitz. The Greater Portland-Vancouver region is one of only ten U.S. regions to receive this opportunity.

The Advanced Manufacturing Jobs and Innovation Accelerator Challenge Grant for Innovations in Advanced Materials and Metals Manufacturing Project (JIAC IAM^2) is a three-year award (2012-2015) funded by the Small Business Administration, the National Institute of Standards & Technology and the Economic Development Administration of the Department of Commerce, the Employment and Training Administration of the Department of Labor, and the Department of Energy. It focuses on specific industries with the greatest potential for the regional manufacturing ecosystem.

Two aspects of success singled out the Portland, Oregon-Vancouver, Washington region for this distinctive recognition: first, the collaborative approach among multiple organizations across five counties in two states; and second, the region's manufacturing heritage and its export success as detailed in the Greater Portland Export Initiative (MEI) completed in partnership with the Brookings Institution.

The goal of this research is to provide insights and guidance for strengthening the region's economy by directly affecting its manufacturing capabilities and capacity in two distinct ways:

1. Enable small and medium manufacturers to improve and expand through business and technology improvements, market diversification, and exporting, so they become more productive, hire more employees, and make greater direct financial contributions through wages and taxes.
2. Provide insights that help regional economic development agencies retain existing companies, attract new businesses, and support high-potential businesses.

This report is the third part of a four-part research portfolio addressing advanced manufacturing and advanced materials in major Portland-Vancouver regional industries. The other reports include (part one) Advanced Manufacturing & Advanced Materials; (part two) Computers and Electronics; and (part four) Metals & Machinery.

Thirty companies have been selected to receive direct technical assistance. None will receive financial payments; all will receive substantial support in terms of advanced manufacturing process improvements, advanced materials implementation knowledge, workforce training for incumbent and new employees, market research, and exports.

The Aerospace & Defense industry focuses on military and commercial aircraft, space systems and related supply chain portions of "Aerospace & Defense." This research does not broaden that definition to include land vehicles and systems, naval vehicles and systems, or security and defense contracting software and services. The scope also does not include users of these products and services, thus excluding the air transportation industry (freight and passenger airlines).

While prepared for the Columbia River Economic Development Council by the Oregon Microenterprise Network, this research has been developed in collaboration with many regional entities including: Business Oregon, Oregon Manufacturing Extension Partnership, Impact Washington Manufacturing Extension Partnership, Pacific Northwest Defense Coalition, Southwest Washington Workforce Development Council, and Worksystems, Inc.

1 Note: This research includes industry and employment statistics that vary depending on sources; data reflects the seven-county Portland Metropolitan Statistical Area (MSA), even though only five of the seven counties were included in the award. However, the variances are not significant enough to affect the overall meaning of the information provided about the grant region.

EXECUTIVE SUMMARY

The Aerospace & Defense Industry (A&D) is powered more by Computers & Electronics (C&E) than it is by aviation fuel. Just as "smaller, better, faster" is crucial in C&E, "lighter, farther, faster" is now imperative in A&D. The global industry is flying high, having grown more than 50% in the past ten years despite the banking crisis, recession, European debt, and geopolitical instability in the Middle East.[2]

Findings

Industry environment forces affecting A&D manufacturers include:[3]

- Fuel prices
- Economic growth
- Environmental regulations
- Infrastructure limitations
- Market liberalization policies[4]
- Emerging markets
- Changes in other modes of transportation
- Technology changes

Electronics fly the plane as much as the pilot does, and electronic systems must be adapted to new composites, which are less conductive than traditional metal. Sensors, guidance systems, brakes, communications . . . all depend on C&E.

Materials for manufacturing include high-grade aluminum, titanium, carbon fiber and carbon and boron composites, as well as special steel alloys. Airbus and Boeing are making wings, tails and fuselage from a strong, durable, lightweight mix of materials.

Manufacturing includes systems development for guidance, communications and space vehicles – all based on C&E technology. Aircraft components are designed using CAD-CAM systems, and computers are crucial for testing and operating aerospace products. Prototyping and testing can take years, but additive manufacturing is changing that dramatically.

2 Navigating the Future, Airbus Global Market Forecast 2012-2031

3 Boeing Current Market Outlook 2013-2023

4 When government does not discriminate against imports or interfere with exports by applying tariffs, subsidies or quotas

“What began eight years ago as a plan for Airbus’s first jet built mainly with lightweight composites is now a complex assemblage of millions of parts governed by millions of lines of computer code.”

Bloomberg Businessweek, February 26, 2014

Supply Chain

While designs are specified by Original Equipment Manufacturers (OEMs) referred to as "primes" in the A&D industry (because they are prime contractors to the federal government), products are usually developed in conjunction with subcontractors. Smaller contractors generally work for specific Tier One or Tier Two contractors.

Product Markets

There are two major aerospace market segments: commercial and defense. The U.S. Department of Defense (DOD) is the industry's largest client. Other customers include foreign defense agencies, civilian agencies, commercial airlines, NASA, cargo transportation companies, private companies and private individuals. Substantial opportunity exists in both defense and commercial markets for helicopters and unmanned vehicles in particular.

Pricing

Costs for materials and supplies are highly variable. Boeing commercial aircraft range from $50 million to $300 million. Private aircraft range from single engine planes at $100,000 to small jets costing $50 million or more.

Regulation

Aerospace manufacturing is highly regulated by U.S. agencies, all branches of the military, NASA, the Federal Aviation Authority and Homeland Security. Certifications are required and companies contracting with the military are subject to on-going oversight and audits. They must follow policies for security, export controls, technology transfer, and market access that may limit their ability to compete globally.

U.S. Government Contracting

Long sales cycles mean relationship building and a voice on Capitol Hill are important. Contracts are fixed-price or cost reimbursement. Aircraft component manufacturers can sell directly to airlines and the military and have their products specified in contracts for new aircraft.

Talent

Highly skilled, sometimes unionized workers comprise aerospace labor, including scientists, engineers and skilled production workers who typically earn more than other manufacturing employees. Forty to fifty percent of the current aerospace workforce will retire over the next ten years. With no major space development program to entice them, it is difficult to attract qualified engineers who opt for jobs in other industries. Lack of skilled workers could cost the U.S. its market leadership.

Exports

Growing markets in China, India, Brazil and other developing nations provide huge growth opportunities in commercial aerospace. As their economies grow, so does a worldwide middle class that wants to travel and to ship goods around the world by air. Increasing demand from countries investing in modern civil and military aircraft will also lift the industry.

Competition Hits Close to Home

The Pacific Northwest is one of the world's preeminent aerospace hubs. One hundred fifty aerospace companies throughout Washington employ more than 89,000 people.[5] Regional companies supporting them include machine shops, tooling firms, engineering and design firms, suppliers of metals and advanced materials, and interiors specialists. C&E companies employ thousands more, from Puget Sound through Vancouver to Portland. As the Aerospace & Defense industry grows in the U.S. and internationally, the region has much to gain. However, as with Intel in the C&E industry, much of the region's A&D business comes from one company: Boeing.

5 Washington Aerospace Partnership Competitiveness Study, Accenture, November 15, 2011

Until recently, Boeing competition has been limited to the European Union's Airbus. Today, companies in Canada, Brazil, China, Japan and Russia are competing to challenge the Boeing-Airbus duopoly.[6]

To limit their risk, supplier companies in A&D should seek to diversify their products, the industries they supply, and the geographic markets into which they sell.

Regional A&D Strengths

- "Know-how" for implementation of defense contracts
- Relatively low cost of doing business
- Climate of innovation – smart, flexible, willing to change
- Homegrown small and medium companies willing to fight hard to compete
- Strong base in industrial manufacturing
- Strong National Guard and aviation presence
- Access to Pacific Northwest aerospace and defense primes
- Cross-industry cooperation attractive for federal defense appropriations and workforce training funds
- Intra-industry collaboration and support organizations (e.g., Pacific Northwest Defense Coalition)
- Potential for increased civil aviation expenditures to off-set declines in military spending

Regional A&D Cautions

- Most prime military companies and Tier One suppliers are not here
- Aging workforce means companies are losing qualified staff
- Shortage of qualified workers makes it difficult to replace retirees and fill new A&D technical jobs
- Logistics and transportation infrastructure: bridges, highways
- Innovation capacity, technology transfer & commercialization – primes invest with universities and R&D labs to develop new technologies, but they retain and protect intellectual property rights as crucial to their competitiveness
- Lack of capital investment and state funding
- Industry is project-driven and revenue projections are difficult
- Reductions in federal defense spending

Implications

To limit the region's risk, government, universities and economic development agencies can strengthen A&D resources and competencies by investing in:

- Bi-state efforts to improve logistics and infrastructure, especially highways, bridges and rail systems for port access
- Workforce training and apprenticeships for A&D and C&E machinists, welders and other skilled occupations
- Cooperative university/industry degree programs focused on industry needs. For instance, Texas A&M and five other Texas universities offer degrees in Drone Technology.
- R&D and commercialization through more grants and SBIR/STTR (Small Business Innovation Research and Small Business Technology Transfer) awards
- Joint university/industry R&D efforts in computing, manufacturing and materials innovation
- Development of small and medium manufacturing businesses to ensure a robust, knowledgeable, convenient supply chain with certifications needed to compete globally
- Targeted tax reform and incentives enhancing regional business attraction
- STEM (Science, Technology, Engineering & Math) education for K-12 and secondary students to fill future jobs

6 Ibid

TRENDS

"Countries want stuff made in their countries; companies want to be close to their markets. Boeing has a distributed supply chain, with fuselage fabrication outsourced for market accessibility."

"... huge boom in drones for commercial use ..."

"Practical applications . . .intelligence, surveillance, reconnaissance, border patrol, coastal monitoring, anti-piracy . . . environmental, search and rescue, disaster relief, fire fighting."

"... photo infrared from airplanes to monitor crop health and measure moisture and dryness, soil temperature, amount of nitrogen . . . farmer [uses] a 4' aircraft preprogrammed with GPS."

"45% to 55% is unmanned systems; that will really grow when the FAA opens up more airspace. Police, Homeland Security, agriculture will all use it."

"Cost overruns are not allowed. The F35 Joint Strike Fighter costs $400 billion. Lockheed Martin doesn't get paid if they make a mistake or run late."

Aerospace "... requires NADCAP certification to do work for the Air Force, Bombardier, GE Aircraft, Textron, UT . . . Getting two certifications is not as daunting as getting the first one."

"Many U.S. companies think all scale is U.S. scale; but they need to scale by 100x or even 1000x to compete globally. How do you scale that big?"

"Small runs accommodate change . . . no shelf-life inventory . . . low cost for engineering revisions, design changes and obsolescence."

SUPPLIERS

"We self-fund and buy equipment up to $25,000. Can't afford the $100,000 machines."

"Obsolescence is a big challenge for aerospace . . . Shelf life dates are regulated and new projects require new components."

"Basic commodities have to be purchased from ethical sources and you must . . . trace their sources . . . act responsibly -- environmentally, socially and legally."

"Build aerospace parts for 100 years . . . 1967 components are still being reordered in 2013."

"Find a niche where you fit without trying to be everything to every customer. Situate next to companies who need what you do."

SUPPLY CHAIN

"Insitu was spun off [from Boeing] for aerospace and electronics design, development and production of high-performance unmanned aircraft."

"Coatings and painting go to Michigan . . . has concentration and expertise because of the auto industry."

"95% of what [we] need is here within an hour's drive. Japan, China stuff all comes through local and regional distributors. Circuit boards, plastic, metal . . . Most of what we do is also sold within two hours of here."

"Aircraft are modular, allowing upgrades as technology advances." "Technology is not in the mechanics of the equipment, it's in the electronics and the automation."

". . . ceramics, polymers and plastics, glass, special surface treatments, graphene, fiberglass and composites . . ."

TECHNOLOGY

"Carbon fiber composites for aircraft like the Boeing Dreamliner . . . lighter, stronger weight . . . bigger windows . . . higher cabin pressure for more passenger comfort."

"Radio Frequency use in aircraft is growing. Pilot and ground crews need to text. By 2014 all European aircraft must be able to text alphanumeric messages to the ground instead of using radio . . . air waves are so busy."

"GPS . . . unarmed systems in commercial aircraft . . . talk autonomously to avoid a crash at PDX."

"Lidar is like radar . . . remote sensing technology that measures distance with a laser and analyzes reflected light."

". . . thick film-based printed sensors, printed batteries, smart labels . . . integrated devices."

EXPORT

"More is coming back on shore . . . shift from outsourcing to manufacturing at point of use. Japanese car makers are all in the U.S. South now . . . cheaper to build here than ship."

"Do more with Canada but know their regulations are different. U.S. bidders need to be certified to cross into Vancouver and Calgary. AS9100 is not enough."

"Know what ITAR means you can't do."

"Regulatory controls are a big challenge. Defense is particularly fraught, even for labeling and documentation. Know how to code documents to protect them. Have expert guidance . . ."

". . . [set] up factories in Brazil and [partner] with locals to avoid paying tariffs."

THE REGION

"Value-added engineering wants to stay here . . . local engineering centers . . . local wire harness manufacturers."

"Ports, energy, close to Asia . . . all are better here than South Carolina, Kentucky and Arizona."

"University research is hard to scale up here . . . no great regional partner universities like Carnegie Mellon had with three others on one site in Philadelphia. Core is under one roof versus distributed in the Northwest. We can't compete with that, even with rock star professors we have. It's nichier here."

"I see no value or relevance in working with local universities. We do work with Virginia Polytechnic Institute and State University."

"We are conveniently located to the coasts . . . centrally located between Asia and the East Coast."

INTRODUCTION

The airplane was invented in 1903 and has since "transformed travel, warfare, and our view of the world."[7] The Wright Brothers' "Flyer" was a fabric-covered wooden structure steered by shifting the pilot's hips to move the rudder.[8] Today's aircraft are made of lightweight alloys and composites impervious to the elements and run by complex avionic systems. After the pilot of a Bombardier Q400 or an Airbus A330 passenger jet controls the plane during takeoff, they can switch to autopilot and let software do the flying while the plane cruises at 16,000 feet.

The first automatic pilot, called a "metal airman," consisted of two gyroscopes: one mounted horizontally, the other vertically. They were connected to the plane's controls and powered by a wind-driven generator behind the propeller. One gyroscope kept the plane level while the other did the steering.[9] Onboard computers with complex software and sensors that record information and automatically adjust altitude, speed and bearings control modern autopilots.

Dashboard dials have been replaced by digital displays. "On a typical flight, a human pilot holds the controls for a grand total of just three minutes . . . pilots monitor screens and key in data . . . they've become computer operators."[10]

The Aerospace and Defense (A&D) industry includes manufacturers of aircraft and aircraft parts, weapons and intelligence systems, satellites and launch vehicles. Communications and remote sensing satellites are used for military, commercial and scientific purposes. Launch vehicles are used to deploy satellites into orbit for weather, GPS systems and surveillance. Unmanned Aerial Vehicles are used for defense, surveillance and agriculture.

Military and commercial markets combined, the U.S. industry grew 5.9% in 2012, up from 1.6% growth in 2011.[11] In 2013 it increased 4.3% to $719 billion driven by a surge in the commercial aerospace market.[12] Commercial aerospace, the largest growth sector, includes business and civil uses. The military and defense includes Homeland Security and surveillance as well as warfare. Experts predict another year of record output in 2014. The industry is expected to grow to a value of $4.5 trillion over the next 20 years.

7 James Fallows, The 50 Greatest Breakthroughs Since The Wheel. The Atlantic, Technology Issue, p. 56 November 2013

8 http://www.pbs.org/wgbh/nova/wright/flye-nf.html

9 Nicholas Carr, The Great Forgetting, citing Popular Science, 1930. The Atlantic Magazine, November 2013

10 Ibid p. 78

11 IBISWorld, 2013

12 Price Waterhouse-Coopers Aerospace & Defense 2013 Year in Review and 2014 Forecast

Technology Trends

- Fifty percent of the cost of a Boeing 787 goes to hardware, and fifty percent to navigation, guidance and control; and of that, fifty percent goes to software[13]
- Systems changes: how the aircraft is controlled, how it talks to other aircraft and to ground control; how it collects data and what is done with the data
- Software that is bug-free and intricately connected to the hardware, developed by Rockwell Collins and Ramco Aviation
- Increased communications with ground control for more efficient landings
- Aircraft-to-aircraft communications monitoring the rudder, landing gear and other parts to coordinate flight patterns; the U.S. Air Force has tiny drones that can swarm together for surveillance, targeting and assassination; Boeing has a system for larger unmanned aircraft
- Congress has authorized the FAA to plan air traffic control systems for unmanned craft by 2015
- Big data to integrate data collection among aircraft and satellites; DARPA's XDATA program is being developed to handle massive amounts of data
- Flying commuters via Jet Packs, a la The Jetsons, and flying cars are in the future, though still not in the works
- Aerospace engineering education: there are 65 training and university programs in the U.S. Of the 38,000 new aerospace engineering jobs in 2013, students took 4,000; Aerospace is the third most popular field for engineering students; many go into programming because "they know their software will be implemented on real hardware"[14]
- Systems: Aerospace has moved from hardware-based science and technology to systems-based engineering
- 3-D Printing: General Electric already produces LEAP engine nozzles with this additive manufacturing process

13 www.asme.org/engineering

14 Top 5 Aerospace Trends of Now and the Future. American Society of Mechanical Engineers. www.asme.org

Materials Trends

Lightweight metals and carbon fiber (also known as graphite fiber or carbon graphite), which consists of thin, strong crystalline filaments of carbon, are used as strengthening materials, especially in resins and ceramics. The strands are thinner than human hair, twisted together like yarn, and bonded with plastic polymer resin by heat, pressure or in a vacuum. They are used in advanced composites because of their strength and light weight. The more complex the weave, the more durable the composite will be.[15]

Materials commonly used in A&D include corrosion-resistant metals such as titanium, titanium alloys and super alloys. Materials of particular interest include nickel-based alloys, thermal barrier coatings, modern carbon composite materials, thermal and night vision sensor materials, radiation-hardened electronics, high precision optics, glasses and plastics, solar panels, paints and ceramic armor materials. All require tight control of material properties, composition and chemistry.

- Stainless and specialty steels
- Copper
- Aluminum and aluminum alloys
- Titanium and titanium alloys
- Magnesium
- Nickel-based alloys
- Zirconium
- Hafnium
- Niobium alloys
- Grain-oriented electrical steel
- Carbon fiber

Business Trends

- New competition for Boeing and Airbus from China
- Increased helicopter production
- Changing business models, including air taxis providing unlimited air transport for a monthly subscription fee
- Outsourcing of turnkey services, trading off complete control for cost
- Concerted transfer of knowledge from the retiring generation to new workers[16]
- On-going consolidation
- Intensifying cost pressure, requiring contractors to rethink operating models and economics to operate at lower production rates due to cuts in A&D budgets[17]
- Greening of aerospace and defense products: fuel efficiency, lower carbon emissions[18]

15 composite.about.com/od/aboutcarbon

16 http://www.stantonchaseonleadership.com/2013/09/aerospace-and-defense-industry-faces-the-best-and-worst-of-times/

17 Booz & Company Consulting
http://www.booz.com/global/home/what_we_do/industries/aerospace_defense

18 Ibid

Aerospace & Defense Industry Sectors*

NAICS Code	Manufacturing Sector	Regional L.Q.
33451	Measuring & Controlling Devices: Search, Detection, Navigational Instruments, Guidance, Aeronautical and Nautical Systems, Night Vision Instruments, Auto Leveling Instruments	1.53
33641	Aircraft Engines & Parts, Space Vehicles & Missiles, Unmanned Aerial Vehicles	0.60

*North American Industry Classification System, U.S. Census Bureau. This research does not address Military Armored Vehicles, Tanks, Guns, Ammunition, Body Armor, and Shipbuilding

Figure 1

Key Supplier Industries

NAICS Code	Manufacturing Sector	Regional L.Q.
33441	Circuit Board & Electronic Components, Computers & Peripherals, Semiconductors & Circuits	9.25
3315	Ferrous & Non-Ferrous Metal Foundry Products	4.53
33451	Measuring & Controlling Devices: Search, Detection, Navigation Instruments, Guidance, Aeronautical and Nautical Systems, Night Vision Instruments, Auto Leveling Instruments	1.53
33271	Machine Shop Services	1.17
3321	Fabricated Metals, Light Metals, Composites	.25
3311	Iron & Steel Manufacturing	Not Disclosed
33142	Copper Rolling, Drawing, Extruding	Not Disclosed
3252	Plastics & Polymers	Not Disclosed

*North American Industry Classification System, U.S. Census Bureau

Figure 2

A Location Quotient, or LQ, is a way to quantify how concentrated a particular industry is compared to the national average. It indicates what makes a region unique. An LQ greater than one is above the national average.

This research focuses on aerospace, avionics and aeronautics. It also provides in-depth looks at the helicopter and unmanned aerial vehicle (UAV) markets, as they are growth opportunity segments. It does not focus on military weapons and equipment, land systems, or homeland security for the following reasons:

- Commercial aircraft is a growing market
- Aerospace is very important to the Northwest economy
- Aerospace offers export opportunities in developed and developing economies
- The industry is very broad; justice cannot be done to all parts within the confines of one report

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

Despite defense spending cuts of $85 billion in 2013, 2014 is predicted to end with modest growth for the combined commercial and military aerospace and defense industry.

The current rise in commercial aircraft production indicates years of growth potential, mostly due to replacement; by 2020, mid- and older-generation aircraft will represent only 5% of the planes in service. However, that is not expected to make up for lower industry revenue and employment due to the downturn in defense spending.[19]

Developed and more mature markets will see continued growth. By 2031, over 60% of all air traffic will involve advanced aviation, as older aircraft are replaced with more fuel-efficient models. It is estimated that 42% of all aircraft with more than 100 seats will be delivered to North America and Europe,[20] as the rest of the world develops and upgrades their aerospace capabilities and infrastructure.

The commercial sector is growing and rapidly globalizing, propelled by increasing passenger demand from international markets with growing middle classes who can afford to travel. Growth in defense is likely to be moderate but steady. U.S. and European budget cuts will be countered by international demand for increased capacity and upgraded sophistication of civil and military aircraft for passenger travel, agriculture, firefighting and medevac, as well as defense.

19 Aerospace & Defense Industry in the U.S. A financial and economic impact study. Deloitte, March 2012

20 Navigating the Future, Airbus Global Market Forecast 2012-2031

Aircraft manufacturing is dominated by large commercial and military OEMS called "primes." Tier One and Tier Two subcontractors provide much of their pre-assembly work. Negotiations among primes, contractors and subcontractors are complex, with strict requirements for certifications and delivery guarantees.

Demand is volatile for U.S. military aircraft, weapons and intelligence systems because of the complexities of long-range national defense planning and budgeting, the divisive political climate of the U.S. Congress, and a highly competitive international market. Demand is more predictable for commercial markets based on population growth, economic development, and aging U.S. and European fleets.

All segments of the industry are capital-intensive. Designing complicated new systems requires long lead times. Production requires coordination of capital, manufacturing equipment, skilled personnel, materials and parts.

The aerospace industry is a global universe of public institutions and private corporations focused on research, technology, and manufacturing for flight, defense and atmospheric reach; it encompasses national defense, communications, and commercial air travel. It promises to be at least as important in the future as it has been since it began in 1908, when the U.S. military awarded a contract to the Wright Brothers for a single airplane. Lucrative defense contracts for fighting a series of international wars drove industry growth in the early and mid-20th century. Commercial aviation derived much of its equipment and technology from wartime industrial development after WWII. Bombers and military cargo airplanes were converted to civilian use, and veterans of military aviation became pilots in civilian aviation.

In 1957 when the Soviet Union successfully launched Sputnik, the first man-made satellite to orbit Earth, the aerospace industry focused its attention on space flight. The space race became a major component of the Cold War, and industrialized countries, especially the Soviet Union and the U.S., poured resources into space travel and weaponry such as intercontinental ballistic missiles (ICBMs). Moon landings, interplanetary exploration, and manned orbital satellites became realities. The scope of the aerospace industry has since grown and changed dramatically, thanks to technology changes as well as geopolitics. While military contracts remain a large economic driver for aerospace, computers and electronics have generated the biggest changes, such as satellites that provide a reliable global communications network.

The market has also evolved, as commercial and corporate aircraft are now a significant driver of product development for corporations that once supplied only the military. As those companies merged, their national identities declined and their military role receded. Early in the 21st century, aerospace became increasingly global as governments collaborated on programs such as the international space station, working together to develop more efficient use of technology and resources.

Aerospace is driven by research and development grants and programs at major colleges and universities. The industry requires huge R&D investments and capital-intensive manufacturing. Time frames are different for A&D than for most other industries. Boeing plans 20-year forecasts for planes that can cost up to $20 billion.[21] That is a management challenge for primes and suppliers, given the rate of technological change, the expense of new development projects and the length of time they take to design, prototype, test, build, retest, refine, retest and take off. Demand is constant for new technologies in fuel efficiency, aerodynamics, electrical and computer-based capabilities, weight reduction and new materials. All that change has to be accomplished with extended product life cycles: planes being replaced today are 40 to 45 years old and still flying.

The contribution of A&D is more than direct economics. By enabling international trade and encouraging tourism and foreign investment, it's also a major driver of social and economic development. It fosters immigration, provides increased productivity, job opportunities and higher standards of living.[22]

"If aviation were a country, it would rank 19th globally in terms of GDP."[23]

21 "Boeing beholds a broader balance," Flight Daily News, p. 20, June 17, 2013

22 Navigating the Future, Airbus Global Market Forecast, 2013-2031

23 Oxford Economics, published by Air Transport Action Group, 2012

Global Aerospace Contribution:[24]

- 57 million jobs
- $2.2 trillion economic impact, 3.5% of global GDP
- 3.1 billion passengers in 2013 – predicted to be 3.5 billion by 2016
- 10.7% growth in air cargo shipped, estimated to grow 4.7% per year over the next 20 years. Air traffic will double by 2033[25]

The top 20 global A&D companies reported combined revenues of $365.8 billion during the first nine months of 2013, a year-over-year increase of 4.3%. The top 20 U.S. companies grew 1.5% to $266.2 billion.[26]

Companies in this industry manufacture and overhaul complete aircraft, develop prototypes and convert aircraft. The industry includes the manufacture, conversion and overhaul of aircraft engines and propulsion systems, and it makes related parts and auxiliary equipment, including aerial spray systems. Global competition will increase to meet emerging market demand, and revenue is expected to increase.[27]

Aircraft are the largest source of industry revenue. Aircraft engines and engine parts represent the second largest segment. The industry has had its ups and downs in the past couple years. The recession caused domestic and global consumer discretionary spending to fall, which led demand for air travel to tailspin. Consequently, demand from domestic and international airlines dropped by 16.3% and 20.6 % respectively in 2009. However, the following year, demand for air travel began to recover and airlines again began purchasing aircraft and parts. Foreign demand was particularly strong as air travel in growing emerging markets took off. Since more than half the industry's revenue is generated through exports, global demand allowed industry revenue to recover from its recessionary low. The increase in 2013 was expected due to strong global and domestic demand for commercial aircraft.[28]

The defense segment, which benefited from strong military demand for combat operations in the Middle East, saw revenue decline as federal defense spending began to drop in 2011. The end of combat operations in Iraq, plus budget cuts, reduced the amount of money the government allocated toward purchases of military aircraft and related parts.

Price competition during the recession, as well as the need to reduce supply chain complexity, led to consolidation, with industry enterprises declining by an estimated 0.7% to 1,272 businesses in the five years preceding 2013. Consolidation will continue as increased demand encourages larger suppliers with the necessary capacity to handle increased demand.

24 International Air Transport Association, December 2012

25 International Air Transport Association 2013 Annual Review, June 2014

26 Boeing World Air Cargo Forecast 2014-2015

27 2015 Global Aerospace & Defense Industry Outlook. Deloitte, November 19, 2014

28 IBISWorld 2013

Product & Service Sectors

Demand comes from aircraft companies, commercial airlines, charter flight airlines, corporations, individuals, and the military. Common parts include:

- Engine
- Fan blades
- Plane wings (including newly developed sharklet wing-tips used by Airbus and JetBlue)
- Helicopter rotors
- Fuselage
- Cockpit
- Cabin
- Windows
- Tires
- Electromechanical systems
- Computers
- Landing gear
- Debris rejection systems
- Brakes
- Seats – permanent and ejectable

There are three major components of the Aerospace Industry: Aircraft, Aircraft Engines & Engine Parts, and Other Aircraft Parts & Auxiliary Equipment.

Aircraft

Aircraft manufacturing accounts for an estimated 58.9% of industry revenue. This segment includes civilian and military aircraft as well as modifications to finished aircraft, including airplanes, helicopters and unmanned vehicles. Civilian aircraft include large commercial aircraft, medium or regional aircraft, business jets, helicopters and ultra-light aircraft. That market, headed by Boeing, includes air freighters built for logistics transport. Boeing manufacturers supply for nearly all commercial passenger airlines and freight and logistics companies that provide air transportation, such as DHL, UPS and FedEx.

Aircraft manufacturers are contracted by governments to build military aircraft, including fixed and non-fixed wing aircraft. This sector is further segmented into bomber, attack fighter, tanker, cargo, trainer and rotary aircraft. A fighter or attack aircraft is designed primarily for attacking another aircraft, whereas a bomber is used to attack ground targets by dropping bombs. The production of unmanned aerial vehicles, which are remotely controlled or flown autonomously based on preprogrammed flight plans, has increased in recent years as the military's use has skyrocketed. Military aircraft account for an estimated one-third of all aircraft manufacturing.

NAVIGATIONAL INSTRUMENTS
New technologies drive growth

This industry manufactures navigational, measuring, regulation and control instruments for aeronautical equipment, navigation, search, detection, and guidance systems. Suppliers include electrical equipment and wiring device manufacturers, glass products makers, hose and belt, and plastic pipe manufacturers. Products are used in avionics for aircraft, satellites and spacecraft. There are no major market players, leaving room for new suppliers.

Aircraft Engines & Engine Parts

Military and civilian aircraft engines, engine parts, and engine modification account for about 20.3% of industry revenue. Examples of aircraft engines include turbine, shaft, jet and rocket engines. Engines can be further segmented into takeoff thrust categories, which can then be matched against aircraft classes. In recent years engine fuel efficiency has increased as high oil prices and environmental concerns have created demand for more fuel efficient and clean means of propulsion. Besides improving efficiency, manufacturers have also used more composite material to reduce weight. Sales of engines and engine parts are expected to increase slightly as a percentage of industry revenue.

Other Aircraft Parts & Auxiliary Equipment

Parts and auxiliary equipment include civilian and military components and subassemblies, aircraft mechanical power transmission equipment, electrical systems, propellers, helicopter rotors, R&D on parts (excluding engines), and landing gear. Due to the high wear and tear on aircraft parts, sales in this segment depend on the amount of aircraft flying time. Some parts such as subassemblies use advanced materials such as composites, while others like fasteners are more standardized and see little innovation. This segment is expected to increase as a percentage of total sales due to renewed activity in commercial aviation, which more than compensated for the decline in federal defense spending during 2012.[29]

- Boeing predicts demand for 35,000 new airplanes over the next 20 years due to "vigorous growth" in emerging and low-fare markets.[30]
- Installation of lightweight high-definition cameras made by Portland-based Flir Systems for surveillance and search-and-rescue – used to search for Costa Concordia survivors and to hunt for the Boston Marathon bombers.

29 Predicast Wireless News, July 21, 2013

30 Paris Airshow News, p. 33, June 17, 2013

COMMERCIAL & BUSINESS AIRCRAFT SECTOR

This segment accounts for 14.4% of industry revenue and is primarily made up of commercial airlines, primes, and parts wholesalers. After delaying orders for new aircraft due to poor economic conditions, domestic airlines have recently begun buying new planes to meet rising demand for air travel and reduced fuel costs. Primes purchase parts from industry suppliers to assemble their aircraft. As global demand for commercial aircraft has increased, so has demand for parts, with primes struggling to meet market demand. The commercial segment's share of revenue climbed in the five years prior to 2013, reaching an all-time high thanks to new aircraft types and increased production demand. For the first time in several years, business aircraft demand is expected to increase as well, and backlogs already exist.

The industry will become more globalized over the next few years, as emerging markets in Asia and elsewhere continue to grow.[31] Foreign airlines will purchase an increasing number of commercial aircraft and parts to meet their needs for increased air travel. Geopolitical tensions in the Middle East and Asia show no serious signs of slowdown, which could translate to more demand for U.S.-built military aircraft. In the five years preceding 2018, industry exports are forecast to climb at an annualized rate of 5.3% to $154.1 billion.[32]

Since 2009, sales of piston and turboprop aircraft have been depressed due to the poor economy. While some growth is expected in 2013-14, this segment may remain sluggish due to the number of high-quality, previously owned planes on the market; the reduction in people earning pilots' licenses; tight credit conditions; and the price of fuel.

Suppliers to primes will face increased production requirements and are expected to invest in workforce training, new tooling capabilities and manufacturing capacity in order to remain competitive.

Mergers and acquisitions in 2012 were twice the level of 2011, including United Technologies Corporation's acquisition of the Goodrich Corporation. Mergers and acquisitions were consequently weak in 2013 amounting to $11.9 billion; but they are expected to increase again in 2014, as many producers are in high-cash positions and interest rates are at record lows.[33]

31 IBISWorld, 2013

32 Ibid

33 Mission Control: Aerospace & Defense Mergers and Acquisitions, PriceWaterhouseCoopers, 2014

For the billionaire who has everything . . .
Gulfstream delivered 30 G650 jets in 2013. For $65 million, one can travel 7,000 miles nonstop at the speed of sound, circling the globe in 41 hours 7 minutes. Sales of this private jet are backordered until 2017.

Bloomberg Business Week, Defense & Transportation, January 2014, p. 121

The commercial sector is comprised of the following market segments:

Civil Aviation

- Commercial passenger transport aircraft
- Commercial freight transport aircraft
- Business & corporate aircraft
- Helicopters
- General aviation aircraft

Maintenance

- Engines
- Repair & overhaul
- Interiors, conversion, modification
- Spare parts management & services
- Chemicals, paints, coatings
- Fuel & lubricants
- Machines & tools

Airport Equipment & Services

- Ground support equipment & services
- Cargo & logistics
- Airport security
- Air traffic management
- Air traffic control equipment
- Radar & navigation receivers & transmitters
- Simulators & training equipment
- Equipment

THE AEROSPACE & DEFENSE AIRCRAFT SECTOR

The military aerospace and defense sector is comprised of the following sectors:

Aircraft

- Combat & transport aircraft
- Military helicopters
- Unmanned aerial vehicles

Space Technology

- Launchers & spacecraft
- Satellites & space systems
- Navigation systems
- Imaging

Military & Defense Technology

- Air defense systems
- Military training & simulation
- Battlefield management

Weapons, Armaments & Combat Control Systems

- Missiles
- Lethal & non-lethal ammunition
- Pyrotechnics
- Artillery, weapons & armaments
- Launchers & launching systems
- Fire control systems

Land Systems

- Armored & unarmored combat vehicles
- Troop transports
- Logistics vehicles
- Platforms & propulsion
- Robots

Homeland Security

- Individual clothing & equipment
- Health & survival equipment
- Personal security, protection & rescue
- Surveillance
- Mine clearance equipment
- Antiterrorism & special forces

COUNTERFEITING

"17% to 20% of worldwide components in aerospace and defense are estimated to be counterfeit. Prime contractors want counterfeit mitigation programs and only buy from authorized distributors . . . counterfeit parts . . . create the potential for product malfunction . . . personal injury and even death."

Source: www.industryweek.com/supplychain. The Ticking Time Bomb of Counterfeit Electronic Parts. July 22, 2013. See also globalpurchasing.com, Aug. 13, 2013. www.hq.nasa.gov

Global defense revenues were flat for the first nine months of 2012 vs. 2011. Demand is expected to continue to be slow in 2014. The defense sector has declined due to:

- Reduced federal defense spending in the U.S. and Europe
- Reductions in U.S. fighting overseas (Iraq, Afghanistan)
- Change in warfare from ground forces to targeted and unmanned missions

The U.S. dominates the sector with 41% of spending. Increased demand from international markets is expected to help balance U.S. defense declines, as countries like Brazil, Australia and Saudi Arabia upgrade their fleets.

Major U.S. Defense Competitors Supply Each Other

The top ten defense contractors to the Department of Defense receive billions of dollars in government contracts annually. When they are not fighting each other for a bigger share of the pie, they work for each other to build planes, tanks and ships.[34] Lockheed Martin supplies United Technologies. Lockheed and Boeing competed with Northrop Grumman and McDonnell Douglas (owned by Boeing) to build the F22 fighter jet. Lockheed won and hired Northrop to build the jet's radar system.

L-3 Communication supplies circuit cards for Lockheed's F-35 Lightning II fighter jet. Northrop Grumman makes the fuselage and United Technologies builds the engine. General Dynamics provides alarm systems for Lockheed's sea-launched ballistic missile program. Boeing makes U.S. Air Force tanker planes and hires Northrop Grumman to make its infrared countermeasures system, while Raytheon makes its radar-warning receiver and digital GPS anti-jam receiver.

Abrams tanks are built by General Dynamics with parts from Northrop Grumman and Raytheon. Boeing is Raytheon's top supplier of goods and services. Northrop Grumman's second largest supplier is Lockheed Martin, but General Dynamics supplied Northrop's Enhanced Polar System Control and Planning Segment.

34 Business Week, Politics & Policy. Defense Spreading the Wealth, p. 29. Feb 3, 2014

U.S. Aerospace Companies Share Common Growth Strategies[35]

1. Increasing Mergers & Acquisitions

- Lockheed Martin acquired Chandler/May Inc., manufacturer of unmanned aerial systems; now making U.S. Coast Guard's new Super Hercules C4ISR planes
- Boeing acquired Tapestry Solutions, Federated Software Group, CDM Technologies and Miro Technologies, software supplier specializing in enterprise asset and supply chain management and logistics
- General Dynamics acquired Applied Physical Sciences Corp., an R&D services company
- Raytheon acquired SafeNet Inc. Government Solutions, a data security firm, and Teligy Inc. cybersecurity
- Northrop Grumman bought MS Network Security, an Australia-based cybersecurity, mobile communications, and advanced analytics company

2. Joint Ventures & Collaborative Alliance Contracts

- Boeing and Textron are building U.S. Marine Corps Osprey ground-based trainers
- Lockheed Martin assists IERUS Technologies via Department of Defense Mentor-Protégé Program
- BMW and Boeing joint research program on carbon fiber materials, manufacturing and recycling
- Sojitz Corp. (Japan) and Boeing cybersecurity training
- Northrop Grumman and Finmeccanica SpA U.S. Air Force Combat Rescue Helicopter development
- General Dynamics and Huntington Ingalls engineering and support services for U.S. Navy amphibious transport docks

3. Foreign Military Sales

U.S. exports are predicted to remain strong. Middle Eastern Gulf countries are concerned about Iran's potential nuclear capability. Saudi Arabia is purchasing Command, Control, & Communications Computers and Intelligence systems. The Indian Coast Guard and Chinese companies are purchasing U.S. navigation equipment for cargo ships. Sales in South and East Asia are increasing and should make up for decreases from U.S. and European defense budget cuts. Even the Finnish Air Force is purchasing U.S. aircraft.

4. International Expansion

U.S. primes are focused on generating revenue from international military and commercial sales. Aging inventories and increasing security concerns are spurring export demand for C-17, F-15 and F-16 aircraft. Aviation is also a growth area for countries in Asia and Latin America with increasing middle class travelers, as well as in developing economies such as India, China, and Russia. All are reported to be increasing investment in the civil aircraft market. To remain competitive, U.S. makers must stay at the top in terms of technology such as advanced materials, sensors, information processing and sophisticated weaponry.

5. Business Consolidation

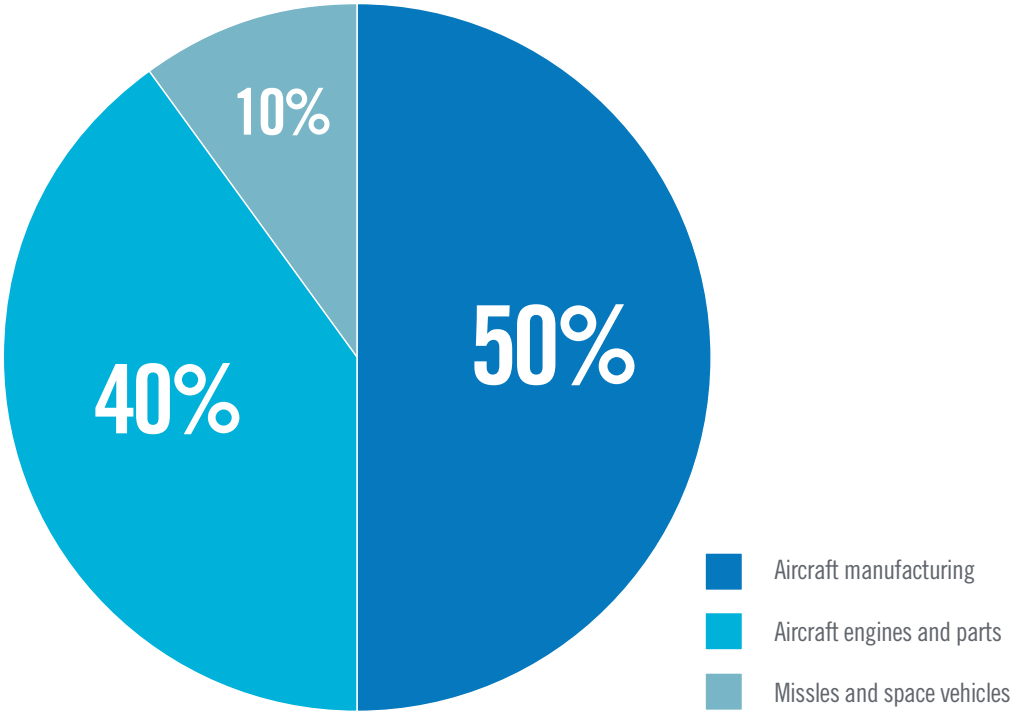
Companies are restructuring to save money and streamline operations. Boeing has downsized its defense executives by 30% since 2010, closed California facilities, and combined several business units. General Dynamics is cutting 350 jobs from its electronics division, and Lockheed Martin began a restructuring with layoffs in 2012-13.

35 Zacks Investment Research, Aerospace & Defense Industry Outlook, December 2012

Major Market Distribution Channels[36]

More than 50% of the industry's production is exported, and aircraft are the majority of those exports. That reflects demand for U.S. quality from foreign governments and commercial airlines.

Product Segmentation By Revenue[37]



Product Market Segmentation

Figure 3

Aircraft are the largest source of industry revenue. Engines and engine parts represent the second largest segment, accounting for 40% of revenue. Engine types include gas turbines, gasoline engines, gasoline engine parts, internal combustion engines, jet propulsion engines and rocket engines. They are further classified by the amount of thrust required and their maximum takeoff weight. Sales of engines and parts are predicted to increase thanks to demand for quieter, more fuel-efficient engines, even though over the past 40 years fuel burn has been reduced by 70% and aircraft noise has been reduced by 75%.[38]

Auxiliary equipment and other aircraft parts include civilian and military aircraft subassemblies and parts, mechanical power transmissions, propellers, helicopter rotors, rivets, flight systems and parts R&D For example, a Boeing 747 has more than six million individual parts.[39]

36 http://clients1.ibisworld.com/img/reportimages/us/industry/33641a/us_industry_33641a_06_MajorMarketSegmentsChartData.png

37 First Research, April 29, 2013

38 Navigating the Future, Airbus Global Market Forecast 2013-2031

39 Ibid

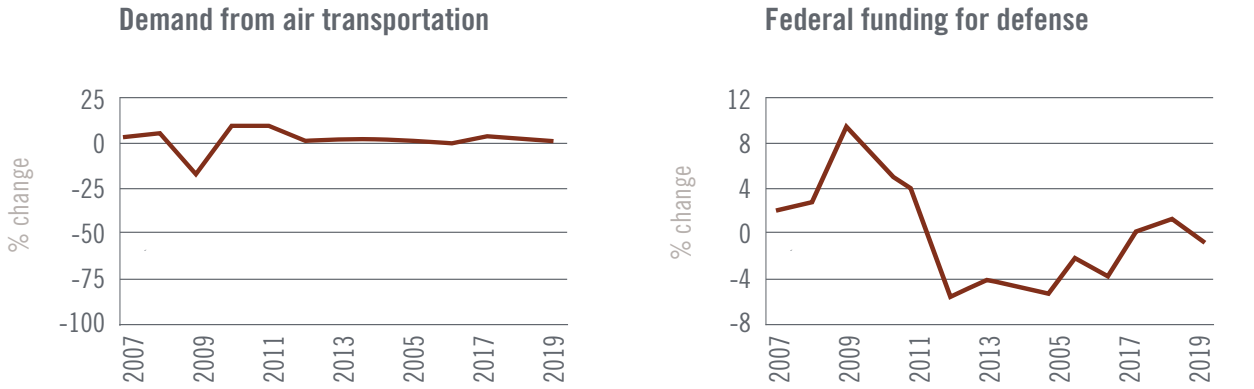
Aircraft Services Segmentation

The services sector is a growth area. Domestically and internationally there is a shortage of aviation mechanics and technicians, yet the long life span of commercial aircraft requires maintenance and repairs, as reflected by its 43.8% market share in 2013.

Projected Demand For Commercial & Defense Aviation

While defense spending is declining and air transport demand is flat, growth in parts, services, and new equipment is predicted to hold steady.

Air Transportation Demand



Source: IBISWORLD.COM

Figure 4

INDUSTRY & BUSINESS TRENDS

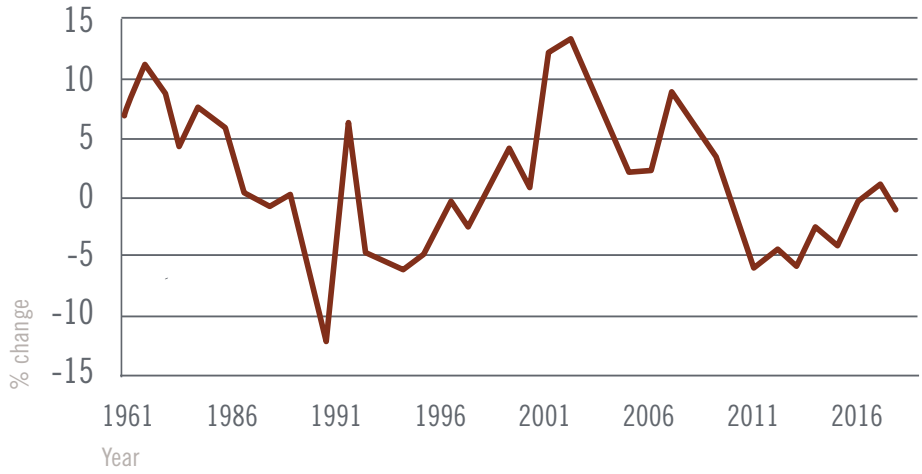
U.S. Federal Defense Spending

On March 1, 2013, the Budget Control Act created a $37 billion reduction in defense spending. Another $52 billion in cuts are expected over the next nine years. Budget deals may mitigate that between now and 2015, but defense contractors are already feeling its impact. In 2012, the top U.S. defense contractors experienced a 3.3% reduction in revenue. Through 2013 they saw a 4% increase in revenue vs. 2012. Revenue is predicted to increase in 2014, but at a slower rate.[40]

Estimated to be $660 billion in 2013, defense spending's compound annual growth rate from 2008 to 2013 was -0.2%. Growth is projected to remain flat through 2018 when it will be $596.8 billion.[41] Defense spending declined 5.6% in 2012 and was expected to fall another 4.3% in 2013.[42] That assumes troop counts in Iraq, Afghanistan, and other war-related areas will decrease to 60,000 by 2015. The Congressional Budget Office states that expected savings will be reinvested in "development or purchase of unmanned intelligence, surveillance, and reconnaissance assets; more ships; a new ground combat vehicle; the Advanced Extremely High Frequency Satellite; and the F-35 Joint Strike Fighter."[43] Other investments will include equipment upgrades, and any new wars will lead to expenditures above current forecasts.

Federal Funding for Defense, 1981 – 2016[44]

Following the impact of the Iraq War, industry revenue dropped and is expected to plateau through 2020.



Source: IBISWORLD.COM

Figure 5

40 2014 Global Aerospace and Defense Industry Outlook: Expect another record year for commercial aerospace and continued declines in defense spending. Deloitte, 2014

41 2013 Aerospace & Defense Year in Review and 2014 Forecast. Price Waterhouse-Coopers, April 2014

42 Ibid

43 Congressional Budget Office

44 IBISWorld, Federal Funding for Defense Business Environment Profile, January 2014

Revenue Outlook

Year	Revenue $ Million	Growth %
2015	190,390.0	4.5
2016	197,395.2	3.7
2017	204,598.7	3.6
2018	212,164.9	3.7
2019	219,269.2	3.3
2020	226,427.3	3.3

Source: IBISWorld, January 2014

Common Industry Challenges

- Technological obsolescence
- Reduced profitability
- New customer requirements
  - Electro-optical sensors
  - Cyber warfare
  - Unmanned platforms
  - Smart system solutions for security, energy and mobility
  - Low cost homeland security systems
  - New platforms and services
    - Earth observation
    - Communications
    - Navigation
    - Research and satellite services
  - Airborne surveillance and monitoring

Commercial and Defense Markets are Focused on New Technologies

- Weight reduction and fuel efficiency via composites and other new advanced and lightweight materials
- Radar and Lidar (Light Detection & Ranging remote sensing method for examining the surface of the earth)
- Software
- Simulation
- Integrated electronic and software environments
- Autonomous systems

Global Business Trends

- Defense focus on quick-strike capabilities: helicopters, missiles and mobile transport carriers
- Increased helicopter demand in the U.S. and Europe to replace aging fleets
- Air Force Fighter Fleet modernization requiring replacement of nearly all aircraft in the next 15 to 20 years
- Growth in Homeland Security/Surveillance Aerospace
- Growth in aerial firefighting, forestry and agricultural uses
- After-market parts for maintenance of aging fleets
- Increased operating efficiency to lower airline operating costs and decrease carbon emissions
- Outsourcing partnerships and alliances for faster, more efficient production of components and systems
- Global growth from emerging markets' increasing passenger travel
- Needs for increased security
- Increased demand that aircraft be built in their countries of origin to keep jobs at home
- New market entrants, particularly in commercial aircraft receiving government subsidies
- Increased government scrutiny and compliance of anti-bribery, anti-money laundering and ethical practices to keep competition healthy
- Defense budget reductions in U.S., U.K., and Europe
- Defense budget increases in Russia, India, Saudi Arabia, United Arab Emirates and Brazil
- Emergence of new primes in China, Japan and Russia
- **Primes' rationalization of their supplier bases**
- **Contracting and consolidating supply chain due to increased demand for integrated products and systems**

The last two points above are of particular significance to regional suppliers. Primes seek to limit costs and risks by reducing the number of suppliers on which they depend. Suppliers are merging to provide the scale and scope of capabilities sought by primes demanding modular and systems-level product solutions.

AVIATION INNOVATION

Products' battery technology is advancing rapidly to increase storage, extend the power grid and deploy renewable energy. New materials and nanoscience will allow engineers to double or triple a battery's energy density and reduce its cost by 50% to 70%. This will transform transportation and bring electric vehicles down to the cost of gas-powered vehicles.

- Increased use of electronics, computers and software connecting parts and systems, including communications in the air and with the ground; automated controls require parts suppliers to upgrade their knowledge and technology
- Increased production of piston and turboprop aircraft as well as business jets
- UAVs – Unmanned and Autonomous Aerial Vehicles: aircraft that fly without a human crew for commercial, military, defense/surveillance and civilian use
- VLJs – Very Light Jets: small aircraft approved for single pilot operations, seat four to eight people; maximum takeoff weight < 10,000 pounds
- Lower cost fuel-efficient jet engines
- Digital product definition, design and manufacturing for anywhere, anytime manufacturing

Seventy percent of new passenger plane deliveries will be single-aisle, reflecting emerging market growth and expansion of low-cost carriers; wide-body plane count will grow marginally to accommodate more international travel.

Air traffic control system improvements implemented by 2025 include satellite-based positioning, and navigation and timing systems to reduce fuel consumption, congestion, and weather-related delays. Those changes will require equipping aircraft with new on-board technologies.

There will also be more focus on passenger and crew health, safety and comfort, addressing air pressure, air quality, restricted movement, background noise, vibration, lack of privacy when speaking, lighting, seat design and cabin layout.[45]

New Materials

Composites, hybrid metals, alloys and polymers. The Airbus A350 uses a blend of 53% carbon fiber composite, 19% aluminum alloy, 14% titanium, 6% steel and 8% "miscellaneous" materials.[46] Advances in composites and metallic manufacturing are changing how aircraft are made.[47] Airbus has developed advanced aluminum alloys that can be welded flat and then formed to final cured shape.

45 Flight Daily News, Technology Research, p. 96. June 17, 2013

46 Intelligent and Aerodynamic Airframe. www.a350xwb.com

47 Manufacturing Technology – Aerospace's Secret Sauce. Aviation Week, May 3, 2013

New Manufacturing Processes:

- 3D printing/Additive Manufacturing: GE is "printing" jet engine parts; astronauts will be able to make replacement parts in space and build space stations using moon rocks as aggregates
- Automated tape laying (ATL) replaces manual lay-up for large carbon fiber components that are flat or have simple curves
- Use of automated fiber placement (AFP) that makes smaller, more complex parts more precisely using narrow carbon-fiber tapes
- Move away from riveting to machining single-piece structures out of solid metal, reducing time and cost of component production
- Laser beam welding to join parts and produce fuselage panels
- Chemical milling is being replaced by machining that reduces hazardous chemicals use, but requires special machines that support one side of a panel while material is being removed from the other side
- Industrial robots and auto-riveting machines are common; but Airbus now has a small, crawling-drilling-riveting robot assembling fuselage sections
- Flexible drilling heads hold themselves in place with suction cup feet while drilling holes and rapidly inserting 8500 rivets in a fuselage section
- Optical Coherence Tomography (OTC) assesses aerospace materials such as coatings and fiberglass composites with cross-section imaging

New Technology

- "Fly By Wire" [48] – use of semiautomatic, computer-regulated systems for controlling the flight of an aircraft or spacecraft
- Replacing conventional big guns and heavy armor with next generation high technology, such as high-powered microwave weapons, hypersonic ballistic missiles and unmanned war planes
- Satellite-based high resolution full-motion video cameras, space-based solar arrays convertible to microwaves, or high voltage wireless signals, ground, sea and air-based distribution networks, supersonic commercial aircraft
- New radar and telecommunications systems
- Solar, electric and battery powered aircraft: The first solar powered electrically charged plane, Solar Impulse, completed its night-and-day cross-America flight, landing June 16, 2013 at 12:15 a.m.[49]
- Lightweight wings and fuselage made of composite materials
- 3-D printing of extremely complex parts such as GE TAPS combustor nozzles and turbine blades. GE purchased two Cincinnati-based additive manufacturing companies and opened two new production plants in 2014[50]
- Composite window frames made by Oklahoma-based Nordam Interiors installed on Boeing's 787 Dreamliner for a 50% weight reduction and superior damage tolerance vs. standard aluminum frame windows. The low-density composite is made from high strength carbon fiber and epoxy resin; it will also be used in Boeing fuselages for better fuel efficiency, lighter weight materials, lower maintenance and life cycle costs
- Smart interactivity based on Apple's iPad: natural, direct, hands-on human-machine interfaces to help the pilot "heads up and heads down" without mechanical switches, buttons and knobs; increased use of customizable touch screens for all aircraft systems and functions
- Air traffic control systems to manage growth while controlling noise pollution, easing congestion and reducing carbon emissions without compromising safety standards through seamless interactions between the pilot and the electronics;[51] Thales Avionics' (France) traffic control system is expected to be "flight ready" by 2018
  - Reprogramming flight management with flight plan changes reduces need for pilot "heads down" time
  - 4-D arrival operations sequence landing traffic and avoid congestion
  - Airborne separation management regulates traffic flow by adjusting speeds for smoother merging
  - Optimized takeoff and climb profile reduces noise and CO_2 emissions
  - Increased pilot/ground/passenger connectivity
- Intelligence, surveillance, reconnaissance, precision strike, cyber security, energy security, data fusion, and mission software development

48 Navigating the Future, Airbus 2013

49 Ibid

50 Paris Airshow News, p. 8, June 17, 2013

51 Ibid

THE WORLD MARKET

Valued at $706 billion in annual revenue,[52] the global aerospace market is dominated by manufacturers in the U.S., Canada and France. Foreign competitors, including Airbus, are an increasing challenge for U.S. manufacturers. The top 20 global companies accounted for $364.8 billion. The largest sales markets are Europe and Japan, with rapidly expanding markets in China and India, and developing markets in Brazil and Mexico. India, China, the U.S., Russia and Mexico are top receivers of foreign direct investment in A&D.[53]

Growth has moderated in Latin America and the slowdown was considerable in Brazil. The Mexican economy has strengthened as business and consumer confidence have increased, sustaining domestic demand.[54] Boeing and Airbus are expected to continue enjoying increased production for growing markets, driven by more passenger travel and demands for more fuel-efficient aircraft.

The Chinese market will be enhanced by two significant factors: its growing middle and high-wealth classes, and the government's opening of air space formerly reserved for military use. Saudi Arabia's market is expected to grow for the same reasons.

Additionally, the U.S. and U.K. have revised export controls for the A&D industry. Their Defense Trade Cooperation Treaty in 2012 allowed export of some military products and services between "approved communities" within the U.S. and U.K. without export licenses or approvals. This will streamline supply chains and reduce export administration burdens, improving collaboration across intricate supply chains and complex military platforms built with international cooperation. The U.S. and Australia will implement a similar treaty, as will the U.K. with Brazil, Turkey, Japan, France and Bahrain. That will make the U.K. a very attractive market for locating manufacturing and distribution operations. More open markets and less bureaucracy should save processing time and money.

Civil aircraft represent 76% of the Canadian aerospace industry, so Canada has not been as affected by military spending cuts as the U.S. and Europe. Canada exports 60% of its production to the U.S. and 24% to Europe.

India is one of the most promising markets for planes, submarines and missiles. Indian companies are undertaking joint ventures with overseas companies and offer cost advantages for design, engineering services, components and assemblies. This could lead to U.S. suppliers directly serving the Indian government, civil and business markets through local manufacturers.

Boeing was the largest and most profitable firm in 2013, followed by Airbus and Lockheed Martin; however, Airbus experienced the largest growth and Lockheed suffered the biggest decrease in revenue due to its dependence on the U. S. military.

For more updated information released after the publication of this report, please refer to the following resources:

1. 2014 Global Aerospace and Defense Sector Financial Performance Study: Growth Slowing; Strong Commercial Aerospace; Continued Contraction In Defense. Deloitte, July 2014
2. 2014 Global Aerospace and Defense Industry outlook: Expect another record year for commercial aerospace and continued declines in defense. Deloitte Global Services
3. Aerospace & defense 2013 year in review and 2014 forecast. Pricewaterhouse Coopers, 2013

52 2014 Global Aerospace and Defense Sector Financial Performance Study: Growth Slowing; Strong Commercial Aerospace; Continued Contraction In Defense. Deloitte, July 2014

53 PricewaterhouseCoopers and Flight International, 2013

54 Boeing Current Market Outlook, 2013-2023

LARGEST GLOBAL A&D COMPANY REVENUES & GROWTH 2013 VS. 2012[55]

Company	2013 Revenue ($B)	% Change
Boeing, U.S.	$86.6	36.0%
EADS (Airbus), UK	$74.8	15.0%
Lockheed Martin, U.S.	$47.2	(-1.5%)
General Dynamics (Gulfstream), U.S.	$31.5	(-11.7%)
United Technologies (Pratt&Whitney, Sikorsky), U.S.	$29.1	17.2%
Northrop Grumman, U.S.	$28.1	6.6%
Raytheon, U.S.	$24.4	(-3.0%)
Finmeccanica, Italy (AugustaWestland)	$20.2	(-2.0%)
GE Aviation U.S.	$20.0	4.2%
Safran, France	$15.9	14.3%
Rolls Royce	$13.7	10.0%
Honeywell Aerospace U.S.	$12.0	3.0%
L3 Communications, U.S.	$11.8	1.8%
Textron (Bell, Cessna) U.S.	$9.12	8.8%
BAE (UK)	$8.73	(-6.9%)
Bombardier Aerospace, Canada	$8.63	(-8.63%)
Huntington Ingalls Industries, U.S.	$6.71	0.9%
Embraer, Brazil	$6.20	13.2%
Thales, France	$5.83	(-5.8%)
Mitsubishi Heavy Indus. Aerospace	$5.53	(-5.0%)
Harris, U.S.	$5.45	1.0%

Figure 6

Up & Coming Competitors Vying for the Global Market

- Airbus, U.K.
- Bombardier, Canada
- Mitsubishi, Japan
- Embraer, Brazil
- Irkut/United Aircraft Corp., Russia
- COMAC, Shanghai

Incumbents focus on intellectual property and innovation to improve fuel efficiency and reliability; they offer high quality and mature supplier networks. Growing competitors offer lower labor costs and many have government subsidies. They are working with component and assembly suppliers to develop innovative new engines and avionics.

55 Top 100 Special Report, Slideshare.net, 2014

U.S. Defense Spending vs. Global Defense Spending[56]

The U.S. spends six times more on defense than China,[57] 11 times more than Russia, 27 times more than Iran and 33 times more than Israel.[58] Though China is often cited by some as the country's next possible great military adversary, U.S. military spending currently doubles that of all of the countries in Asia combined. In 2012, the U.S. consumed 41% of total global military spending. It also remained among the top 10 highest spending countries as a percentage of Gross Domestic Product (GDP), a widespread measure of military spending.

Global 2013 Defense Expenditures of $1.747 Trillion (2.4% of world GDP)[59]

(Budget authority in billions of current U.S. dollars)

Country or Region	2013 Spending $B
U.S. (includes war & nuclear)	$641
Asia	$407
Europe	$410
Middle East & North Africa	$142
Russia & Eurasia	$119
Latin America & Caribbean	$77
Sub-Saharan Africa	$26
Canada	$18

Figure 7

Global Shares of Defense Expenditures

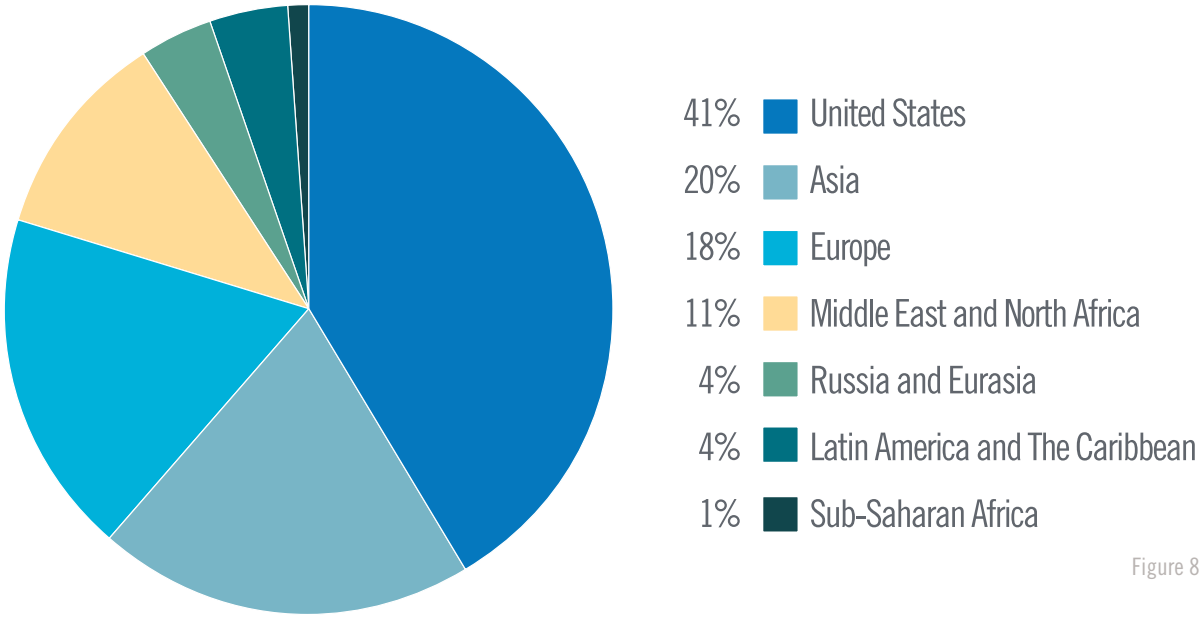


Figure 8

56 Center for Arms Control & Nonproliferation, April 34, 2013; and SPIRI Milex Data, 1988-2013

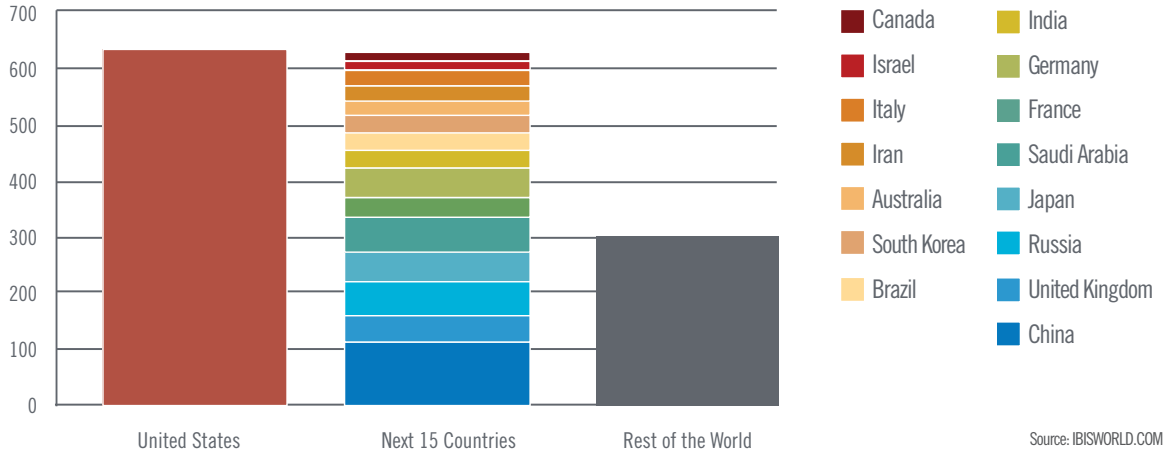
57 Defense News. Top 100: Looking Beyond Defense. July 21, 2013

58 Ibid

59 Stockholm International Peace Research Institute, Military Expenditure Database, *www.sipri.org*

U.S. vs. Global A&D Spending[60]

(Budget authority in billions of current U.S. dollars)



Source: IBISWORLD.COM

Figure 9

World's Largest Defense Buyers[61]

(Budget authority in billions of current U.S. dollars)

Country	2013 Spending	Percent of GDP
United States	640.0	2.40%
China	188.0	3.80%
Russia	87.8	4.10%
Saudi Arabia	67.0	9.30%
France	61.2	2.20%
United Kingdom	57.9	2.30%
Germany	48.8	1.40%
Japan	48.6	1.00%
India	47.4	2.50%
Italy	32.7	1.60%
Brazil	31.5	1.40%
Australia	24.0	1.60%
Canada	18.4	1.04%

Figure 10

60 Ibid

61 Ibid

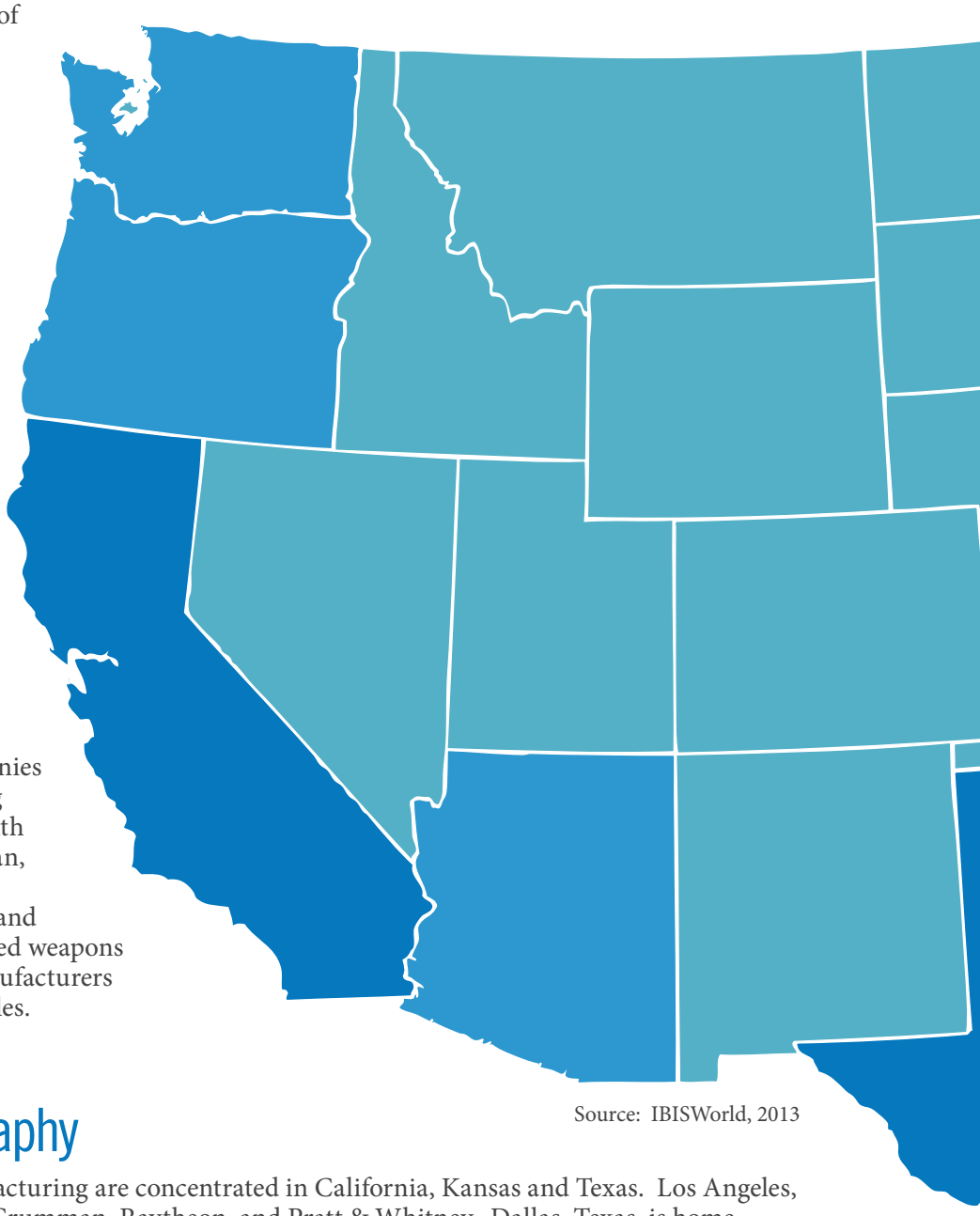
THE U.S. MARKET

The U.S. industry is highly concentrated, with 20 companies dividing 90% of the market share. The industry is predicted to grow at a compound annual rate of 5% from 2013 to 2017.[62]

Reductions in U.S. spending due to budget cuts and sequestration are likely to have negative effects on R&D and employment. That threatens technology capabilities, and may mean not enough work to keep all companies in business, thus reducing competition.

Defense contractors face on-schedule on-budget demands with no margin for error. Delays are expected to result in contract scale-backs or terminations, and budget limitations now prohibit cost overruns.

To compensate, U.S. A&D companies will focus marketing on emerging markets such as India, Brazil, South Korea, Japan, Saudi Arabia, Taiwan, Singapore, and the U.A.E. Those countries have increasing wealth and security concerns and sophisticated weapons systems, all strengths of U.S. manufacturers competing for foreign military sales.



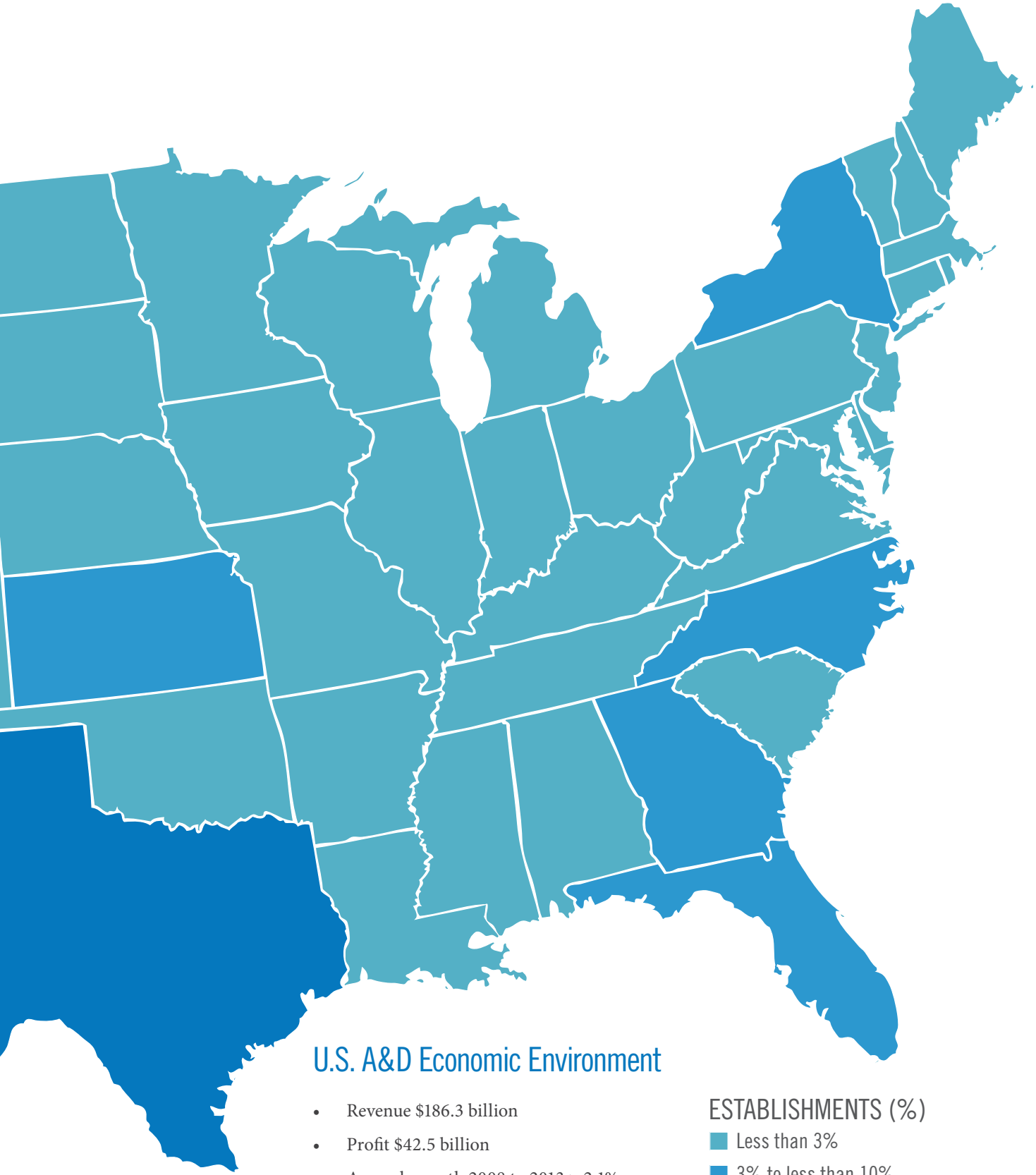
Source: IBISWorld, 2013

U.S. Industry Geography

Aircraft parts and aircraft manufacturing are concentrated in California, Kansas and Texas. Los Angeles, California, is home to Northrop Grumman, Raytheon, and Pratt & Whitney. Dallas, Texas, is home to Triumph AeroSystems and Bell Helicopter. Wichita, Kansas, has Learjet, Hawker Beechcraft, Spirit AeroSystems, and Cessna. Boeing is headquartered in Chicago, Illinois, and manufactures all over the U.S., but primarily in Washington, Oregon, and South Carolina.

While Texas and California dominate production, Washington and Oregon have between 3% and 10% of U.S. aerospace and defense manufacturing, as shown in figure 11.

62 Inforum forecast based on Interindustry Economic Research Fund Inc. data, College Park, Md. 2013



U.S. A&D Economic Environment

- Revenue $186.3 billion
- Profit $42.5 billion
- Annual growth 2008 to 2013 > 2.1%
- Annual growth 2013 to 2018 > 1.8%
- 1,374 businesses

ESTABLISHMENTS (%)

- Less than 3%
- 3% to less than 10%
- 10% to less than 20%

Figure 11

External drivers of demand:

- Aircraft, marine and railroad transportation equipment wholesaling
- Federal defense funding
- Domestic airlines
- International airlines
- World price of steel

Industry Structure:[63]

- Mature in life cycle
- Medium revenue volatility
- Low capital intensity
- Moderate industry assistance and concentration
- Heavily regulated
- Intense technological change
- High barriers to entry
- High globalization
- Medium level of competition

U.S. Competitive Environment

Retrofitted and new planes are in demand. The industry has introduced more energy-efficient planes, including Boeing's 787 Dreamliner. In addition, military demand has resulted in the Joint Striker Fighter jet and unmanned aerial vehicles known as drones. Overall industry revenue would have been greater except for the 2011 grounding of all 50 Dreamliners due to battery failures.[64]

Revenues of the top 20 U.S. based A&D companies grew by 4.8% by the end of third quarter 2014, and profitability has grown significantly.[65]

Civil demand is expected to grow, with technological improvements in manufacturing airplane engines and components. The industry is focused on improving fuel efficiency, reducing weight and increasing passenger capacity. Summer 2013 saw record numbers of U.S. travelers booked for international flights, making it the busiest summer travel season ever, driving commercial airlines to invest in upgrades.

Military demand, which accounts for 30% of all aircraft manufacturing, is expected to decrease due to sequestration, budget caps, and reduced military engagement overseas. However, there is a big backlog of orders that will help the industry maintain growth of 1.8% through 2018. The aerospace industry is responsive to technology advancements, political developments and threats to homeland security, which may increase demand. It has also benefitted from a weak dollar over the past five years.

The federal government contracts with industry companies to produce defense aircraft including fighter jets, unmanned surveillance aircraft and logistics vehicles. The Navy has commissioned updated communications for guided missiles; the Air Force is replacing Boeing's B52 heavy bomber fleet. Pratt & Whitney received a $500+ million contract from the U.S. Department of Defense for new engine production for the Joint Strike Fighter jet.

63 IBISWorld, November 6, 2013

64 Ibid

65 Alix Partners, July 7, 2014

Lockheed Martin is developing the F-35 Lightning II Joint Strike Fighter with a potential value of $400 billion depending on the number delivered, as their cost is $150 million per aircraft.[66] The company will also build as many as 3,000 warplanes to replace U.S. Air Force, Navy and Marine fighter jets (F-16, A-6 and F-14), as well as the GR-7 for Britain's Royal Navy. Other military aircraft in various stages of development include Lockheed Martin's multibillion-dollar F-22 Raptor program, which will replace F-15s; large transport aircraft to replace C-130s; and new bombers, helicopters and refueling planes.

Growth also continues in smaller markets for regional jets and very light jets, as technology advances in fuel efficiency, construction techniques and lightweight materials lead to upgrades. Savings derived via these new planes outweigh the costs of running 20-year planes with old technology. Smaller and lighter aircraft for business ownership, and fractional ownership such as NetJets, has increased in response to crowded major airports with commercial flight delays. Demand for Textron's Cessna and other very light jets are expected to continue.

Wholesalers are a key part of the supply chain for this industry, serving commercial passenger and freight operations as well as the military. The majority of revenue for the aircraft, marine and railroad transportation equipment wholesaling industry comes from sales to A&D primes. Most sales are related to commercial aircraft, including jetliners and business jets, while military sales account for about one-quarter of all wholesaled aircraft equipment. Aircraft used for private purposes represents a minority of this segment's sales.

Aircraft engine and parts wholesaling has grown due to the increasing popularity of airfreight transportation, which relies on used aircraft and equipment. International demand is a growth opportunity, and foreign aircraft are usually more spacious and expensive than domestic aircraft.

Steel is a crucial input in aircraft engine and parts manufacture, so price fluctuations affect the industry dramatically. Prices increased in 2013; profit represents about 22.8% of total industry revenue. The commercial segment of the aircraft, engine and parts manufacturing industry generally earns high profits due to transaction volumes, while defense contracts are typically rewarded with low margins but generous incentives such as tax breaks. Profit margins tend to increase as industry players obtain greater market share. Major players gain a higher profit margin as they mark up parts and components outsourced to third-party manufacturers, allowing them to offer discounts of 5% to 15% off listed product prices. Net profit has remained relatively consistent during the past five years due to minor fluctuations in aircraft orders.

Despite increased demand and growing revenue, profit is expected to hold steady overall; however, suppliers to Boeing are seeing increased profitability with parts for new aircraft, which is important as leading edge technology and specialty engineering require workers with masters or doctoral degrees that command high wages. Production workers with limited skills still need electronics and/or mechanical training, so wages are expected to remain fairly high at an estimated 13% of revenue.

66 U.S. Department of Defense. Air Force Leader Outlines Joint Strike Fighter's Value. December 13, 2013

Largest U.S. Aerospace & Defense Companies

Company	U.S. Locations	2013 BB Revenue	Product or Service
The Boeing Company	CA*, WA, SC, OR	$86.6	Aircraft
United Technologies Corporation	CT*, CA	$57.7	Propulsion Systems, Aircraft
Lockheed Martin	MD*, TX, GA, CA, SC, FL, MS, PA, WVA	$47.2	Aircraft
General Dynamics Corporation	VA*, AZ, CA, CO, MD, MA, MI, MN, NJ, NC, TX, VA	$31.5	Business Jet Aircraft
Northrop Grumman VA*	all 50 states	$25.2	Unmanned Systems
Honeywell NJ*	AL, NY, CA, IL, NJ, TX, LA	$37.7	Aircraft, Systems & Components
Raytheon CA*	CA, MA, HI	$24.4	Missiles, Defense Systems
GE Aviation OH*	OH, MD, NC, NH, MA, KY, VT, MI	$22.0	Aircraft Engines
L-3 Communications NY*	AL, NY, AZ, CA, FL, GA, IL, MA, MD, MI, MS, NH, NJ, NY, OH, OK, PA, TX, UT, VA	$14	Electronic Systems
Textron RI*	RI, FL, UT, CA, TX, KS, LA, GA, IL	$12.2	Manufacturing
URS Corporation CA*	CA	$10.6	Engineering Services
Oshkosh Corporation WI*	WI	$7.7	Land Vehicles Manufacturing
Precision Cast Parts	OR* and 32 states	$7.2	Avionics & Communications
Exelis Inc. VA*	AZ, AL, CA, VA	$5.5	Civil & Defense Aerospace Systems
Harris Corporation FL*	FL, OR	$5.4	Avionics & Communications
Spirit AeroSystems KS*	KS, OK, TN, NC	$5.4	Fuselage, Wings, Propulsion, Underwiring
Rockwell Collins, Inc. IA*	IA, CA, OR, FL, NY, UT, VA, TX	$4.7	Communications & Avionics
Alliant Techsystems Inc. VA*	VA, MI, UT, CA	$4.6	Satellites, Ammunition, Missiles

* Indicates company headquarters

Sources: bga-aeroweb.com, Barr Group Aerospace 2014, Defense News; August 4, 2014, Defensecontractormarketing.com, July 22, 2014; SourceTech411.com, August 12, 2013

Figure 12

Major Aerospace & Defense Suppliers, 2013[67]

Top Ten Suppliers of Five Leading Aerospace & Defense Primes

Boeing ($3.5 billion)

- Spirit AeroSystems Holdings Inc.
- Triumph Group Inc.
- Honeywell International Inc.
- United Technologies Corp.
- BAE Systems Plc
- Rio Tinto Plc
- Finmeccanica SpA
- TE Connectivity Ltd.
- Mitsubishi Heavy Industries Ltd.

Northrop Grumman Subcontractors ($683 million)

- General Electric Co.
- Honeywell International Inc.
- Precision Castparts Corp
- Onex Corp.
- Israeli Aerospace Industries Ltd.
- Danaher Corp.
- Alcoa, Inc.
- Harris Corp.
- 3M Co.

Raytheon ($432.9 million)

- Boeing
- GenCorp. Inc.
- Celestica Inc.
- Avnet Inc.
- Computer Science Corp.
- Ducommun Inc.
- Alcoa Inc.
- Exelis Inc.
- B/E Aerospace Inc.
- Meggit Plc

Lockheed Martin ($1.3 billion)

- United Technologies Corp.
- Finmeccanica SpA
- Rolls-Royce Holdings Plc
- General Electric Co.
- BAE Systems Plc
- Avnet Inc.
- Honeywell International Inc.
- ThyssenKrupp AG
- Boeing
- Northrop Grumman

General Dynamics ($526.4 million)

- General Electric Co.
- Flextronics International Ltd.
- Precision Castparts Corp.
- Alcoa Inc.
- Rolls-Royce Holdings Plc
- Parker Hannifin Corp.
- Curtiss-Wright Corp.
- Rockwell Collins Inc.
- Goodyear Tire & Rubber Co.
- Wincanton Plc

U.S. Defense Market

Defense spending is the major source of revenue for the top global aerospace and defense companies, and the U.S. accounts for more than 40% of global defense spending.[68] However, the U.S. defense budget is shrinking and is projected to continue to decline for the next eight years to around $500 billion by 2021. The 2011 Budget Control Act reduced spending by $487 billion over the next ten years; in addition, there are $42 billion in sequester reductions.

67 Bloomberg Government Supply Chain Estimates, Jan. 17, 2014

68 Zacks Investment Research, Aerospace & Defense Stock Overview, December 12, 2012

With recent wars coming to an end, the Department of Defense wants to downsize the number of military personnel by 100,000 and civilian and contractor personnel by 5% over the next five years. At the same time, it wants to increase advanced weaponry: drones, bombers, and missiles. Specific areas to be cut were identified as[69] aircraft inventory, ship count (more surface ships than submarines), and active and reserve basic combat training.

Projected savings from reduced troop deployments are planned to be reinvested in purchases of unmanned intelligence, surveillance and reconnaissance technologies and products, more ships, a new ground combat vehicle, the Advanced Extremely High Frequency Satellite, and the F-35 Joint Strike Stealth Fighter. Upside growth is expected from new technologies for surveillance, reconnaissance and cybersecurity, including unmanned vehicles.

Sales to foreign military are also predicted to increase as countries face increasing safety threats.[70] U.S. defense spending as a result of the Iraq and Afghanistan wars reached an all-time high, increasing 9.3% in 2008 and 6.2% in 2009. It declined 5.6% in 2012 and fell another 4.3% in 2013.[71]

The industry is consolidating as major companies have available cash to grow by acquisition in spite of defense budget cuts.

25 Largest Global Defense Companies 2012[72]

1. Lockheed Martin, U.S.
2. The Boeing Company, U.S.
3. BAE Systems, U.K.
4. Raytheon Company, U.S.
5. General Dynamics Corporation, U.S.
6. Northrop Grumman, U.S.
7. AEDS, Netherlands
8. United Technologies Corporation, U.S.
9. Finmeccanica S.p.A., Italy
10. L-3 Communications, U.S.
11. BAE Systems Inc. (U.K.), U.S.
12. Thales Group, France
13. Science Application International Corporation, U.S.
14. Huntington Ingalls Industries, U.S.
15. Almaz-Antey, Russia
16. Safran S.A., France and Safran, U.S.
17. Honeywell International, Inc., U.S.
18. Rolls-Royce Holdings plc, U.K.
19. Sikorsky Aircraft Corporation (United Technologies Corporation), U.S.
20. United Aircraft Corporation, Russia
21. General Electric Company, U.S.
22. Oshkosh Corporation, U.S.
23. MBDA (BAE Systems, UK/EADS, trans-European/ Finmeccanica, Italy), France
24. Excelis Inc., U.S.
25. Pratt & Whitney (United Technologies Corporation), U.S.

69 Center for Strategic and Budgetary Assessments

70 Ibid

71 IBISWorld, July 2013 and Congressional Budget Office data

72 Stockholm International Peace Research Institute, www.sipri.org

Business Environment & Funding For Defense

- Estimated 2013 market value: $660 billion
- 2008-2013 CAGR: -0.2%
- Forecast value for 2018: $596.8 billion
- 2013-2018 CAGR: -2.0%

The U.S. spends more on military defense than the next 13 nations combined; China, Russia, U.K., France, Japan, India, Saudi Arabia, Germany, Brazil, Italy South Korea, Australia and Canada (in declining amounts) spent $695 billion. U.S. spending on international security and military defense was $718 billion in 2011.[73] The wars in Iraq and Iran alone amounted to $159 billion in 2011 (exclusive of veterans' benefits). Total spending was projected to be $729 billion in 2012; that was expected to decline to $716 billion in 2013. Weapons procurement represents, on average, $100 billion of total expenditures annually.

The night before the sequester took effect, contracts were signed by the Defense Logistics Agency, the Department of Defense division that provides the military with spare parts and other equipment. They included:[74]

- $2.5 billon to Pratt & Whitney for weapons systems spare parts
- $600 million for alternative energy projects for the Army Corps of Engineers
- $230 million to Raytheon in support of the sea-going X-band radar station used to detect ballistic missile launches
- $200 million on interceptor body armor made by Federal Prisons Industries
- $130 million to Lockheed Martin for sonar
- $65 million to BAE Systems for military helmets
- $64 million to build a new fuel pier
- $49 million to Boeing for an upgraded MH-6 Army helicopter
- $40 million to Nammo Talley for hand grenades
- $24 million to Thales for radio signal amplifiers
- $18 million to Phoenix International Holdings for a robot rescue submarine
- $17 million for liquid nitrogen
- $15 million for helium
- $19 million for cots
- $6 million for telescope mirrors impervious to temperature changes

Money was also spent on spy satellites equipped with infrared cameras and software to monitor communications signals and images.

73 Pete G. Peterson Foundation, with data compiled by the Stockholm International Peace Research Institute

74 Foreign Policy, October 1, 2013

Military product spending in 2014 went toward the following:[75]

- Electronic equipment & components
- Data processing equipment and software
- Ammunition & explosives
- Instruments & laboratory equipment
- Fiberoptics
- Communications/detection
- Coherent radiation for electromagnetic lasers
- Hardware & abrasives
- Materials handling equipment

Manufacturing environment for military aerospace, military land systems, ship building, defense electronics, and space is more demanding than ever.[76]

A&D suppliers need to be aware of the current market environment and its implications for their businesses.

Greater accountability in program management: Virtually every segment of the A&D industry has suffered difficulties in the execution of major programs. No segment – neither large commercial aircraft nor military spacecraft – has been immune from costly program failures. Many analysts attribute these failures to management errors, lack of self-discipline among customers, systems integration issues, or shortages of skilled labor. Some speculate this spate of failures has a systemic cause:[77] the increasing obsolescence of traditional approaches to program and risk management, given the evolving structure of the A&D industry.

Ongoing consolidation of the aerospace and defense sector: The A&D sector pursued widespread consolidation during the economic downturn of the 1990s. The result was a large number of companies exited, especially on the defense side. Those remaining did not attempt to outlast decline in demand by cutting costs and curtailing investment.

Intensifying cost pressures: Expensive defense programs face large cost overruns and scheduling delays, putting contractors at risk. They must develop a demonstrable affordability strategy and find new opportunities among new defense spending priorities with lower production rates. Suppliers must consider all elements of cost – direct labor, material, and overhead – to offer affordable alternatives for customers.

Greening of aerospace and defense products: Volatility in oil prices is creating greater demand for fuel efficiency and alternative fuel options. Product manufacturers and integrators will need to develop products that meet those needs.

Defense & Security

Reductions in U.S. spending are likely to have negative effects on R&D spending and employment. That threatens technology capabilities and may mean insufficient work to keep all companies in business, thus reducing competition.

75 Ibid

76 Booz & Company Aerospace & Defense Key Trends, November 2013. Booz & Company is the primary consultant to the U.S. Military; it was acquired by PricewaterhouseCoopers in 2014 and the name was changed to Strategy&

77 Booz & Company 2012 Aerospace & Defense Industry Perspective, November 2013

Boeing is the industry leader, with customers such as Japan's All Nippon Airways and Poland's LOT Airlines. Boeing estimates emerging markets such as China will see significant growth. China alone is expected to be running 3,200 large passenger jets by 2025, and will need 2,612 new aircraft over the next 20 years.

India's newly liberalized aviation market will increase demand, as will successful start-up airlines. The Indian government now has flight agreements with the U.S., U.K., China and Qatar.

Slowing technological innovations and increasing levels of import competition reflect the industry's mature status and are leading to diminishing returns on investment, as well as weak growth in capital expenditures. Most new aircraft are variations of existing planes that were introduced to reduce operating costs. For instance, the 787 is a variation of a wide-body plane that seats more than 200 people, but the 787 has 20% better fuel efficiency.

Major companies have shifted manufacturing bases to low-cost countries, such as China and India. The total number of industry companies is anticipated to remain flat through 2018, as U.S. operators seek to locate production near emerging markets.

Major U.S. Aerospace Players and Market Share

The Boeing Company, Chicago, IL

The only U.S. maker of large commercial jets and the second largest defense contractor for the U.S; they outsource to many subcontractors. Private and business aircraft are made for it by General Dynamics (Gulfstream) and Textron (Cessna). Subcontractors produce system assemblies for:[78]

- Engines
- Fuselages
- Interiors
- Rotors
- Electronic and hydraulic control systems
- Avionics
- Guidance systems

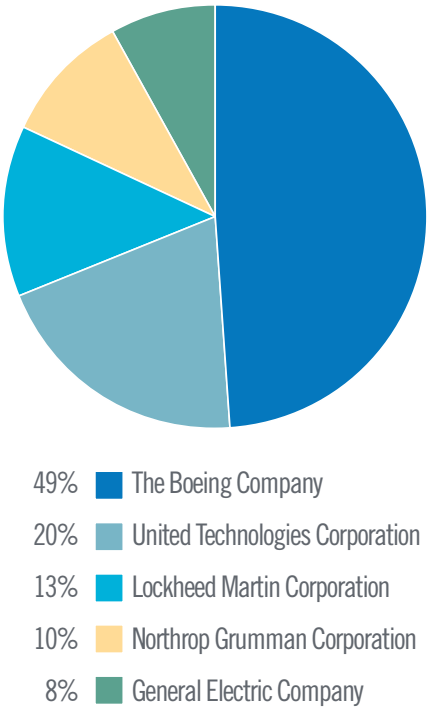


Figure 13

United Technologies Corporation, Hartford, CT

Manufacturer of aerospace systems and products; holding company composed of:

- **UTC Aerospace Systems (formerly Hamilton Sundstrand)** – produces aerospace products such as power generation and distribution systems; flight, engine control and environmental control systems; fire protection and detection systems; auxiliary power systems, air compressors; metering pumps and fluid handling equipment.
- **Pratt & Whitney** – manufactures commercial, military, business jet and general aviation aircraft engines and parts, industrial gas turbines and space propulsion systems.
- **Sikorsky** – makes military and commercial helicopters, after-market helicopter and aircraft parts.

78 First Research Industry Profile, Aerospace Products & Parts Manufacturing, April 29, 2013

Lockheed Martin, Bethesda, MD

Designs, develops and manufactures military combat aircraft and high technology flight systems for missiles, guided weapons, naval systems, ground combat vehicles, radar systems, unmanned systems, sensors and situational awareness, and tactical communications.

Northrop Grumman Corporation, West Falls Church, VA

Produces aerospace and electronics products, aviation parts and network-enabled systems for civil and military markets. The U.S. government is its primary customer for manned and unmanned aircraft, spacecraft, laser systems, microelectronics, surveillance systems, space systems, battle management and engagement systems, and advanced programs and technology.

General Electric Company, Fairfield, CT

The Aviation Division of GE makes small and large jet engines for commercial and military aircraft, including fighter jets, helicopters, transport and unmanned aircraft.

General Dynamics Corporation, Falls Church, VA

Produces commercial and military aircraft including Gulfstream business jets, armament systems, land systems, ordnance and tactical systems, advanced information technology systems, and ships for the U.S. Navy and commercial customers.

Raytheon Company, Waltham, MA

Specializes in military, security and civil defense electronics systems for sensing, command, control, communication and intelligence.

Textron Inc., Providence, RI

Manufactures Cessna airplanes, Bell Helicopters and others including Greenlee, Kautex, Lycoming and E-Z-GO.

Honeywell International, Inc., Morristown, NJ

Manufactures business and commercial airplanes, helicopter engines, avionics for sensors and switches, and "green" jet fuel, synthetic vision and unmanned systems.

Crane Aerospace & Electronics, Lynnwood, WA

Manufactures brake control and landing gear systems and components for missiles, satellites and unmanned aerial vehicles.

FLIR Systems Inc., Wilsonville, OR

Designs and manufactures high definition imaging, infrared and precision laser systems for thermal imaging and threat detection. Their products are used for search and rescue, navigation, transportation safety, border and maritime patrol, environmental monitoring, and chemical, biological, nuclear, radiological and explosives detection, and are frequently mounted on aircraft. The company recently received a two-year, $25 million contract to supply a customer in the Middle East.[79]

79 Flight Daily News, p. 83. June 18, 2013

HELICOPTERS

While defense spending has slowed and the commercial market is experiencing moderate growth, the helicopter sector is experiencing so much growth there is a shortage of helicopter pilots and mechanics.[80] There are several reasons why:

- Vietnam War-era helicopter pilots are retiring
- Current military pilots are receiving bonuses for staying in the service
- The helicopter market is growing on a global basis as more countries develop their own aviation infrastructure

While the recent recession set the helicopter industry into a tailspin, the industry is forecast to enjoy a healthy recovery through 2015 and beyond, growing at least 5%.[81] New technologies are generating interest in safety-enhancements such as health and usage monitoring, workload-reducing automatic flight control systems, and maintenance-saving vibration reduction systems.[82] Manufacturers are concentrating on advanced materials, such as carbon fiber, to reduce weight and provide jet-like smoothness and vibration control.

Airbus Helicopter (formerly Eurocoptor), Bell and AgustaWestland dominate the market, but there are a myriad of international competitors, growing individually as well as collaborating across countries to increase market share.

While North America and Europe take the largest share of the market, developing economies such as Latin America, China, the Middle East and India are rapidly growing markets.

The global civil helicopter market alone was worth $3.69 billion in 2013. The military market was worth $4.82 billion (source: Visiongain.com, Global Civil Helicopter Market 2013-2023, March 2013). While the U.S. federal government is the largest spender on military equipment including helicopters, their purchases are expected to decline. However, those dollars will most likely transfer to state and local governments to meet civil and regional security demands. In the meantime, growth from civil and military demands in developing countries is expected to increase.

The commercial market is expected to enjoy the greatest increase in units and revenues, and the civil market is projected to experience significant growth as well. Developing countries are investing in aerial capabilities for fighting forest fires and high-rise building fires, as well for agricultural uses. Developed markets have aged fleets and are planning replacement units with upgraded technology and greater fuel efficiency. Vast countries such as Brazil, without extensive highway or rail systems, are experiencing increased use of helicopters for commuting and business travel.

World Leaders in Helicopter Manufacturing

- Airbus Helicopters (formerly Eurocopter)
- AgustaWestland (Finmeccanica)
- Bell (Textron)
- Boeing Rotocraft Systems
- Sikorsky (United Technologies Corporation)

80 http://www.northeasthelicopters.com/industry-growth.htm

81 Honeywell Civilian Helicopter Purchase Outlook, 2011

82 CapGemini Helicopter Market Outlook 2011-2015

Global Helicopter Market 2013-2023

Key Drivers[83]

- Off-shore oil and gas exploration
- Military defense and surveillance
- Civic management and public safety
- High-rise firefighting
- Forest firefighting
- Law enforcement
- Health emergency medical services
- Agriculture
- VIP transport

The largest markets for civil helicopters are North America and Europe; however, both are saturated and not expecting significant growth. Europe is expected to decline from 2015 to 2023. Asian Pacific, Middle Eastern and Latin American emerging markets are expected to grow.

While military spending in mature markets such as the U.S. is declining, demand for helicopters and their after-market peripherals will grow, but demand will shift from federal defense spending to states, counties and major cities. China's helicopter market is expected to grow to $1.4 billion over the next ten years. India is also experiencing growth in civil aviation, but lacks pilots and training facilities. India's growth will also be limited by lack of helipads and landing infrastructure. The country's Rotary Wing Society is developing a directory of existing helipads. Operations mostly fly out of Delhi and Mumbai, close to ocean-based oil rigs.

Emergency medical services and law enforcement represent 29% of civil helicopter usage. The segment is very small in China, India and the Middle East but is expected to grow based on demand due to lack of infrastructure, growth in urban populations, and modernization of agricultural methods. Airbus Helicopter (formerly Eurocopter) and Bell expect to increase their market share in these regions.

Increased demand will result in a shortage of trained pilots and technicians. China expects to add 2,000 new helicopters over the next ten years, requiring 6,300 additional helicopter pilots. They are signing agreements with aviation colleges to fill that demand, and Bell is establishing a helicopter maintenance facility in Guangzhou.

Programs like Portland Community College's (PCC's) Aviation Maintenance Technology (AMT) Program are being courted by Chinese and Middle Eastern aerospace clients to provide training for a field with little margin for error and a high degree of mechanical aptitude. PCC provides one- and two-year Applied Science degrees in Aviation Maintenance, Airframes and Powerplants.[84]

Currently, disasters and emergencies in both urban and rural areas are a problem in developing countries due to lack of infrastructure. Growth is expected to come from increased civil EMS, agriculture and military usage.

83 Reportlinker, World Now, ABC TV. New York, October 30, 2013

84 http://www.pcc.edu/programs/aviation-maintenance/

Top Ten Civil Helicopters (unit sales)[85]

- MD Explorer
- MIL Mi-26
- AgustaWestland AW139
- Airbus Helicopter (Eurocopter) EC 120
- Bell 429
- HAL Dhruv
- Kazan Ansat
- Kamov Ka-62 (not yet certified)
- Kamov Ks-226 Sergei
- Robinson R44 Raven

Commercial helicopters are expected to grow 15% in Latin America between 2014 and 2020.[86] Light helicopters are seen as practical because of their low price, technological advances and new GPS systems. The Mexican market is expected to reach $326 million, and Brazil's market is predicted to grow driven by helicopter use in oil and gas exploration.

Market demand for medium and heavy helicopters is expected to increase in Africa, Australia, Russia, the U.K. and Ireland.

Global Military and Civil Helicopter Market Segmentation:[87]

Market Segment	2012 Actual	2021 Forecast
Military	72.3%	67.8%
Commercial	18.5%	18.4%
Government	9.2%	13.8%

Figure 14

Primes and suppliers may have to shift production due to diminishing federal military spending, which will leave them competing for smaller procurement programs for border control, maritime surveillance, agriculture and other civil sector uses. Development of multipurpose/multifunctional platforms is expected to be in demand by military and civil end users.

The principle demand will be for intermediate and medium helicopters that are increasingly more complex to operate and maintain. Primes expect growing demand for maintenance facilities and trained maintenance personnel.

85 www.aircraftcompare

86 http://www.abc27.com/story/23830476/the-commercial-helicopter-market-2013

87 Global Civil and Military Helicopter Market. Frost & Sullivan, August 2012

Global Military Helicopter Growth 2012-2021 By Product Segment[92]

Market Segment	Growth
Heavy	3.8%
Heavy Lift Cargo	9.4%
Intermediate	8.2%
Light single engine	2.5%
Light twin engine	3.2%
Medium	72%
Ultra Light	0.1%

Figure 15

Global Civil Helicopter Growth 2012-2021 By Product Segment[93]

Market Segment	Growth
Heavy	4.3%
Heavy Lift Cargo	6.9%
Intermediate	14.5%
Light single engine	6.3%
Light twin engine	8.9%
Medium	58%
Ultra Light	1.1%

Figure 16

A complete list of U.S. and Global Helicopter manufacturers is included in Appendix C.

Helicopter Market & Business Trends

- Outsourcing partnerships and alliances for components and systems to produce faster and more efficiently
- Collaboration among primes:[90]
  - NH Industries and European Helicopter NH90 developed for NATO
  - Sikorsky, Bell, Boeing and AVX Aircraft Co. working to produce the next generation helicopter for the U.S. Army
  - AgustaWestland and Russian helicopters joint development of a new single-engine helicopter
- Increasing competition from unexpected places:[91]
  - Turkish Aerospace Industries is competing with Bell and Boeing to provide attack helicopters to South Korea
  - Brazil, Turkey and South Korean primes (owned by Airbus, Sikorsky and AgustaWestland) are negotiating cooperation between their domestic manufacturers
- Primes rationalizing supplier bases
- Contracting and consolidating supply chain due to increased demand for integrated products and systems
- Disruptive technologies being adopted by leaders such as AgustaWestland and Bell are driving replacement of existing aircraft

Helicopter Product Trends

- Power increases to support increased takeoff weight
- New materials for engine hot sections
- High efficiency turbines and compressors
- Compact engines
- Cutting edge rotor blades, once metal but now composites
- Greater fuel efficiency
- Increased operating efficiency to lower airline operating costs and decrease carbon emissions
- Computerized electronic automated controls and software systems requiring parts suppliers to upgrade knowledge and technologies
- Lower cost technological product improvements such as fuel efficient engines
- Digital product definition, design and manufacturing for anywhere, anytime manufacturing

88 Global Civil & Military Helicopter Market, Frost & Sullivan 2012

89 Ibid

90 Frost & Sullivan Civil and Military Helicopter report, 2013

91 Ibid

UNMANNED AERIAL VEHICLES

UAS/UAV Growth Opportunity[92]

"45% to 55% [of production] is unmanned systems; that will really grow when the FAA opens up more airspace. Police, Homeland Security, agriculture will all use it. Aerial operations will grow significantly in 3 to 5 years for everything from firefighting and crop dusting to national security and crime management."

Sr. Manager at an electromechanical services firm in the Portland-Vancouver region. Sept. 2013.

The U.S. market for Unmanned Aircraft Systems, also known as Unmanned Aerial Vehicles (UAVs), is defined as equipment, networks and personnel required to control an unmanned aircraft or Unmanned Aerial Vehicle. UAVs do not have a human operator onboard. They use aerodynamic forces for power, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload.[93] UAVs are commonly known as "drones." The market was valued at $3 billion in 2010 and $7 billion in 2013. It is projected to reach $8 billion by 2018.[94] Uses include civil, commercial, military, security and scientific purposes. Seventy percent of growth and market share is in the U.S.; Israel is also a strong market. New mission capabilities, low cost and reduced operations risk will drive growth. The U.S. Air Force and others are researching an "All UAV Future" that will drive electronics, sensors and cameras.[95]

The industry has experienced annualized double-digit growth since 2007; while that is predicted to slow in pace, profits are expected to increase as the price of semiconductors and electronics are forecast to fall.

Defense spending is growing more toward unmanned vs. manned aircraft. Half of market expenditures will be for procurement, but half will be for R&D. The U.S. is predicted to dominate the market for the next five years, with growth coming mostly from U.S. and European defense spending (France and Germany). The Asia Pacific region also has growth potential. The U.S. military has more success with strategic endurance UAVs than tactical short range UAVs, which were pioneered by Israel. The Asia Pacific region also has growth potential.

92 Lucintel Brief: Growth Opportunity in Global UAV Market, March 2011

93 Unmanned Aerial Systems (UAS) Market Overview. GovWin, Deltek Inc. July 18, 2012

94 Unmanned Aerial Vehicle Market 2013-2018. Marketsandmarkets. November 15, 2013

95 www.defense.gov/pubs/DOD-USRM-2013.pdf

The industry has 36 companies with 38 manufacturing facilities. The top four companies account for 59.2% of revenue; Northrop Grumman and General Atomics Aeronautical Systems combined are 40.5%, generating $2 billion from UAV manufacturing. Costs for development and production are very high and most revenue is generated through U.S. military contracts.[96]

UAV

- Unmanned vehicles remotely piloted or self-piloted to carry cameras, sensors, communications equipment
- Safe in high-risk situations where pilot is at risk
- Cost effective addition to manned aircraft capabilities
- Smaller than manned aircraft, easily and cost-effectively transported and stored
- Make significant fighting capability contributions to operational war forces

Blimp

- Pressure airship powered, steerable, lighter than air, with no rigid internal structure; if it deflates it loses shape; balloon with fins and an engine
- Used as advertising and promotional vehicles
- Military use is for anti-submarine and land reconnaissance

Zeppelin

- Rigid or semi-rigid airship with metal skeleton; more expensive than blimps but more stable for longer trips and weather conditions
- Have powerful engines to carry heavy loads
- Used for passenger and military transport, bombers and scouts

UAV, Blimp & Zeppelin Applications

Segments	Applications	UAV Strength	B/Z Strength	Market Potential
Civil	Disaster Relief	Capture Data	Skylifter Ops	High use of B/Zs
Commercial	Weather, Storm Tracking Advertising	Precise Data Collection UAVs not used	Constant data access and low costs	High B/Z market share
Military/Security	Defense Wireless Communications	Reconnaissance & Surveillance, missile capabilities; use in sensitive areas	Low cost; survey large areas for long times	UAVs have major share vs. B/Zs
Science	Precision Agriculture Cargo Transportation	Precise data collection	High cargo capacity; able to lift heavy loads	Market is optimistic about B/Z use

Figure 17

96 Ibid

Three Classes of UAVs

There are three classes of UAVs based on range, endurance, weight, speed, altitude, payload and cost.

Class	Close Range	Short Range	Endurance
Range	50 km	200 km	> 200 km
Endurance	30 min – 2 hours	8 to 10 hours	Min 24 hours
Weight	2 – 20 lbs.	<10,000 lbs.	<229,000 lbs.
Speed	-	<300 mph	<454 mph
Altitude	< 1,000 ft.	<50,000 ft.	<65,000 ft.
Payload	-	<3,800 lbs.	<1,900 lbs.
Cost	$500-$1,500	<$8 million	<$123 million

Figure 18

Civil & Commercial UAV Market

- Forest fires
- Wildlife protection
- Riots, robbery, looting
- Illegal cross border immigration
- Asset and property protection
- Natural disaster relief
- Traffic monitoring and road accidents
- Agricultural activities
- Communication connectivity

Current Characteristics & Usage

- Small scale
- Low intensity
- Unidentified perpetrators
- Uncertainty or sporadic activity
- Wide area
- Hidden activities
- Among civilians

Future Characteristics & Usage

- Real time intelligence
- Constant uninterrupted surveillance
- Wider reconnaissance area
- Immediate and precise action

Defense UAV Market

Traditional Wars

- Large scale
- Centralized
- Formal attack
- Defined territory of war
- Limited war field
- Away from civilians
- Declared war

New War Challenges

- Small scale
- Low intensity
- Decentralized
- No formal declaration of attack
- Undefined territory
- Larger territory of activities
- Among civilians
- Espionage & other hidden activities

Future Requirements

- Real time intelligence
- Constant uninterrupted surveillance
- Wider area for reconnaissance
- Immediate and precise action

UAV Market Trends

- Increased awareness of UAVs
- Growth in unmanned aerial combat vehicles
- Increased endurance limits
- Increased mission capabilities
- Increase in high altitude, long endurance UAVs
- Solar powered UAVs
- Short or vertical takeoff UAVs

Major UAV Manufacturers

- Northrop Grumman
- General Atomics Aeronautical Systems (General Dynamics spin-off)
- Gulfstream Aerospace
- Boeing
- Alenia Aeronautica
- BAE Systems
- Dassault Aviation

Federal Prime Drone Contractors ($K)[97] 2008 – 2011

Parent Company	FY08	FY09	FY10	FY11	Total
General Atomics International	$204,247	$270,413	$446,462	$660,611	$1,581,732
Textron Inc.	$552,870	$5,904	$464,135	$502,769	$1,525,677
Northrop Grumman Corp.	$180,645	$330,488	$182,641	$258,578	$952,352
Aerovironment Inc.	$93,203	$94,007	$157,155	$247,573	$591,938
Composite Engineering, Inc. (CEI)	$40,610	$8,825	$71,081	$62,604	$183,120
Honeywell International Inc.	$4,922	$101,266	$22,893	$15,354	$144,436
Boeing Company	$692	($50)	$23,297	$90,318	$114,256
Alliant Techsystems Inc. (ATK)	$13,284	$25,689	$33,591	$38,897	$111,461
BAE Systems PLC	$24,022	$23,196	$28,356	$18,566	$94,141
TCOM, L.P.	$30	$44	$13	$88,542	$88,629
Orbital Sciences Corporation	$415	$46,277	$31,755	$813	$79,260
Insitu Inc. (wholly owned subsidiary of Boeing Company)	$138	$32,049	$7,851	$29,928	$69,966
L-3 Communications Corp.	$4	$6,612	$6,801	($0)	$13,418
Rally Point Management, LLC	n.a.	n.a.	n.a.	$12,384	$12,384
Aerostar Integrated Systems JV	n.a.	n.a.	n.a.	$6,151	$6,151
Neany, Inc.	$219	$1,974	n.a.	$3,635	$5,828
Aurora Flight Sciences Corp.	n.a.	n.a.	n.a.	$4,986	$4,986
Gichner Systems Group Inc. (Kratos Defense & Security Solutions, Inc. Company)	$311	$2,067	$955	$126	$3,458
Aerostar International Inc.	n.a.	n.a.	n.a.	$3,206	$3,206
Canadian Commercial Corp. (CCC)	$1,164	$630	$476	$851	$3,121

Note: Federal drone spending declined 41% in 2013 vs. 2012, according to the 2013 Annual Review of Government Contracting, p. 8. www.govex.com.

Figure 19

97 Unmanned Aerial Systems Market Overview, GovWin, Deltek Co. July 18, 2012

Largest Manufacturing Sectors Associated With Drones[98] ($K) 2008 – 2011

NAICS Code & Description	FY08	FY09	FY10	FY11	Total
336411 - Aircraft Manufacturing	$968,757	$84,443	$1,255,046	$1,755,989	$4,064,236
336410 - Aerospace Product and Parts Manufacturing	-	$788,248	-	-	$788,248
541330 - Engineering Services	$112,740	$78,106	$113,500	$49,344	$353,690
336413 - Aircraft Parts & Auxiliary Equipment Manufacture	($576)	$96	($8,910)	$170,903	$161,513
336414 - Guided Missile and Space Vehicle Manufacture	$37,538	-	$64,910	$55,920	$158,367
334290 - Other Communications Equipment Manufacture	-	-	$51,510	-	$51,510
611512 - Flight Training	-	-	-	$12,384	$12,384
541380 - Testing Laboratories	-	-	-	$2,955	$2,955
336412 - Aircraft Engine and Engine Parts Manufacturing	-	-	-	$2,330	$2,330
541710 - R&D in Physical, Engineering, & Life Sciences	($475)	$489	$1,477	$257	$1,747
541712 - R&D in Physical, Engineering Sciences	-	-	$50	$1,000	$1,050
423410 - Photograph Equipment & Supplies Wholesalers	-	-	$875	-	$875
334511 - Search, Detection, Navigation, Guidance, Aerospace & Nautical Systems Manufacture	$746	-	-	$38	$784
326299 - All Other Rubber Product Manufacturing	$397	-	-	-	$397
541990 - Other Professional, Scientific & Technical Services	-	$41	$121	-	$163
488190 - Other Support Activities for Air Transportation	-	-	-	$95	$95
334515 - Instrument Manufacture for Measuring & Testing Electricity & Electric Signals	$54	-	$13	-	$67
334510 - Navigational, Measuring, Electromedical & Control Instruments Manufacture	-	$58	-	-	$58
339999 - All Other Miscellaneous Manufacturing	-	-	-	$49	$49
423860 - Transportation Equipment & Supplies Wholesalers	$25	-	-	-	$25

Figure 20

98 Ibid

Largest Drone Purchasing Agencies ($K) 2008 – 2011

Agency	FY08	FY09	FY10	FY11	Total
Army	$1,006,069	$670,574	$1,152,308	$1,496,240	$4,325,190
Navy	$40,243	$236,273	$86,737	$201,054	$564,307
Air Force	$65,534	$32,200	$174,639	$233,430	$505,803
U.S. Special Operations Command	$6,003	$16,285	$55,474	$85,754	$163,515
Customs and Border Protection	$1,362	-	$13,691	$33,995	$49,048
Federal Highway Administration	-	-	-	$1,000	$1,000
National Oceanic And Atmospheric Admin	-	$97	-	$13	$110
Federal Supply Service	$24	$16	-	-	$39
National Park Service	-	-	$15	-	$15
National Aeronautics And Space Administration	-	-	-	$12	$12
U.S. Coast Guard	$1	-	-	-	$1

Figure 21

Updating the drone market for 2014-2015

Twelve companies are predicted to dominate the drone market in the next year:

The Boeing Company; General Atomics; Lockheed Martin Corporation; Northrop Grumman; AeroVironment, Inc.; Prox Dynamics (Norway), Denel Dynamics (South Africa); SAIC; Israel Aerospace Industries; Textron Inc.; General Dynamics Corporation; DJI (China) (source: International Business Times, January 10, 2014).

Current UAV Missions

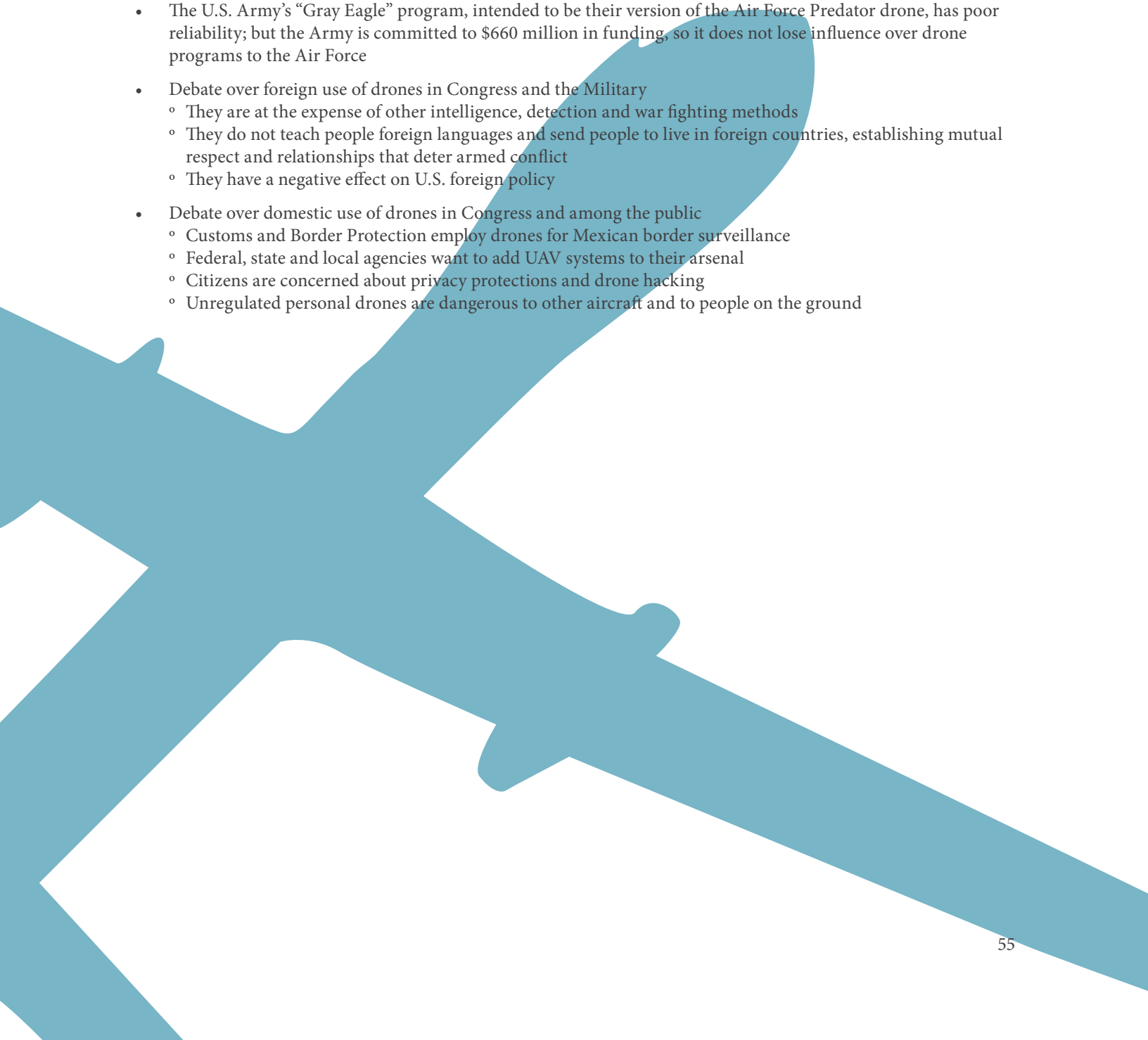
- Intelligence, Surveillance, Reconnaissance (ISR)
- Electronic warfare
- Anti-surface warfare
- Mine warfare
- Explosive ordnance disposal
- Force protection/strike

Future UAV Missions

- Resupply cargo ships and troop units overseas
- Combat search and rescue
- Refueling aircraft
- Air-to-air combat
- Space exploration

Unmanned Aerial Systems Trends

- More UAS/UAV personnel are needed. The U.S. Air Force has a shortfall of pilots and sensor operators; 1,400 needed by 2015
- Demands for testing and training have exceeded airspace availability for military operations
- Interoperability and standards: drone manufacturers install proprietary controls and software; Pentagon has no system to control multiple drones at once; it is looking for a "drone app store" system where control teams can "shop" for mission-specific applications and services; pilots need to be able to control and share information across a fleet of drones
- Cybersecurity – GPS vulnerabilities can be used to hijack a drone. Drones can be "spoofed" or fed false GPS information to bring them down. Iran claims to have cyber-attacked and brought down a U.S. Sentinel drone
- The U.S. Army's "Gray Eagle" program, intended to be their version of the Air Force Predator drone, has poor reliability; but the Army is committed to $660 million in funding, so it does not lose influence over drone programs to the Air Force
- Debate over foreign use of drones in Congress and the Military
  - They are at the expense of other intelligence, detection and war fighting methods
  - They do not teach people foreign languages and send people to live in foreign countries, establishing mutual respect and relationships that deter armed conflict
  - They have a negative effect on U.S. foreign policy
- Debate over domestic use of drones in Congress and among the public
  - Customs and Border Protection employ drones for Mexican border surveillance
  - Federal, state and local agencies want to add UAV systems to their arsenal
  - Citizens are concerned about privacy protections and drone hacking
  - Unregulated personal drones are dangerous to other aircraft and to people on the ground



Space Vehicles & Missile Manufacturing (NAICS 33641)

This industry makes guided missiles and space vehicles, including prototypes, component parts, propulsion units and support equipment. Companies work closely with government agencies through the national Missile Defense Agency of the Department of Defense. Government funding is on the decline, but civic and commercial uses are growing. Major players include Lockheed Martin, Northrop Grumman, Boeing and Raytheon. Major supply chain inputs are circuit boards and electronic components, computer systems, engines and turbines, molybdenum and other metals, and semiconductors.

Tanks & Armored Vehicles Manufacturing (NAICS 33699)

Despite stable demand from international markets, reduced U.S. government spending will hamper growth. The industry makes military armored ground combat vehicles, all-terrain vehicles, and tracked vehicles, combat tanks and special components for tanks such as self-propelled weapons. Key inputs include engines and turbines, nonferrous metals, paint, hardware, structural metals products, tires and wind turbines. Demand comes from national security purposes. Major manufacturers are General Dynamics Corporation (Abrams) and BAE Systems PLC (Bradley).

Shipbuilding (NAICS 33661)

Military shipbuilding will prosper despite a decline in commercial orders. Shipbuilders also operate shipyards, which have dry docks and fabrication equipment for construction, repair, conversion and alteration. Shipbuilders also produce prefabricated ship and barge sections and provide services such as ship scaling. Inputs include steel and aluminum, engines and turbines, hardware, metal pipes and tubes, paint, and navigational instruments. Ships (not for personal or recreational uses) are used by industries such as oil and gas extraction, iron ore mining, ocean and coastal transportation, port and harbor operations, marine cargo, sightseeing, and national and international security and defense. Major manufacturers include Huntington Ingalls Industries, Inc., which took over Northrop Grumman's shipbuilding operations and has 30.6% market share; and General Dynamics Corporation, which has 30.1% market share.

Rolls-Royce, the U.K. manufacturer of engines and turbines, is developing unmanned ships. They have created a virtual reality drone prototype that simulates 360-degree views from the vessel's bridge. They believe crewless drone ships will be safer, cleaner and less expensive. Sea trials may happen as early as 2015.[99]

99 Will Drone Ships Sail The Seven Seas? Bloomberg Businessweek, March 3-9, 2014

THE PORTLAND REGIONAL MARKET

Regional Defense Spending

The Oregon Business Plan defines A&D as cutting across multiple industries: electronics manufacturing, medical equipment, aerospace technology, ships, civil defense, homeland security, military technology, advanced fabrication and machining, firefighting, textiles, outdoor gear and cars.[1]

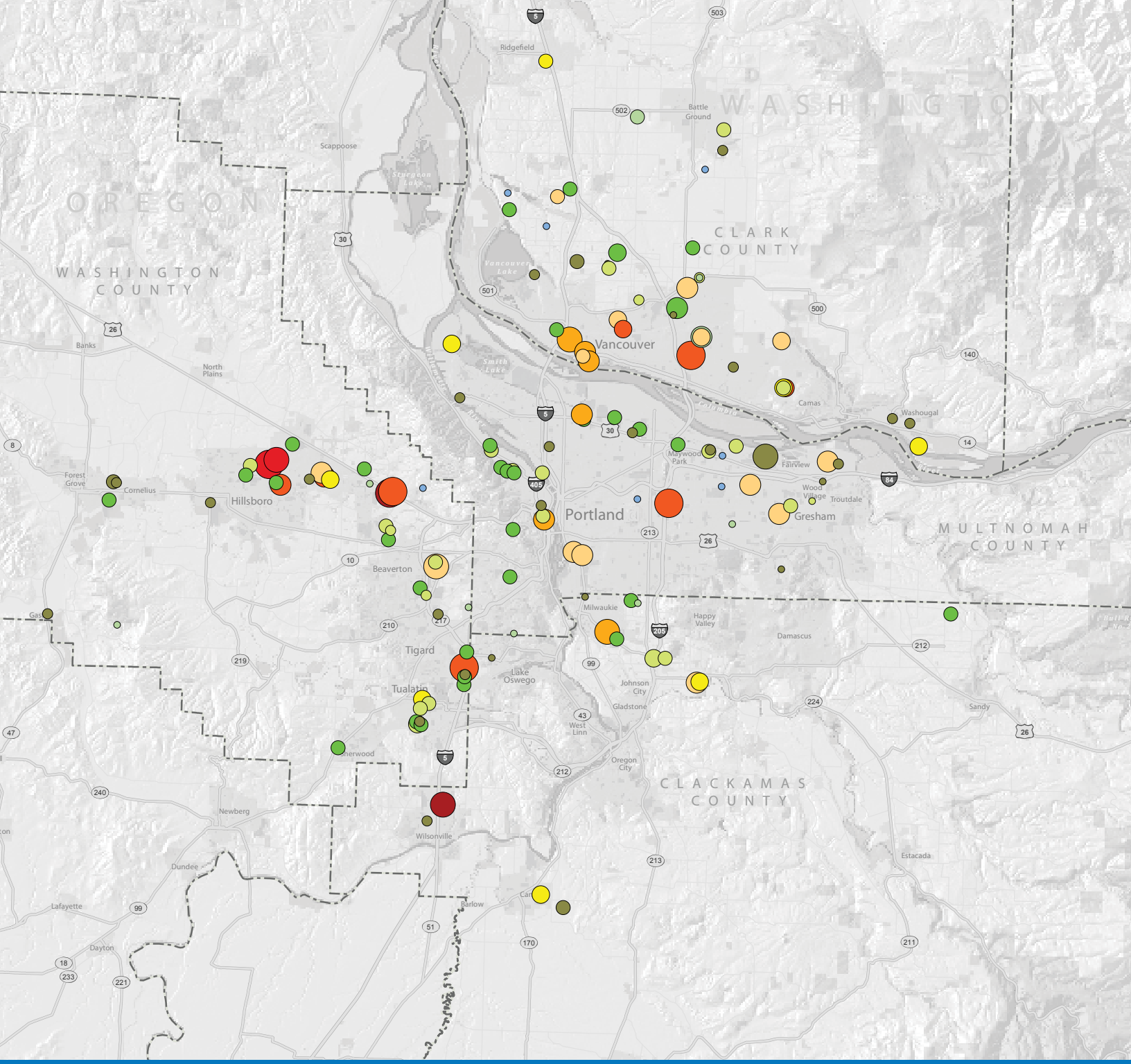
Oregon does not have considerable strength in the A&D industry. However, Portland regional suppliers have the capabilities needed to supply the industry, especially Boeing's operations in Gresham. High-quality electronics, metal parts and machinery, plastics, composites, manufactured metal and light metal components, and computers and electronics assemblies are intrinsic parts of aircraft. Oregon companies provide propulsion design, composite structures, telemetry, tracking and control systems, software, and electronics manufacturing.

Washington State, including Clark and Cowlitz counties, has significant A&D companies supplying the industry.

The Pacific Northwest Defense Coalition currently has 160 member firms from Washington, Oregon, Idaho, and Montana that employ more than 100,000 workers.[2]

1 Oregon Business Plan 2013

2 PNDC website



Portland Regional Aerospace & Defense Companies

Annual Sales by Color

- $1 - $500,000
- $500,000 - $1 million
- $1 - $2.5 million
- $2.5 - $5 million
- $5 - $10 million
- $10 - $20 million
- $20 - $50 million
- $50 - $100 million
- $100 - $500 million
- $500 million - $1 billion
- $1 Billion +

Full Time Employees by Size

- 1-4
- 5-9
- 10-19
- 20-49
- 50-99
- 100-249
- 250-499
- 500-999
- 1000-4999
- 5000-9999

Major A&D Suppliers With Presence In The Pacific Northwest

(For a complete list of five-county regional A&D businesses, see Appendix A.)

The Boeing Company, Seattle, Washington, and Gresham, Oregon

Builds aircraft for commercial, military and defense purposes: rotorcraft, electronic systems, missiles, satellites, launch vehicles, advanced information and communication services. Provides service to NASA and is the prime contractor for the International Space Station. Provides products and support services to customers in 150 countries. It is the largest U.S. exporter in terms of sales.

FLIR Systems Inc., Wilsonville, Oregon

Founded in 1978 to commercialize infrared technology previously only available at high cost to the military. Provides infrared imaging systems and thermal imaging cameras for aerospace, commercial vision applications, infrastructure security, and transportation safety. Acquired ICX to add detection systems for tracing oil spills and detecting gas leaks.

United Technologies Corporation, Hartford, Connecticut

Owns Sikorsky Aircraft, Pratt & Whitney, UTC Aerospace Systems (formerly Hamilton Sundstrand).

UTC Aerospace Systems, Hartford, Connecticut

Formed from the merger of Hamilton Sundstrand and Goodrich Corporation in 1999. Designer and manufacturer of UAVs, satellites, ground and naval vehicles.

Liebherr Group, Seattle, Washington

Aircraft air management, flight control and actuation systems, hydraulic and landing gear systems.

Meggitt Polymers & Composites, McMinnville, Oregon

Designs, engineers and manufactures sealing solutions.

Pacific Scientific – OECO, USA., Milwaukie, Oregon

Acquired by Meggitt, this company engineers extreme environment products for aerospace, defense and energy markets.

Leupold & Stevens, Beaverton, Oregon

Enhanced optical combat sights.

PCC Structurals Inc., Portland, Oregon

Components for aircraft engines, airframes, power generation and armaments.

Oregon Iron Works, Clackamas, Oregon

Hardware manufacturing for space launch vehicle access platforms, ground support systems and missile defense components and silos. Subsidiary of Vigor Industrial.

Leidos, Bremerton, Washington

Enhanced night vision technology, multimedia connectivity, and portable X-ray systems.

Vigor Industrial, Portland, Oregon

Shipbuilding and repair for U.S. Coast Guard and U.S. Navy. Parent company of Oregon Iron Works.

Glenair Quartic Sales Group, Redmond, Washington

Engineering design and product development services for aerospace, rail, ships and spacecraft.

Peregrine Power LCC, Wilsonville, Oregon

R&D and product engineering for power systems, electronics and controls.

Silicon Forest Electronics, Vancouver, Washington

Manufacturing and service for electromechanical systems in aerospace, defense, unmanned systems and instrumentation.

Tektronix Inc., Beaverton, Oregon

Low volume, high performance microelectronics, RF and microwave component development, high speed data converter modules and component testing.

Timbercon, Inc., Tualatin, Oregon

Fiberoptics for precision optical alignment with air, sea, ground and space applications.

Vanguard EMS Inc., Beaverton, Oregon

Electronics prototyping, manufacturing, testing and custom components for defense, security and aerospace.

DOD Spending in the Northwest from 2011 through 2013 has gone to the following contractors:[100]

- B.E. Meyers & Co. Inc.; Redmond, Washington. Optoelectronics systems integrator
- BAE Systems Applied Technologies; Groton, Connecticut; U.K. Advanced defense, security and aerospace systems
- Celeris Systems Inc.; Anaheim, California. Systems engineering, testing, integration
- Chugach Alaska Corporation, Alaska. Construction, project management, IT, oil spill response
- Cubic Corporation; Olympia, Washington. Global Tracking Solutions and cyber products for data transmission
- Dakota Creek Industries; Anacortes, Washington. Shipbuilding and repair
- Delphinus Engineering Corp.; Bremerton, Washington. IT and marine engineering
- EHW Constructors; Kitsap Naval Base, Washington. Explosives handling, wharf construction
- EJB Facilities Services (NAVFAC); Silverdale, Washington. Naval Base Bangor. Facilities support
- Epsilon Systems Solutions Inc.; Bainbridge Island, Washington. Research, system architecture, and software development
- FLIR Systems Inc.; Wilsonville, Oregon. Thermal imaging, radar, integrated surveillance, detection and sensor systems
- ICI Services Corp; Hill Air Force Base, Utah. Army, Navy & Homeland Security logistics and facilities management services
- INDUS Technology; Silverdale, Washington. Engineering and IT services
- ManTech Systems Engineering, Silverdale, Washington. Global logistics and IT
- McLaughlin Research; Keyport, Washington. Logistics, engineering, IT, CAD
- Modutech Marine Inc.; Tacoma, Washington. Boat building and repair
- Notkin Engineering Inc.; Seattle, Washington. Mechanical engineering
- Phacil, Inc.; Camp Pendleton, California. Cyber security and GIS systems
- Prism Maritime Ltd.; Chesapeake, Virginia. Quality management systems
- Safe Boats International LLC; Bremerton, Washington. Aluminum boats for military, fire and rescue
- Science Applications International Corp. (now Leidos); Eugene and Salem, Oregon; Bothell, McChord, Lynnwood, Poulsbo, Silverdale, Washington. Logistics, IT, systems engineering
- Scitor Corporation; Reston, Virginia. Systems engineering and integration, IT, mission operations support
- Talon Industries, Inc.; Arlington, Texas. Firearms
- The Boeing Company; Seattle, Washington and Gresham, Oregon. Aircraft manufacturing
- The Walsh Group Ltd.; Seattle, Washington. Construction
- USA Environmental Inc.; Virginia, Alabama, Hawaii. Munitions Response and Range Sustainment, GPS surveying and GIS mapping
- Vet Industrial Inc.; Bremerton, Washington. General contracting
- WFI Government Services, Inc.; Reston, Virginia. Wireless communications, IT and security systems for Keystone, Washington, Naval Operations

100 PNDC, Department of Navy Contracts: Challenges & Opportunities. James VanAntwerp, SES. Through mid June 2013 – report pulled from http://www.usaspending.gov/data on September 19, 2013

Regional Industry Strengths

- Experience with the implementation of defense contracts
- Low cost of doing business
- Climate of innovation – smart, flexible manufacturers who are willing to try new things
- Homegrown small businesses – willingness to fight hard to compete
- Established manufacturing base
- Strong National Guard presence
- Cross-industry cooperation to attract federal defense appropriations, workforce training and funding
- Intra-industry collaboration with other industrial organizations (e.g., Manufacturing 21)

Regional Industry Challenges

- Most military companies and vendors are located outside of Oregon
- Aging workforce – loss of qualified staff
- Logistics and transportation infrastructure: roads and bridges
- Innovation capacity for technology transfer and commercialization
- Lack of finance from venture capital and state funding
- Industry is project-driven and revenue projections are difficult

Regional Competitiveness Scorecard

As measured in a regional assessment created for the state of Washington by Accenture, six factors affecting aerospace manufacturing and competitiveness[101] must be assessed to determine a region's readiness for A&D industry growth and sustainability.[102]

1. Workforce
2. Education & Social Institutions
3. Supply Chain Network
4. Physical Infrastructure
5. Economic Factors
6. Political Climate

Workforce

Productivity, learning curve, and wages of the manufacturing workforce drive total cost. Engineering innovation generates opportunities for efficiency and revenue. Factors to consider include:

- Skill mix, quality
- Aerospace wages
- Collective bargaining

Wages

Labor costs include wages, salaries, fringe benefits, and insurance and represent about 13.4% of industry revenue. Larger firms generally have higher costs because they have broader product lines, sell to a wide range of geographical markets, have high R&D costs, and sell more technologically advanced products.

101 Washington Aerospace Partnership, Aerospace Competitiveness Study, Accenture, November 15, 2011

102 Washington Aerospace Partnership Competitiveness Study, Accenture, November 15, 2011

Oregon Wages Related To Aerospace & Defense Manufacturing Occupations[103]

NAICS	Firms	Employment	Payroll	Average Wage
Copper Rolling, Drawing, Extruding, and Alloying				
33142	No Data	No Data	No Data	No Data
Ferrous Metal Foundries				
33151	10	3,584	$273,639,032	$76,350
Nonferrous Metal Foundries				
33152	15	1,028	$59,051,481	$57,443
Metal Valve Manufacturing				
33291	6	153	$7,594,897	$49,640
All Other Fabricated Metal Product Manufacturing				
33299	80	1,664	$73,948,562	$44,440
Commercial and Service Industry Machinery Manufacturing				
33331	14	1,048	$70,279,275	$67,060
Engine, Turbine, and Power Transmission Equipment Manufacturing				
33361	10	155	$9,322,872	$60,148
Navigational, Measuring, Medical, and Control Instruments Manufacturing				
33451	69	4,359	$384,979,296	$88,318
Aerospace Product and Parts Manufacturing				
33641	13	2,335	$195,097,088	$83,553
Other Transportation Equipment Manufacturing				
33699	19	240	$8,739,241	$36,414
TOTAL	236	14,566	$1,082, 651,744	$74,327

Figure 22

Education and Training

An aging aerospace workforce may limit future productivity advantages. Educational and workforce development institutions (educational, R&D, industry support) are central to maintaining advantage. Investment in higher education will be crucial to maintaining this competitive advantage.

- Demographics
- Higher education
- Secondary education
- Quality of life indicators

Neither Washington nor Oregon universities or colleges are top sources of engineering talent for the U.S. aerospace industry. Top schools include:[104]

1. Pennsylvania State University
2. Georgia Institute of Technology
3. California Polytechnic State University
4. Purdue University
5. Virginia Polytechnic Institute and State University
6. University of California Los Angeles

103 Bureau of Labor Statistics, Quarterly Census of Employment & Wages

104 Aviation Week and Space Technology, August 22, 2011

Industry Institutions

Regional R&D is supported by organizations such as Oregon's State Innovation Council and Signature Research Centers, the Oregon Metals Initiative, the Pacific Northwest Defense Council, and the Pacific Northwest Aerospace Alliance. The industry also enjoys the benefits of Impact Washington and the Oregon Manufacturing Extension Partnership that support regional manufacturers with lean production and management techniques, and market expansion strategies. Numerous export assistance agencies provide access to overseas markets.

Supply Chain Network

The strength and maturity of existing aerospace final assembly and/or component facilities influence nonrecurring investments to support production. The region provides an extensive network of suppliers in electronics, computerization, metals manufacturing, and other materials and parts for aerospace and defense manufacture. The regional supply chain feeds Boeing and its prime suppliers such as Honeywell International and Rockwell Collins.

- Capabilities and quality
- Manufacturing network
- Logistics costs
- Procurement and material

Economic Factors

The cost of land and initial construction are key components of non-recurring costs; insurance and liability influence the total loaded labor cost of the aerospace workforce.

- Access to financing, capital
- Land availability, pricing
- Cost of living
- Insurance, liability

Physical Infrastructure

The region has road access to PDX airport and the ports of Portland and Vancouver, as well as extensive rail access. Production sites are also within trucking distance of major Washington and California marine and airports. However, traffic congestion on I-5, I-205, and state roads such as Route 26 impede speedy travel to PDX and marine ports.

- Airports
- Rail
- Roads
- Seaports

Political Climate

Taxation is a key element of total loaded cost. Competitive state incentives can improve return on investment for site construction and modifications.

- Industry incentives
- Taxation
- Labor rules
- Industry vision and support

The Accenture report[111] defining these areas of competitiveness suggests that, while Washington State has made significant investments to retain Boeing's manufacturing, it faces stiff national competition and has opportunities to strengthen its existing manufacturing infrastructure.

- Workforce development programs and educational investments are required to replace the region's aging aerospace workforce
- The existing supply chain is robust and provides an advantage over other states; but there are resources such as advanced materials coating capabilities that are missing
- Other states (e.g., South Carolina, Arizona, and Texas) are taking an active role in developing their aerospace industries; Washington and Northwest Oregon must take a proactive stance to maintain and grow their current advantages

105 Ibid

Washington A&D Industry Overview[106]

- Strong financial position, but does not offer competitive incentives
- Leads in education and workforce quality/learning curve, but risks losing advantage as its workforce ages
- Threat of work stoppages by unionized workforce can threaten stability
- Enjoys a significant economic multiplier via the A&D industry: economic output, jobs, labor, income, and tax revenue; each direct aerospace job is estimated to create 1.8 additional jobs
- Boeing employed 81,099 in November 2014;[107] an additional 8,000 are employed in 150 other aerospace firms throughout the state
- Approximately 2,800 Boeing suppliers are located in Washington; Boeing purchases in 2011 topped $3.36 billion
- Receives B&O (Business & Occupation) tax revenue of 0.2904% (only West Virginia, Ohio and Washington levy B&O taxes)

Benchmark states with existing aerospace clusters identified as direct competitors to Washington State and the Portland Metro Region include:

- California (Victorville air freight and Long Beach existing Boeing)
- Florida (Melbourne Space Coast)
- Kansas (McConnell Air Force Base, home of Boeing Spirit, Hawker and Beechcraft)
- New Mexico (Albuquerque Holloman Air Force Base)
- North Carolina (Kinston Jetport and Spirit Aerosystems)
- South Carolina (Charleston, existing Boeing facility, Air Force Base)
- Texas (San Antonio Lackland Air Force Base)
- Alabama (Huntsville Space Center)

Any of those states are potential sites for future Boeing production.

106 Ibid

107 www.boeing.com

Aerospace & the Washington Economy[108]

- $76 billion economic impact in 2012
  - $476 million in state tax revenues
  - 1,350 business establishments
  - 132,500 jobs and $11.5 billion in wages (11% of all Washington earnings)
- Boeing employs 81,099 people and supports $70 billion or 11% of statewide gross income: supplier purchases, wages and other spending
- Total aerospace and supporting industry revenues grew 35%, by $15.9 billion, between 2010 and 2012
  - Wages grew 15% – $1.5 billion
- Companies in Clark, Cowlitz and Skamania counties contribute to manufacturing, materials, machining, testing and calibration, air transportation and maintenance, repair and overhaul. Clark County alone has 84 A&D establishments
- A&D represents 49% of all Washington exports, worth $37.1 billion

Washington State's 2013 $1 Billion Aerospace Investment

- Sales & Use Tax Exemption for computers used in development and design
- B&O Tax Credit for property taxes on land and buildings
- B&O Tax Credit for Aerospace Manufacturers for Preproduction Development Expenditures
- B&O Tax Credit for Aerospace Product Development
- Preferential B&O Rate for FAR Certified Repair Station
- Preferential B&O Rate for manufacturing, wholesaling and retail of commercial aircraft
- Project Olympus Workforce Training and Capital/Land Improvement
- Project Pegasus Workforce Training and Capital/Land Improvement

108 Impact of the Aerospace industry in Washington State, October 2, 2013. Alex Pietsch, Director, Office of Aerospace; CAI Community Attributes Inc. Washington Aerospace Partnership; and Washington State Aerospace Industry Strategy 2014 Update. www.governor.wa.gov/documents/WEB_2014_Strategy.pdf

REGIONAL INDUSTRY SWOT[109]

Strengths

- Experienced workforce
- Extensive Boeing design and manufacturing assets
- $20M Department of Labor grant to build aerospace capabilities via community and technical colleges
- Strong aerospace industry advocates at regional, state and federal government levels
- Qualified suppliers working with Boeing to manage cost and quality
- Culture of innovation for product development and process improvement
- Dept. of Defense R&D presence via Battelle Institute in Washington

Weaknesses

- Large portion of Boeing workforce retiring in five to seven years, with resultant loss of experience and knowledge, both tacit and explicit
- Current workforce development and university efforts are not substantial enough to produce quality manufacturing and engineering employees at the scale required by industry growth
- Existing facilities are mature and new investment is expensive relative to other states
- Limited statewide coordination of aerospace strategies and actions
- Boeing's unionized workforce stoppages may induce it to look to other states offering nonunion workers and major financial incentives

Opportunities

- Increase four-year and graduate aerospace engineering programs
- Increase STEM education in K-12
- Increase apprenticeship programs and provide formal paths to trade certifications
- Collaborative industry/university research in computing, manufacturing efficiency and materials innovation
- State-level roles and responsibilities for retaining and attracting aerospace businesses
- Regionally coordinated economic development efforts to support the industry

Threats

- Cash and in-kind incentive programs from states such as South Carolina
- Competitive states offering low cost development areas with existing infrastructure and port access to serve aerospace manufacturing activities (South Carolina, Texas)
- Increasing competitiveness of other states' workforce as the talent gap grows in Washington/Oregon
- Supply chain disruption is possible from potential natural disasters (e.g., earthquake) – but that is the same in South Carolina and Texas (hurricanes)

Figure 23

109 Oregon Employment Department, 2014

Regional Challenge

Primes and suppliers rely on knowledgeable, experienced workers. While the weak economy has kept employees working longer, the A&D workforce is aging and older employees will soon retire in significant numbers. Companies face a challenge replacing both skilled workers and professionals.

High school and community college graduates may not have the technical knowledge, work experience and basic math and communication skills required for the A&D industry. University engineering graduates may no longer be attracted to the industry as the space program fades and budget cutbacks diminish R&D investments leading to exciting new technologies. An interesting study cited by Accenture[110] shows the skilled positions most in demand by U.S. A&D firms; though they vary in priority, they are common across all firm sizes.

High-Demand Work Areas By Size Of Organization Ranked In Order Of Priority

<1,000 Employees	1k-9,999	10k-49.9k	>50k
Aerospace Engineer	Mechanical Engineer	Systems Engineer	Systems Engineer
Structural Engineer	Systems Engineer	Software Engineer	Aerospace Engineer
Program Manager	Aerospace Engineer	Program Manager	Programmer/Software Engineer
Business Developer	Software Developer	Mechanical Engineer	Mechanical Engineer
Financial Analyst	Enterprise IT Expert	Business Developer	Program Manager
Software Developer	Software Engineer	Software Developer	Software Developer

Figure 24

The International Association of Machinists & Aerospace Workers Union says the industry faces similar recruiting challenges for machinists – 40 to 45% of aerospace machinists and engineers are over 50 years of age.[111]

Aerospace industry jobs range from assembly line workers to physicists and are available in every industrialized country. Training is available for potential aerospace workers at every level from community colleges, technical schools, major universities, and specialized corporate training programs. Universities renowned for aerospace, avionics and astronautics include Carnegie Mellon, Ohio University, Kansas State, and Embry Riddle with campuses in Prescott, Arizona, and Daytona Beach, Florida.

Regional Supply Chain

The A&D industry supply chain is extensive, complex and interdependent. Much like the computers and electronics supply chain that also supports it, the A&D industry supply chain is more web-like than linear. It operates as an integrated network for the procurement of components and complex modular systems such as nose-cone assemblies.[112]

110 Aviation Week and Space Technology, August 22, 2011 and Accenture Aerospace Competitiveness Study, November 15, 2011

111 Ibid

112 Development of supply chain management within the aerospace manufacturing sector. Bales, Maull and Radner, Supply Chain Management, p. 250, 2004

Risk has been passed from primes to second and third tier subcontractors who must plan, purchase and stock materials to meet immediate demand. For instance, the metals supply chain, an intrinsic part of aircraft manufacturing, is separate from the aerospace and defense supply chain and is managed by the components and parts producers. It is now easier for supply chain actors to cooperate within the network rather than compete against it. Suppliers are challenged to provide more services, to embed themselves with manufacturers, and to provide products at lower cost. Boeing expects cost reductions of 3% to 5% per year.[113] Manufacturers are passing engineering responsibility to suppliers but still want faster delivery times. They are aware of potential component and material shortages and are diversifying sources of supply to reduce production risk.

In response, suppliers are consolidating to gain market share and control prices and margins. They are investing in processes and technologies to increase operational integration with manufacturers, improving communications and reducing the risk of mistakes and time delays. They are moving closer, physically and virtually to their primes, and are trying to enter higher margin after-market support businesses, where they may compete directly with primes. They are also diversifying their customer base to maintain revenues and margins.

Primes are also rationalizing their supply chains. Turbomeca, a division of France's Safran, is reducing its suppliers from upwards of 400, down to a maximum of 150 key partners, with whom it will share designs, improve performance and decrease costs. It will deal directly only with those Tier One suppliers and delegate management of Tier Two companies to its first tier.[114] Suppliers also need capital investment to keep pace with production and innovation such as composite materials, bleedless engines, and lithium ion batteries.

Procurement forms the bulk of industry expenses and includes the acquisition of aircraft equipment, safety equipment and other materials (e.g., steel plates, copper tubing and aluminum, ferrous and nonferrous castings, electronic components). Raw materials used to construct or repair aircraft and their components vary depending on the specifications and size of the craft or engine being repaired or constructed. Since these costs consistently account for about half of an average firm's revenue, the industry is vulnerable to fluctuations in the price of materials and supplies.

Consolidation of the U.S. aerospace industry has placed pressure on component suppliers and helped keep finished goods costs from rising. Much of the material used is made around the world, and finished components are usually imported. Import duties and exchange rates can also affect purchase costs. In 2013, purchases represented about 48.9% of industry revenue.[115]

113 Washington Aerospace Partnership Competitiveness Study, Accenture, November 15, 2011

114 Ibid, p. 51

115 IBISWorld, 2013

"Boeing turns up the heat on suppliers."[116] It is the only U.S. prime manufacturer of commercial aircraft; it outsources to many subcontractors. General Dynamics (Gulfstream) and Textron (Cessna) make private and business aircraft. Their subcontractors produce system assemblies for:[117]

- Engines
- Fuselages
- Interiors
- Rotors
- Electronic and hydraulic control systems
- Avionics
- Guidance systems
- Flight simulators; a synthetic environment must take into account terrain, terrain changes in real time affecting traction, dynamic weather changes including snow accumulation, and radio frequency environments by using data bases, common data base standards, and cloud computing
- Tires
- Brakes

"Stable and mature supply chains are crucial here"[118] as evidenced by Boeing's lithium-ion battery problems on its 787. In January 2013 the plane was grounded for three months due to fire risk caused by over-heating batteries; that caused consternation among suppliers. Boeing identified "the 787's suppliers as the biggest limiting factors in the production system."

The industry giant has created a "no fly list" of suppliers who don't meet its standards for quality, delivery speed and cost; they are screening out poor suppliers on one division from all other parts of Boeing. The company is also using "cost down initiatives" to increase competition among suppliers, seeking more bids and introducing more new suppliers to its proposal process.

Boeing has 1,500 suppliers and many more sub-tier suppliers that contributed to delays of their 787 program. From raw materials to fasteners and electrical standards, they were not paying attention to sub-suppliers with whom they do not have direct relationships. That is now changing. Boeing outsources 60% of the value of its planes to external suppliers, but is focusing on supplying itself more internally, especially for engineering. Boeing now looks at five factors to determine whether or not to outsource a part:

1. Cost
2. Quality
3. Efficiency
4. Competitive sensitivity
5. Whether or not a supplier can give Boeing a market access advantage

116 Paris Airshow News, p. 46, June 17, 2013

117 First Research Industry Profile, Aerospace Products & Parts Manufacturing, April 29, 2013

118 Ibid

Supplier Success Factors

Scope: The abilities to provide multiple products at the lowest cost and to provide financial services to aircraft buyers increase a company's customer base and improve their ability to export.

Operational Excellence: Well-run internal processes for efficient inventory management and effective financial controls help a company be competitive and profitable.

Technological Know-How: Fuel efficiency, weight control and state-of-the art electronics are required to be competitive and to succeed in international export markets.

Economies of Scale: The ability to accommodate large production runs and operate with lean manufacturing techniques enables significant cost savings that contribute to profitability.

Exporting to International Markets: Overseas markets represent a significant portion of demand and provide access to increased productivity and profitability. Scale is necessary for participating in the global market.

Managing Purchases: Supply accounts for the bulk of industry expenses and includes the acquisition of aircraft equipment, safety equipment and other materials (e.g., steel plates, copper tubing and aluminum, ferrous and nonferrous castings, electronic components). Raw materials used to construct or repair aircraft and their components vary depending on the specifications and size of the craft or engine being repaired or constructed. Since these costs consistently account for about half of an average firm's revenue, the industry is vulnerable to fluctuations in the price of materials and supplies.

Finding Military Contracting Opportunities

Contracting begins with a bid announcement for military aircraft, satellites or missile systems specifying various requirements. Bids are submitted, usually within three months, and include solutions, designs and cost estimates. Substantial R&D may be required to enhance a bid. Competitive bids are negotiated, a contractor is selected, and a prototype is developed, built and tested. Government contracts are conditional upon continued congressional funding and appropriated on a fiscal year basis, even though contracts extend over several years. If a contract is terminated, the contractor is entitled to the purchase price for delivered items, reimbursement for work-in-progress and a profit allowance. A list of military contracting contacts is included in Appendix D.

How to Stay Competitive With Military Contracts

- Be innovative with technical solutions and specific and realistic about what you are proposing
- Cost is more important than it used to be in best-value approaches; technical approaches need to consider that
- If you get the contract, do what you promised you'd do; you will be monitored and you want a good performance rating if you expect to do business in the industry again
- Reduce costs that drive your indirect rates
- Be sure your proposal and contract performance reflect realistic labor and market trends

Trip Wires – Contract situations that can derail supplier bids

- Excessively high hourly labor rates
- Excessive variation between proposed and actual rates
- Proposed addition of subcontractors beyond what was expected
- Excessive Other Direct Costs (ODCs)
- Lack of competition (when only one offer is received, headquarters approval is required)

INTERNATIONAL TRADE

International trade translates to growth and U.S.-based defense contractors are also looking to exports to offset declining DOD spending.

The export market is estimated to account for about 68.7% of industry revenue. Much of that is generated by commercial aircraft sales to foreign airlines and parts distributors. U.S. companies such as Boeing hold a strong position within the commercial aircraft market, and any increase in demand by international airlines for new aircraft typically leads to increased demand for U.S. planes. Defense-related exports make up less of this segment because of restrictions on the export of advanced weaponry. Additionally, combat aircraft are extremely expensive, with few nations able to afford them.

In the five years prior to 2013, export's share of revenue significantly increased as demand from emerging markets climbed. More and more people within these markets are able to afford air travel; as a result, airlines operating abroad have begun to purchase more commercial aircraft to meet demand. Military-related exports have also risen, as tensions in the Middle East and Asia have led to more defense spending by neighboring nations. Global freight traffic is predicted to rise 4.8% annually over the next 20 years.[119]

Freight Forecast[120]

- Currently more than 200 airlines with 600 freighter aircraft capable of holding 10 tons
- Freight shipments have grown 7% above the pre-recession high in 2007 and 23% above the low in 2009
- China represented 26% of the global air traffic market in 2011
- Worldwide freight is predicted to grow 4.9% per year through 2031
- Asia Pacific region will be the largest driver of growth
- New deliveries in 2014 are forecast to be 1,973 converted aircraft and 851 new aircraft

U.S. imports are forecast to rise at an annualized 3.2% to $54.6 billion, as more aircraft parts manufacturing will be offshored to countries that can produce commodity items at lower cost. Domestic demand for imported commercial aircraft may also rise as new foreign firms enter the market and the strengthening dollar makes imports cheaper. Foreign governments are expected to pressure manufacturers to start production in their countries as a tradeoff for gaining market access.

Countries Exporting the Most A&D to the U.S.

- France
- Canada
- U.K.
- Japan
- Germany

Countries Importing the Most A&D from the U.S.

- France
- U.K.
- China
- Germany
- Canada

119 http://www.aircargoworld.com/ 2013

120 Navigating the Future, Airbus Global Market Forecast 2012-2031

Exports are high but growth is predicted to be moderate due to foreign competition. Major international players include Europe's Airbus (European Aeronautic Defense and Space Company NV), Bombardier, Rolls-Royce, BAE Systems and Brazil's Embraer. From 2005 to 2013, exports comprised nearly half of industry revenues, with imports accounting for 33% of U.S. industry demand. However, U.S. aircraft are still the most highly developed and most in demand in the world, thanks to R&D investments in new technologies.[121] As shown in Figure 27, U.S. exports far exceed imports.

Aerospace Exports

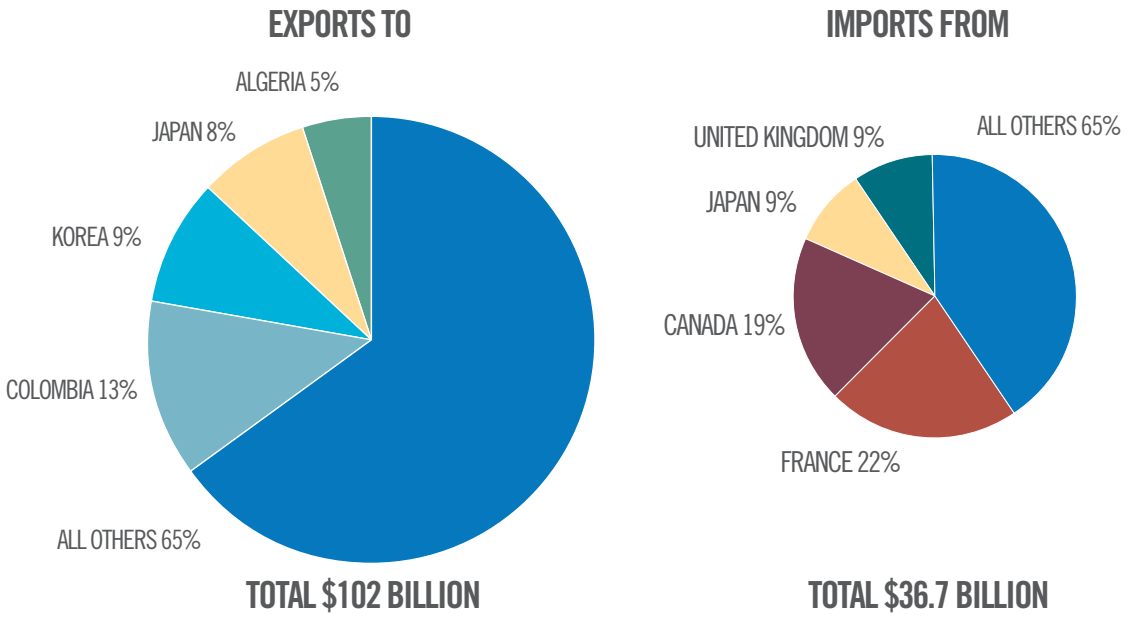


Figure 25

In the five years leading up to 2018, industry exports are forecast to climb at an annualized rate of 5.3% to $154.1 billion. Over the same period, imports are also forecast to rise at an annualized 3.2% to $54.6 billion. More aircraft parts manufacturing will be offshored to countries that can produce at lower cost.

Export growth is predicted to be moderate due to foreign competition. However, from 2005 to 2013, exports comprised more than half of industry revenues. Imports accounted for 33% of U.S. industry demand.

121 Boeing Current Market Outlook, 2013-2023

A Homerun for U.S. & Regional Aerospace Suppliers: Growth + Technology

Regions and suppliers will benefit from A&D over the next 20 years as air traffic has doubled every 15 years since 1970 and will do so through 2030.[122]

- 4.7% CAGR for passenger traffic > 7.5 billion passengers
- 4.9% CAGR for freight traffic
- 28,198 new plane deliveries
  - 38% replacements, 62% growth:
    - 69% single aisle and small jet freighters
    - 17% small twin aisle and regional freighters
    - 8% intermediate twin aisle and long distance freighters
    - 6% large passenger and freighters
- Deliveries worldwide:
  - 9,600 to Asia Pacific
  - 11,550 to North America and Europe
  - 7,084 to Latin America, Africa

Air Passenger Traffic Growth

- Driven by emerging markets' economic growth
- Resilient to crises, has grown 53% since 2000 despite 9/11, SARS, banking crisis and recession
- Domestic Chinese traffic will surpass U.S. domestic traffic in 2031
- India will grow 9.9% per year and have the fifth largest traffic by 2031
- Middle Eastern carriers will grow to 11% of passenger traffic by 2031

World's Busiest Airports

London's Heathrow will remain the world's largest airport in terms of long haul traffic; Dubai will be number two by 2031. Eight of the world's top 20 airports will be in the Asia-Pacific region.

The Top Countries For New Passenger Aircraft Deliveries

	Country	Planes	$ValueB
1.	U.S.	5,289	544.0
2.	China	4,272	634.0
3.	India	1,232	173.7
4.	Germany	986	138.1
5.	U.K.	979	129.8
6.	Russia	958	113.7
7.	United Arab Emirates	882	223.9
8.	Brazil	781	100.1
9.	Ireland	702	n.a.
10.	Australia	652	102.1
11.	Japan	n.a.	098.2

1. LHR - London
2. DXB - Dubai
3. CDG - Paris
4. FRA - Frankfurt
5. JFK - New York
6. LAX - Los Angeles
7. PEK - Beijing
8. PVG - Shanghai
9. HKG - Hong Kong
10. NRT - Tokyo
11. SIN - Singapore
12. AMS - Amsterdam
13. BKK - Bangkok
14. ICN - Seoul
15. YYZ - Toronto
16. MAD - Madrid
17. GRU - Sao Paolo
18. SYD - Sydney
19. SFO - San Francisco
20. ORD - Chicago

122 Navigating the Future: Airbus Market Forecast 2013 - 2031

GLOBAL REGION OVERVIEWS[125]

North America

- Largest aviation market in the world with more than 115 airlines; 4,000 aircraft; and more than 730 million passengers flying from, to and within the U.S.
- One of the oldest fleets in service, 11 years on average
- 5,850 new deliveries expected in next 20 years: 52% replacement, 48% growth

Latin America

Growth has moderated in Latin America and the slowdown was pronounced in Brazil. The Mexican economy has strengthened as business and consumer confidence has increased, sustaining domestic demand.

- Fleet has increased 40% since 2000
- Airports have increased capacity by more than 40% since 2005
- Aging fleet is average 14 years old
- 2,085 new aircraft deliveries expected: 31% replacement, 69% for growth

Asia Pacific

- 25% of the world economy today, perhaps 33% by 2031
- Growing 2.5 times faster than North America or Europe
- Will have 60% of the world's population by 2031
- 9,618 new aircraft deliveries expected in next 20 years: 36% replacement, 64% growth
- Malaysia has created Asia Aerospace City in Subang as an aerospace park located in the Malaysian International Aerospace Center, home to the national airport, international aerospace companies, and engineering services

Europe

- Air passenger traffic is greater than would be expected of the weak economy, as Europeans are great air travelers
- Inter-European air travel is forecast to grow 3.4% a year; foreign travel is expected to grow 4.4% per year
- 5,701 new aircraft deliveries expected in next 20 years: 40% replacement, 60% growth

Middle East

- 6 billion people within 8-hour flight of Gulf countries
- 8.9% growth in foreign air travel in 2011, 7.8% domestic travel growth
- 44% of the population are expatriates, traveling for business and family
- Existing airports being upgraded; new airports being built
- 1,906 new aircraft deliveries expected: 27% replacement, 73% for growth

Eastern Europe

- Russia, with GDP of nearly $2 trillion, has a growing wealthy class; it is the largest country in the world and has 150 million inhabitants
- Underpinned by natural resources, Russia's economy runs on natural gas and oil reserves
- 1,299 new aircraft deliveries: 22% replacement, 78% for growth

Africa

- Higher economic growth expected as the middle class triples to one billion people by 2060
- Domestic air traffic has grown 93% and international traffic by 89% since 2000
- Travel to the Middle East and Asia has grown dramatically, as strong economic ties with China drive growth
- 957 new aircraft deliveries expected over 20 years: 13% replacement, 87% for growth

FINDINGS & IMPLICATIONS

Supply Chain

Declines in the A&D sector due to reduced government spending in mature markets do not necessarily mean less business. As reported by manufacturers, states, regions and cities are now funding civic-related business that was federally supported. Growth is also predicted from developing economies in Latin America and Asia. Those are high-potential export markets to serve, and they offer increased supply chain opportunities for small and medium manufacturers. In addition, continued growth in the commercial sector in support of civic, corporate and agricultural aviation means continued prosperity for the industry. In particular, helicopters and UAVs have significant potential.

Better company management, technology and manufacturing improvements can result in greater margins. This is good for business and also reduces risk for an industry that needs to be scalable quickly in times of armed conflict. Resourcing organizations such as Impact Washington and the Oregon Manufacturing Extension Partnership (OMEP) that help suppliers implement lean manufacturing and product development tools and processes will strengthen the regional supply chain, making it more effective for existing companies and more attractive for recruiting new businesses.

Workforce Education & Training

The National Academy of Engineering, National Association of Manufacturers, Aerospace Industry Association, and the American Institute of Aeronautics[124] have all expressed concerns about "intellectual disarmament," a lack of education in engineering and technology. Boeing and United Technologies drive innovation and technology but need more scientists and engineers. Growth in the commercial sector with big backlogs at Boeing and Airbus, plus doubling of the number of new planes over the next 20 years, means growing profit; but it also means more workers will be needed.

- Clark College's Mechatronics Lab in Vancouver, Washington, is preparing mechanical and electrical engineering technicians, but only graduates an average of 12 students per year – most of whom have job offers before graduation.
- The University of Washington offers aeronautics, astronautics and mechatronics only at its campus in Seattle. Texas A&M and four other Texas universities offer degrees in drone technology. No Oregon or Washington university offers that specialty.
- Portland Community College's Aviation Maintenance Technology (AMT) program trains pilots and technicians. PCC offers one- and two-year Applied Science degrees in aviation maintenance.

Business leaders and economic development professionals can advocate for actions to ensure a well-prepared workforce.

- Strengthen secondary school aerospace apprenticeship programs in relevant trades
- Fund community and technical colleges to focus on A&D industry needs
- Create relevant degree programs at regional universities
- Recruit military veterans
- Actively recruit branches of top tier private research and education institutions into Oregon and Washington

124 Jim Albaugh, Pres. AIAA, Flight Daily News, p. 57, June 17, 2013

Physical Infrastructure

As with the computers & electronics and metals & machinery industries, access to ports, highways and railways is critical for manufacturers producing, shipping and exporting components for A&D. Bridge and roadway access are especially important, as a wide network of primes and suppliers supports this industry throughout the Pacific Northwest.

In conclusion,

while military expenditures for the A&D industry will likely diminish over time, without the threat of war, the commercial and civil sectors can look forward to increased demand in the U.S. and especially overseas. Companies and regions that want to reap the benefits of increased demand and growing exports must invest in their infrastructure, workforce education, and technological capabilities. They must also be cognizant of the increasing inter-connectedness of technologies and supply chains; and they must address the implications of major advances in the sciences of manufacturing, from metallurgy to 3-D printing.

APPENDICES

APPENDIX A: Greater Portland Regional Aerospace & Defense Companies On The GIS Map

Company Name	Address	City	ST	ZIP	Employees	Sales Volume Range
A-1 Precision Inc.	8014 NE 19th Court	Vancouver	WA	98665	10 to 19	$1-2.5 Million
Action Tech PC Inc	24337 S Skylane Dr	Canby	OR	97013	10 to 19	$1-2.5 Million
ADC	6451 NE Colwood Way	Portland	OR	97218	10 to 19	$2.5-5 Million
Advanced Composite Systems	4601 NE 78th St	Vancouver	WA	98665	1 to 4	$1-2.5 Million
AIMMCO	145 Alki Road	Woodland	WA	98674	20 to 49	$5-10 Million
Agilent Technologies Inc	15115 SW Sequoia Pkwy	Portland	OR	97224	500 to 999	$100-500 Million
Alaskan Copper & Brass Co	2440 SE Raymond St	Portland	OR	97202	50 to 99	$20-50 Million
Allied Systems Company	21433 SW Oregon St	Sherwood	OR	97140	250 to 499	$100-500 Million
American Blimp Co LLC	1900 NE 25th Ave # 8	Hillsboro	OR	97124	20 to 49	$5-10 Million
American Machine & Gear Inc	2770 NW Industrial St	Portland	OR	97210	20 to 49	$5-10 Million
American Scientific	13513 NE Whitaker Way	Portland	OR	97230	5 to 9	$1-2.5 Million
Applied Laser Technology	14155 SW Brigadoon Court #B	Beaverton	OR	97005	10 to 19	$2.5-5 Million
Applied Motion Systems	12000 NE 60th Way, Suite A	Vancouver	WA	98682	20 to 49	$2.5-5 Million
Applied Scientific Devices	9655 SW Ventura Ct	Tigard	OR	97223	1 to 4	$500,000-1 Million
Associated Hose Products Inc	6326 NE Columbia Blvd	Portland	OR	97218	5 to 9	$1-2.5 Million
Aviatrix	22831 SW Forest Creek Dr # A	Sherwood	OR	97140	10 to 19	$2.5-5 Million
Axiom Electronics	19545 NW Von Neumann Dr # 200	Beaverton	OR	97006	50 to 99	$10-20 Million
B2 Flight LLC	PO Box 8307	Portland	OR	97207	1 to 4	Less Than $500,000
Bodycote IMT Inc	4605 NW Pacific RIM Blvd	Camas	WA	98607	50 to 99	$10-20 Million
Boeing Fabrication Portland	19000 NE Sandy Blvd	Gresham	OR	97230	1,000 to 4,999	$1 Billion +
Brake Systems	2221 NE Hoyt St	Portland	OR	97232	20 to 49	$10-20 Million
Brighton Electronics	16732 SW 72nd Ave	Portland	OR	97224	10 to 19	$2.5-5 Million
Buell Calibration & Control	2240 SW Lillyben Ct	Gresham	OR	97080	1 to 4	$1-2.5 Million
C Power Industries Inc	33671 S Dickey Prairie Rd	Molalla	OR	97038	5 to 9	$1-2.5 Million
Cascade Coil Drapery	19505 SW 90th Ct	Tualatin	OR	97062	20 to 49	$2.5-5 Million
Cascade Precision Inc	35700 SE Bluff Rd	Boring	OR	97009	10 to 19	$2.5-5 Million
Cascade System Technology	23176 NW Bennett St	Hillsboro	OR	97124	20 to 49	$2.5-5 Million
Celestica	18870 NE Riverside Pkwy	Portland	OR	97230	250 to 499	$1-2.5 Million
Chains & Sprockets Inc	7035 NE Davis St	Portland	OR	97213	1 to 4	Less Than $500,000
CNC Precision Manufacturing	13735 SW Galbreath Dr	Sherwood	OR	97140	5 to 9	$500,000-1 Million
Coiltron Inc	6755 SW Sandburg St	Portland	OR	97223	10 to 19	$2.5-5 Million
Columbia Gear Works	14629 NE Halsey St	Portland	OR	97230	1 to 4	Less Than $500,000
Columbia Machine, Inc.	107 Grand Blvd.	Vancouver	WA	98668	100 to 249	$50 - 100 Million
Combustion Technology LLC	3307 NE 109th Ave	Vancouver	WA	98682	1 to 4	$1-2.5 Million
Compix Inc	15824 Upper Boones Ferry Rd	Lake Oswego	OR	97035	5 to 9	$1-2.5 Million
Connor Manufacturing	22867 NE Townsend Way	Fairview	OR	97024	10 to 19	$1 - 2.5 Million
Controltek	3905 NE 112th Ave	Vancouver	WA	98682	100 to 249	$2.5-5 Million
Cornell Pump Co	16261 SE 130th Ave	Clackamas	OR	97015	100 to 249	$20-50 Million
Cyber Tech Inc	7943 SW Cirrus Dr # C	Beaverton	OR	97008	10 to 19	$2.5-5 Million

Company Name	Address	City	ST	ZIP	Employees	Sales Volume Range
David H Sutherland Co Inc	5600 SW Arctic Dr # 110	Beaverton	OR	97005	20 to 49	$5-10 Million
Delta Computer Systems Inc	1818 SE 17th St	Battle Ground	WA	98604	20 to 49	$5-10 Million
Digital Control System	7401 SW Capitol Hwy	Portland	OR	97219	10 to 19	$2.5-5 Million
Discraft Corp	1990 SE 157th Dr	Portland	OR	97233	1 to 4	$500,000-1 Million
E M Aviation	13411 NE Prairie Rd	Brush Prairie	WA	98606	1 to 4	Less Than $500,000
Eaton Cooper Bussmann Trnsprtn	10955 SW Avery St # A	Tualatin	OR	97062	50 to 99	$5-10 Million
EDT Corp	1006 NE 146th St # J	Vancouver	WA	98685	10 to 19	$2.5-5 Million
Electro Heavy Equipment	7525 NE 47th Ave	Portland	OR	97218	10 to 19	$2.5-5 Million
Electro Scientific Industries	13900 NW Science Park Dr	Portland	OR	97229	500 to 999	$100-500 Million
Enoch Manufacturing Co	14242 SE 82nd Dr	Clackamas	OR	97015	50 to 99	$5-10 Million
Epi Inc	40300 NE 169th Ave	Amboy	WA	98601	5 to 9	$2.5-5 Million
Erickson Air-Crane Inc	5550 SW Macadam Ave # 200	Portland	OR	97239	500 to 999	$100-500 Million
Ershigs, Inc.	5985 S 6th Way	Ridgefield	WA	98642	20 to 49	$10-20 Million
Falk Corp	1113 NW 112th St	Vancouver	WA	98685	1 to 4	Less Than $500,000
FEI Co	5350 NE Dawson Creek Dr	Hillsboro	OR	97124	250 to 499	$500 Million-1 Billion
FLIR Systems Inc	27700 SW Parkway Ave	Wilsonville	OR	97070	250 to 499	$1 Billion +
Furuno USA	4400 NW Pacific Rim BLvd	Camas	WA	98607	50 to 99	$100-500 Million
Grant Edgel Co Inc	4233 NE 147th Ave	Portland	OR	97230	1 to 4	Less Than $500,000
H J ARNETT Industries LLC	20460 SW Avery Ct	Tualatin	OR	97062	10 to 19	$2.5-5 Million
Harris Rebar	2727 NW 35th Ave	Portland	OR	97210	10 to 19	$2.5-5 Million
Helser Industries	10750 SW Tualatin Rd	Tualatin	OR	97062	50 to 99	$10-20 Million
Hewlett-Packard	1115 SE 164th Avenue	Vancouver	WA	98683	5 to 9	$ -2.5 Million
Hinds Instrument Division	5250 NE Elam Young Pkwy	Hillsboro	OR	97124	10 to 19	$2.5-5 MillionHinds
Honeywell	12503 SE Mill Plain Blvd # 150	Vancouver	WA	98684	500 to 999	$100-500 Million
HSA America (Haeraus Shin-Etsu)	4600 NW Pacific Rim Blvd	Camas	WA	98607	20 to 49	$5-10 Million
Independent Marine Propeller	8675 N Crawford St	Portland	OR	97203	5 to 9	$1-2.5 Million
Industrial Gasket, Inc.	4601 NE 77th St., Suite 180	Vancouver	WA	98662	5 to 9	$2.5-5 Million
Inserta Fittings Co	3707 24th Ave	Forest Grove	OR	97116	10 to 19	$1-2.5 Million
Kaman Industrial Tech	18405 NE 149th Ave	Brush Prairie	WA	98606	5 to 9	$1-2.5 Million
Kaso Plastics	5720 NE 121st Ave #C	Vancouver	WA	98682	100 to 249	$20-50 Million
Kem Equipment	10800 SW Herman Rd	Tualatin	OR	97062	10 to 19	$5-10 Million
Kla-Tencor Corp	20475 NW Amberwood Dr # 130	Beaverton	OR	97006	100 to 249	$20-50 Million
Kleenair Products Co	14230 SE 98th Ct	Clackamas	OR	97015	20 to 49	$5-10 Million
Kyocera Industrial Ceramics	5713 E Fourth Plain Blvd.	Vancouver	WA	98661	50 to 99	$20-50 Million
Lacey Harmer Co	4270 NW Yeon Ave	Portland	OR	97210	20 to 49	$5-10 Million
Lattice Semiconductor Corp	5555 NE Moore Ct	Hillsboro	OR	97124	100 to 249	$100-500 Million
Leupold & Stevens Inc	14400 NW Greenbrier Pkwy	Beaverton	OR	97006	500 to 999	Over $1 Billion
Lifeport Inc	1610 Heritage St	Woodland	WA	98674	20 to 49	$5-10 Million
Lockheed Martin	1220 SW 3rd Ave	Portland	OR	97204	5 to 9	$1-2.5 Million
Machine Sciences	10165 SW Commerce Cir #G	Wilsonville	OR	97070	50 to 99	$5-10 Million
Martin Sprocket & Gear	3030 NW Industrial St	Portland	OR	97210	10 to 19	$2.5-5 Million
Matthews Marine Systems	4732 N Albina Ave	Portland	OR	97217	5 to 9	$1-2.5 Million
Max-Viz Inc	15940 SW 72nd Ave	Portland	OR	97224	10 to 19	$2.5-5 Million
Maxim Integrated	14320 SW Jenkins Rd	Beaverton	OR	97005	10 to 19	$5-10 Million

Company Name	Address	City	ST	ZIP	Employees	Sales Volume Range
Megasonics Corp	3 Monroe Pkwy # P	Lake Oswego	OR	97035	1 to 4	$500,000-1 Million
Mettler-Toledo Inc	20160 SW Avery Ct	Tualatin	OR	97062	5 to 9	$1-2.5 Million
Microchip Technology	21015 SE Stark St	Gresham	OR	97030	10 to 19	$5-10 Million
Micropump, Inc.	1402 NE 136th Ave.	Vancouver	WA	98684	100 to 249	$500,000-1 Million
Mike's Rod Bending Spinners	PO Box 1851	Kalama	WA	98625	10 to 19	$2.5-5 Million
Miles Fiberglass and Composites	8855 SE Otty Road	Happy Valley	OR	97086	20 to 49	$10-20 Million
nLight Corporation	5408 NE 88th Street, Bldg. E	Vancouver	WA	98665	50 to 99	$2.5-5 Million
Northwest Copper Works Inc	1303 N River St	Portland	OR	97227	20 to 49	$5-10 Million
Northwest Dynamics Inc	6709 NE 131st Ave	Vancouver	WA	98682	5 to 9	$2.5-5 Million
Oersted Technology	24023 NE Shea Ln # 208	Wood Village	OR	97060	1 to 4	$1-2.5 Million
Olympic Aero Svc	1356 Down River Dr	Woodland	WA	98674	5 to 9	$1-2.5 Million
Onboard Systems	13915 NW 3rd Court	Vancouver	WA	98665	20 to 49	$20-50 Million
ON Semiconductor Corp	23400 NE Glisan St	Gresham	OR	97030	1 to 4	$5-10 Million
Opti-Craft Inc	17311 NE Halsey St	Portland	OR	97230	50 to 99	$20-50 Million
Oregon Iron Works	9700 SE Lawnfield Road	Clackamas	OR	97015	100 - 249	$20-50 Million
Ornelas Enterprises	20175 NW Amberglen Ct #100	Beaverton	OR	97006	20 to 49	$20-50 Million
P & A Metal Fab Inc	13009 SE Jennifer St # 101	Clackamas	OR	97015	50 to 99	$10-20 Million
Pacific Scientific	4607 SE International Way	Milwaukie	OR	97222	250-499	$50-100 Million
PCC Structurals	4600 SE Harney Dr	Portland	OR	97206	1000 to 4999	$100-500 Million
Peco	4707 SE 17th Ave	Portland	OR	97202	100 to 249	$20-50 Million
Phlogiston Products Inc	101 E Main St	Gaston	OR	97119	5 to 9	$1-2.5 Million
Phyl-Mar Swiss Products, Inc.	3136 Evergreen Way	Washougal	WA	98671	5 to 9	$1 -2.5 Million
Piller Plastics	3925 S. Grant St.	Washougal	WA	98671	50 to 99	$10 - 20 Million
Plexsys Interface Products	4900 NW Camas Meadows Dr	Vancouver	WA	98607	50 to 99	$20 - 50 Million
Precision Plumbing Products	802 SE 199th Ave	Portland	OR	97233	50 to 99	$20-50 Million
Protean Technology Inc	38532 SW Fernwood Dr	Gaston	OR	97119	1 to 4	$500,000-1 Million
QBF Inc	10005 SW Herman Rd	Tualatin	OR	97062	20 to 49	$5-10 Million
Quality Gear	7408 SE Johnson Creek Blvd # A	Portland	OR	97206	1 to 4	$500,000-1 Million
R & G Machining & Engine Parts	123 N Molalla Ave	Molalla	OR	97038	10 to 19	$5-10 Million
Ran Bro Tool Company	31678 NW Hillcrest St	North Plains	OR	97133	10 to 19	$1 - 2.5 Million
Ran Tech Engineering & Arospc	5516 SE International Way	Portland	OR	97222	10 to 19	$2.5-5 Million
Rexnord	12608 NW 46th Ave	Vancouver	WA	98685	10 to 19	$2.5-5 Million
Rex Plastics	12515 NE 95th St.	Vancouver	WA	98682	10 to 19	$2.5-5 Million
Rubber & Plastics	7401 NE 47th Ave	Vancouver	WA	98661	20 to 49	$5-10 Million
Russell Automation	21211 NE 72nd Ave	Battle Ground	WA	98604	10 to 19	$500,000-1 Million
Sanmina-SCI Corp	16534 NW Audrey Dr	Beaverton	OR	97006	20 to 49	$2.5-5 Million
Sanmina-SCI Corp	1301 Officers Row	Vancouver	WA	98661	250 to 499	$50-100 Million
Sapa Extrusions	7933 NE 21st Avenue	Portland	OR	97211	100 - 249	$50-100 Million
Sayler Custom Controls	29115 SW Kinsman Rd	Wilsonville	OR	97070	5 to 9	$1-2.5 Million
Sekidenko	2501 SE Columbia Way, Suite 230	Vancouver	WA	98661	20 to 49	$20-$50 Million
Shimadzu USA Mfg Inc	1900 SE 4th Ave	Canby	OR	97013	50 to 99	$10-20 Million
Sigma Design	1714 Broadway Street	Vancouver	WA	98663	10 to 19	$2.5-5 Million
Silicon Forest Electronics, Inc.	6204 E. 18th Street	Vancouver	WA	98661	50 to 99	$100-500 Million
Simplex Aerospace	13340 NE Whitaker Way	Portland	OR	97230	20 to 49	$5-10 Million

Company Name	Address	City	ST	ZIP	Employees	Sales Volume Range
SMC Corp Of America	20170 SW 112th Ave	Tualatin	OR	97062	20 to 49	$2.5-5 Million
Snappy	16233 NE Cameron Blvd	Portland	OR	97230	20 to 49	$5-10 Million
Spectronics Inc	11230 NW Reeves St	Portland	OR	97229	1 to 4	Less Than $500,000
Spencer Fluid Power	2230 NE Columbia Blvd	Portland	OR	97211	10 to 19	$2.5-5 Million
Standard Gear Mfg Inc	2467 SE Ochoco St	Portland	OR	97222	1 to 4	$1-2.5 Million
Sulzer Pumps US Inc	200 SW Market St # 400	Portland	OR	97201	20 to 49	$5-10 Million
Sunset Manufacturing	19355 SW Teton Ave	Tualatin	OR	97062	10 to 19	$2.5-5 Million
Survey Technologies Inc	2867 SW Greenway Ave	Portland	OR	97201	10 to 19	$2.5-5 Million
Syntek Technologies	1500 NW Bethany Blvd # 200	Beaverton	OR	97006	1 to 4	$500,000-1 Million
Tektronix Inc	13975 SW Karl Braun Dr	Beaverton	OR	97005	5 to 9	$2.5-5 Million
TennMax America	14221 NW 50th Ct	Vancouver	WA	98685	1 to 4	Less than $500,000
Theia Technologies	29765 SW Town Center Loop W #4	Wilsonville	OR	97070	5 to 9	$10-20 Million
Thompson Metal Fab	3000 WE Hidden Way, Bldg. 40, Bay 6	Vancouver	WA	98668	100 to 249	$50- 100 Million
Thyssen Krupp	14626 NE Airport Way	Portland	OR	97230	20 to 49	$5-10 Million
Tokyo Electron America	20175 NW Amberglen Ct # 140	Beaverton	OR	97006	100 to 249	$100-500 Million
Tri Quint Semiconductor Inc	2300 NE Brookwood Pkwy	Hillsboro	OR	97124	500 to 999	$500 Million-1 billion
Tube Specialties Co Inc	1459 NW Sundial Rd	Troutdale	OR	97060	100 to 249	$20-50 Million
Tubes N' Hoses NW	13106 NE Fourth Plain Blvd	Vancouver	WA	98682	1 to 4	$500,000-1 Million
Tubular Solutions Inc	2690 NW Nicolai St	Portland	OR	97210	10 to 19	$2.5-5 Million
United Pipe Bending & Fab Inc	10534 NE Marx St	Portland	OR	97220	10 to 19	$2.5-5 Million
US Digital	1400 NE 136th Ave #201	Vancouver	WA	98684	50 to 99	$20-50 Million
US Pipe Fabrication	4827 NW Front Ave	Portland	OR	97210	10 to 19	$2.5-5 Million
Vanguard Ems	9825 SW Sunshine Ct	Beaverton	OR	97005	250 to 499	$20-50 Million
Van-Port Design, Inc.	6600 NW Whitney Road, Ste A	Vancouver	WA	98665	5 to 9	$1-2.5 Million
Vesta's American Wind Tech	1881 SW Naito Pkwy # 100	Portland	OR	97201	100 to 249	$50-100 Million
Viasystems Group	1521 Poplar St	Forest Grove	OR	97116	10 to 19	$2.5-5 Million
Vitesse Semiconductor Corp	4550 Kruse Way # 275	Lake Oswego	OR	97035	1 to 4	$1-2.5 Million
Weissert Tool & Design, Inc.	540 17th St.	Washougal	WA	98671	5 to 9	$1-2.5 Million
West Coast Specialties	6656 SE Crosswhite Way	Portland	OR	97206	10 to 19	$2.5-5 Million
Westak Of Oregon Inc	3941 24th Ave	Forest Grove	OR	97116	5 to 9	$1-2.5 Million
Western Aircraft Propeller	1610 NW Perimeter Way	Troutdale	OR	97060	5 to 9	$1-2.5 Million
Western Integrated Tech	8900 N Ramsey Blvd	Portland	OR	97203	50 to 99	$10-20 Million
Xilinx Inc	8625 SW Cascade Ave	Beaverton	OR	97008	5 to 9	$2.5-5 Million
Zmag America LTD	10260 SW Greenburg Rd # 400	Portland	OR	97223	5 to 9	$1-2.5 Million

APPENDIX B: Major Aerospace & Defense Manufacturers

- AAR Corporation (AIR)
- Aeroflex Holding (ARX)
- AeroVironment (AVAV)
- Agilent Technologies (A)
- Airbus
- Albany International (AIN)
- Alcoa, Inc. (AA)
- Alliant Techsystems (ATK)
- American Pacific (APFC)
- Ametek, Inc. (AME)
- Anaren, Inc. (ANEN)
- Astronics Corp. (ATRO)
- B/E Aerospace (BEAV)
- Ball Corporation (BLL)
- Barnes Group (B)
- Boeing Co. (BA)
- Breeze-Eastern (BZC)
- Carpenter Technology (CRS)
- Computer Sciences Corp. (CSC)
- CPI Aerostructures (CVU)
- Crane Co. (CR)
- Cubic Corporation (CUB)
- Curtiss-Wright Corp. (CW)
- Cytec Industries (CYT)
- Ducommun (DCO)
- Eaton Corp. (ETN)
- Erickson Air-Crane (EAC)
- Esterline Technologies (ESL)
- FLIR Systems (FLIR)
- GenCorp (GY)
- General Dynamics (GD)
- General Electric Co. (GE)
- Griffon Corp. (GFF)
- Harris Corp. (HRS)
- HEICO Corp. (HEI)
- Hexcel Corp. (HXL)
- Honeywell International, Inc. (HON)
- Huntington Ingalls (HII)
- Innovative Sol. & Spt. (ISSC)
- ITT Exelis (XLS)
- Jabil Circuit (JBL)
- Kaman Corporation (KAMN)
- Kratos Defense (KTOS)
- L-3 Communications Holdings Inc. (LLL)
- LMI Aerospace (LMIA)
- Lockheed Martin Corp. (LMT)
- Loral Space (LORL)
- Materion (MTRN)
- Microsemi Corp. (MSCC)
- Moog, Inc. (MOG-A)
- National Technical Syst. (NTSC)
- Northrop Grumman Corp. (NOC)
- Orbital Sciences Corp. (ORB)
- Oshkosh Corporation (OSK)
- Pall Corporation (PLL)
- Parker Hannifin (PH)
- Plexus Corp. (PLXS)
- Precision Castparts (PCP)
- Raytheon Co. (RTN)
- Reliance Steel & Aluminum (RS)
- Rockwell Collins (COL)
- RTI International Metals (RTI)
- SAIC, Inc. (SAI)
- Sanmina Corp. (SANM)
- SIFCO Industries (SIF)
- Sparton Corporation (SPA)
- Spirit AeroSystems (SPR)
- Textron Inc.
- Standex International (SXI)
- Teledyne Technologies (TDY)
- Textron, Inc. (TXT)
- Timken Co. (TKR)
- TransDigm Group Inc. (TDG)
- Triumph Group (TGI)
- United Technologies Corporation (UTX)
- Wesco Aircraft (WAIR)

APPENDIX C: U.S. & Global Helicopter Manufacturers[125]

AgustaWestland, U.K.

Owned by Italy's Finmeccanica. Designs and manufactures in Italy and the U.K., formed in 2000 by a merger of Finmeccanica and GKN's Augusta and Westland Helicopters. Also makes Tiltrotor high-speed aircraft. Tiltwings combine the vertical lift of a helicopter with the speed and range of a fixed-wing aircraft.

Avic International, China

High-speed helicopters, from ultra-light to high altitude. Purchased U.S. Continental Motors Inc.

AVX Aircraft Co., U.S.

Founded in Ft. Worth, Texas, in 2005, AVX is a "horizontal manufacturer" of vertical takeoff and landing aircraft. It has a patented coaxial rotor dual ducted fan design and has submitted a proposal to the U.S. Army for its Future Vertical Lift Aircraft program.

Bell Helicopter, U.S.

Division of U.S. Textron, based in Texas, manufactures military helicopter, tiltrotors, and commercial rotorcraft products in Mirabel, Quebec, Canada. Bell provides training and support activities worldwide.

Boeing Helicopters, U.S.

McDonnell Douglas Helicopter Systems produces commercial helicopters. Boeing Rotorcraft Systems, part of Boeing Integrated Defense Systems, manufactures in Pennsylvania and Arizona.

Columbia Helicopters, U.S.

Based in Portland, Oregon, Columbia was founded in 1957 and makes heavy-lift commercial rotary aircraft. Its "hover barge" is famous for hauling a barge loaded with 40 tons of cargo across water, snow, and ice facing 30-knot headwinds.[126]

Denel Aviation, South Africa

Owned by the South African Government, Denel manufactures military aerospace and defense aircraft and components including helicopters and unmanned aerial vehicles.

Eagle Helicopter, Canada

Builds, converts and maintains helicopters at operations in Calgary, Chile, and Australia.

Enstrom Helicopter Corp., U.S.

Manufactures piston and turbine engine commercial and private market helicopters for police, medical and military operations, utility, wildlife conservation and agriculture as well as business and personal use. Founded in Michigan in 1957, it delivers helicopters to Indonesia, Japan and Thailand.

125 aircraftcompare.com

126 http://www.colheli.com/news/the_hover_barge/

Erickson Air-Crane Helicopters, U.S

Based in Central Point, Oregon, it produces the S-64A Aircrane capable of lifting 20,000 lbs., used in logging and high-rise construction in the U.S., Asia, Europe, Australia and South America. It acquired Oregon's Evergreen Helicopters and Brazil's Air Amazonia from HRT – Participações em Petróleo S.A, expanding its South American operations by six new aircraft, two ground facilities, 59 new employees and a repair station certification.[127]

Airbus Helicopters (formerly Eurocopter), France

World's largest. Established in 1992 as a merger of Daimler-Benz Aerospace and France's Aerospatiale. It employs 17,500 people who design, develop, produce and market the most comprehensive range of civil and military helicopters in the world. Specialized aftercare centers ensure all activities of support, service and training. Generates revenue of more than 4.8 billion euros, solidified orders for 346 new helicopters and achieved a 49% market share in the civil and parapublic sectors. Its strong worldwide presence is ensured by 30 subsidiaries and participation on five continents with an extensive network of distributors and certified agents.

HAL Hindustan Aeronautics Ltd., India

Founded in 1964 via merger of companies manufacturing aircraft since the early 1940s. Products include advanced light helicopter with integrated weapons systems and light combat helicopters. HAL has a variety of aerospace technology joint ventures around the world, but their primary customer is India's Defence Service, Coast Guard and Border Security Force. They have also been a Boeing "Supplier of the Year."

Kaman Aerospace, U.S.

Subcontractor and service provider manufacturing in U.S., Mexico, Canada and Puerto Rico, with headquarters in Connecticut. Designs, tests and certifies helicopter systems and components, major assemblies, complex components, subassemblies and detail parts. Major customers include Sikorsky, Boeing, Bell, Airbus and the U.S. Air Force.

Kamov, Russia

Founded in 1948, Kamov became part of Russian Helicopters in 2008. It developed the Ka-series for the Russian Navy with technology for search and rescue, amphibious landing, surveillance and rotary-wing air attacks on submarines and surface craft. It also manufactures versions for civilian use in construction, installation, transport and rescue. Low noise engines enable operations in metropolitan areas. Kamov incorporates a design school and scientific and technical R&D.

MD Helicopters, U.S.

Founded in 1955 as part of Hughes Aircraft. Sold to McDonnell Douglas in 1984. When Boeing merged with McDonnell Douglas in 1997, MD Helicopters was sold to Dutch RDM Holdings. Patriarch Partners Investment Fund acquired it in 2005. It is now independently operated in Arizona. Fleet users include Korea, U.S. Special Operations, Japan, Jordan, Turkey National Police, U.S. police departments, the Finnish and Argentina Armed Forces, and the Italian government.

127 Avionics Intelligence, September 10, 2013

MIL Helicopters, Russia

Manufactures rotary aircraft for multipurpose, transport, search & rescue, agriculture, medevac, training, police, fire fighting and "VIP" use. Merged with Kamov and Rostvertol to form Oboronprom Corp. in 2006. Overlapping product lines were rationalized in the merger.

NH Industries, Germany

Pan-European enterprise by Germany, France, Italy and the Netherlands. Military transport and navy helicopters designed for demanding weather conditions, sold throughout Europe, the Middle East and Australia/New Zealand. Based in France and owned by Eurocopter, AgustaWestland and Fokker Aerostructures. Assembly is in France, Italy, Germany, Spain, Finland and Australia.

PZL Swidnik, Poland

Operating since 1964 and now owned by AgustaWestland division of Finmeccanica. Manufactures helicopter and fixed wing components for use on civil, private and military aircraft for leading aerospace companies in Europe and the U.S.

Robinson Helicopter, U.S.

Founded in 1973, it manufactures civil use helicopters, overhauls older aircraft and provides training courses for flight instructors and maintenance technicians. Located in Torrance, California.

RotorWay International, U.S.

Kit helicopter manufacturer in Arizona, founded in 1961, purchased by British investors in 1990. Employee-owned in 2007 and acquired by an ownership group in 2009. Sells helicopter kits in 50 countries.

Sichuan Lantian Helicopter Company, China

A joint venture between Russia's Mil Moscow Helicopter plant and China's Lantian Helicopter Co., in operation since 2007. Aircraft are sold in Africa and Pakistan.

Sikorsky Aircraft, U.S.

Founded in 1925 by a Russian-born American immigrant in New York; relocated to Stratford, Connecticut and became part of United Aircraft, now United Technologies, in 1929. Performed the world's first helicopter rescue in 1944. Makes commercial and military helicopters for the U.S. armed forces and customers in 40 countries.

APPENDIX D: Industry Resources

Federal and Military Contracting Contacts

- Seaport Services: *www.seaport.navy.mil/default.aspx*
- Federal Business Opportunities: *www.fbo.gov*
- Naval Undersea Warfare Center, Keyport Forecast: *www.navsea.navy.mil/nuwc/keyport/pages/Small%20Business/Business%20Information.aspx*
- NAVFAC NW Forecast: *www.navfac.navy.mil/products_and_services/sb/opportunities/forecasts_opportunities.html*
- NAVSUP FLC Puget Sound: *www.navsup.navy.ml/navsup/business_opps*

Selected U.S. & World Data Resources

- Aerospace & Defense Intelligence Report 2013: *http://www.bga-aeroweb.com/m/adir.html*
- Aerospace Industry Association: News, links, press releases, government issues *www.aia-aerospace.org*
- Aerospace Industries Association of Canada: Policy issues and advocacy for aerospace companies and jobs
- AeroSpace and Defence Industries Association of Europe
- Air Force Association of Canada
- Ascend Online Fleets: Largest source of helicopter data monthly, quarterly and annual. U.K., Hong Kong, Japan but not Latin America. *www.usaascendworldwide.com*
- Assembly Magazine: Industry news, product news
- Aviation Week: Industry news, homeland security news, issues
- General Aviation Manufacturers Association: Industry news
- The Manufacturer: Information for U.S. and U.K. manufacturers
- U.S. Department of Defense: Military news
- Federal Aviation Administration: *www.faa.gov*
- U.S. International Trade Commission: *www.usitc.gov*
- Airlines for America Industry Association: *www.airlines.org*
- Aerospace & Automotive Industries / International Trade Administration
- U.S. Aerospace Industry Statistics, Reports & FAQs
- American Institute of Aeronautics and Astronautics (AIAA)
- Defense, Navigational, and Aerospace Electronics 2005 Report U.S. Census Bureau
- U.S. Aerospace Industry Statistics, Reports & FAQs
- The Airbus Market Outlook for 2006-2025
- Congressional Reports
- Defense Acquisition Guidebook
- IRD B&P Statistics (Independent Research and Development, Bid and Proposal)
- Aerospace & Automotive Industries / International Trade Administration
- Manufacture of Aerospace Equipment in the European Union
- European Trade in Transport Equipment, Global Defense Review
- Industry Facts & Figures, International Air Transport Association (IATA)
- International Civil Aviation Organization (ICAO)
- Global Outlook for Air Transportation 2006, Avitas, Inc.
- Alacra Wiki – Aerospace & Defense
- Asian Aviation
- Defense-Aerospace
- *DefenseNews.com*
- Eurocontrol: The European Organisation for the Safety of Air Navigation
- European Aviation
- European Commission: Aeronautics
- European Aeronautics: A Vision for 2020
- Defense Procurement and Acquisition Policy
- European Aviation Safety Agency (EASA)
- European Space Agency
- Eurostat
- Federal Aviation Administration (FAA)
- National Aeronautics and Space Administration (NASA)
- National Transportation Safety Board (NTSB)
- U.S. Department of Defense

APPENDIX E: Industry Organizations, Associations, Publications & Conferences

Aerospace & Defense Benchmarking Council – Worldwide forum of management professionals in the aerospace and defense industry for the exchange of performance measurements and benchmarking data

AeroSpace and Defence Industries Association of Europe – European association representing the interests of industries in the aeronautics, space, defense and security sectors

Aerospace Industries Association – Organization representing the interests of industries involved in civil and military aircraft and helicopters, unmanned aerial vehicles, space systems, aircraft engines and related systems, materials and technology across the United States of America

Aerospace Industries Association of Canada – Canadian aerospace industry facts and figures, Canadian aerospace capability guide, 1998/99 aerospace survey, and careers guide

AFCEA UK – Armed Forces Communications and Electronics Association

Air Transport Association of America – Trade organization representing the principle U.S. airlines. The association's purpose is to foster a business and regulatory environment that ensures safe and secure air transportation. By working with members in the technical, legal and political arenas, ATA leads industry efforts to fashion crucial policy and supports measures that enhance aviation safety, security and well-being

American Nuclear Society – Resources on nuclear science and technology: nuclear medicine, nuclear energy, food irradiation, and nuclear techniques used in manufacturing and processing industries

Armed Forces Communications Electronics Association – Association serving the communications, electronics and information systems community

Association for Unmanned Vehicle Systems International (AUVSI) – A non-profit organization devoted to advancing the unmanned systems community and committed to developing and promoting unmanned systems and related technologies

Council of Defense and Space Industry Associations – CODSIA provides a central channel of communications for improving industry-wide consideration of the many policies, regulations, implementation problems, procedures and questions involved in federal procurement actions

Defence Science and Technology Laboratory – DSTL provides services in defense research, defense consultancy and defense evaluation. Previously Defence Evaluation and Research Agency (DERA, U.K.)

Defense Advanced Research Projects Agency - DARPA

Defense MicroElectronics Activity (DMEA) – Leverages capabilities and payoffs of advanced technology to solve weapon system operational problems, increase operational capability, and reduce the effects of diminishing manufacturing sources

Defense News – A Gannett Company publication

Federal Aviation Administration – FAA

Federation of Aerospace Enterprises in Ireland – Provides a voice in Ireland for the aerospace industry and promotes the Irish Aerospace Industry worldwide

French Land Defence Manufacturers Association (GICAT) – Professional group representing the industrial sector supplying equipment to the French Land forces and exports Land and Air land equipment

National Aeronautics and Space Administration – NASA

National Defense Industrial Association – Provides a legal and ethical forum for the interchange of ideas between the government and the defense industry

Pacific Northwest Aerospace Alliance – Redmond, Washington. Promotes industry growth and international competitiveness through education, business opportunity access, information on emerging markets, and relationship development

Pacific Northwest Defense Coalition (PNDC) – Portland, Oregon. Focuses on strengthening our members' business growth, our region's economy, and our nation's security through training, one-on-one counseling, business-to-business networking, and advocacy

Pacific Northwest National Labs (Battelle) – Located in Richland, Washington, PNNL is one among ten U.S. Department of Energy (DOE) national laboratories managed by DOE's Office of Science. Our research strengthens the U.S. foundation for innovation, and we help find solutions for not only DOE, but for the U.S. Department of Homeland Security, the National Nuclear Security Administration, other government agencies, universities and industry

PDX Drones – Promotes development of drone technology for constructive purposes. *pdxdrones.com*

Submarine Industrial Base Council – Represents more than 4,000 U.S. businesses across 47 states that make up the nation's submarine industrial base

SAE International Group – SAE standards are internationally recognized for their role in helping ensure the safety, quality, and effectiveness of products and services across the mobility engineering industry

APPENDIX F: Regional Industry & Economic Development Support Organizations

Business Oregon, *www.oregon4biz.com*: A state organization that works to retain, expand and attract businesses through public-private partnerships, leveraged funding, and support of Oregon companies and entrepreneurs. The Oregon Business Development Commission oversees policies in support of executive and legislative leadership for business. It provides company resources for exporting and is a partner in the Greater Portland Export Initiative.

Columbia River Economic Development Council, *www.credc.org*: CREDC is the business growth and expansion resource for Southwest Washington. It connects businesses and investors to economic resources to advance the economic vitality of Clark County through innovation. It partners with education, workforce and business communities, supports entrepreneurship, and provides leadership for improvements in physical infrastructure and amenities that help create, attract, grow and retain companies.

Greater Portland Inc., *www.greaterportlandinc.com*: A regional economic development partnership helping companies and site selectors find ideal spots to locate and expand. It helps position the Portland-Vancouver metro area as a competitive and vibrant economy. GPI provides business development, regional branding and marketing and regional strategy coordination, including the region's Comprehensive Economic Development Strategy (CEDS), the Greater Portland Export Initiative in conjunction with the Brookings Institution, and the Jobs & Innovation Accelerator Challenge Grants awarded by the U.S. government.

Portland Development Commission, *www.pdc.us*: PDC is the City of Portland's economic development and urban renewal agency. It supports growth and competitiveness, healthy neighborhoods and social equity. It promotes innovation and economic opportunity, providing direct support for startups and growing businesses, including recruiting of new businesses and retention of existing businesses.

Metro, *www.oregonmetro.gov*: The elected regional government for the Portland Metropolitan Area working with businesses and communities to create a sustainable region.

APPENDIX G: Regional & National Exporting Related Resources

Organizations

Impact Washington ExporTech Training Program: *www.impactwashington.org*

Washington State Export Resource Program: *www.exportwashington.com*

U.S. Export Assistance Center Portland: *www.export.gov/oregon*

Business Oregon International Export Assistance: *www.Oregon4biz.com*

Export Council of Oregon: *www.exportcounciloforegon.org*

U.S. Commercial Service, Oregon, International Trade Administration: *www.trade.gov/cs/states/or.asp*

Websites

Trade Leads, Finding Customers, Distributors, Company Directories and Databases

FITA: Federation of Int'l Trade Associations
www.fita.org

Global Industrial Products and Company Database
www.solusource.com

Global eMarketplace
www.alibaba.com

Business Oregon Export Assistance
www.oregon4biz.org

Trade Counseling, Mentoring

Find Your Local Small Business Development Center
www.sba/gov/tools/local-assistance/sbdc

Find U.S. Export Assistance Center (U.S. Commercial Service, U.S/ Dept. of Commerce)
www.export.gov

Find a Local District Export Council that Mentors Exporters
http://www.districtexportcouncil.org/locator/Oregon

Foreign Market Data, Country Economic & Business Climate

U.S. Gov't/US Commercial Service Export Portal
www.export.gov

U.S. Dept. of Agriculture, Foreign Agric. Service
www.fas.usda.gov

Global Business Web Portal
http://globaledge.msu.edu

Global Market Studies to Purchase
www.marketresearch.com

Global Market Studies to Purchase
www.researchandmarkets.com

Economist Economic Intelligence Unit, Country Market Data and Industry Analysis
www.eiu.com

FITA Market Research
www.fita.org or *www.internationaltrade.org*

World Bank Info re: Foreign Market Regulatory Environments
http://doingbusiness.org

Journal of Commerce
www.joc.com

Websites, continued

Trade Information Portals, Tutorials, Export Guides, Links to Other Sources

Basic Guide to Exporting
www.unzco.com

U.S. Gov't. Export Portal
www.export.gov

FITA "Really Useful Links" Trade Info
www.fita.org or *www.internationaltrade.org*

International Trade Assocociation
www.ita.doc.gov

Links to 100 Trade Websites
MSU Global Business portal
http://globaledge.msu.edu

Free On-line Export Training
www.export-u.com

Business Culture

Foreign Business Culture
www.executiveplanet.com

Foreign Business Culture
www.worldbiz.com

See Country Commercial Guides
www.export.gov

Trade Data; Tariffs, Duties; HS (International Harmonized System) Codes

International Trade Administration
www.ita.doc.gov and *http://tse.export/gov*

UN Trade Database
http://comtrade.un.org

USITC Interactive Trade Data Source
http://dataweb.usitc.gov

Census Bureau Trade Data
www.census.gov/foreign-trade

U.S. Int'l Trade Commission
www.usitc.gov

Tariff Info, HS Codes
http://www.fedex.com/GTM?cntry_code=us

Trade Finance

Export-Import Bank Website
www.exim.gov/

U.S. Gov't Trade Finance Guide
http://export.gov/

Trade Shows, Events

Trade Show News Network Events Database
www.tsnn.com

See Trade Events Section under
"Opportunities" Menu
www.export.gov

Legal and Compliance

Legal Export Assistance Network
www.exportlegal.org

U.S. Customs & Border Protection Trade Resources
www.cbp.gov/xp/cgov/trade/

Stanford Univ. Export Control Info & Tools
http://doresearch.stanford.edu/research-scholarship/export-controls

Special 301 Report on Intellectual Property Protection by Country
http://www..tr.gov/trade-topics/intellectual-property

U.S. Bureau of Industry & Security (U.S. Export Controls)
www.bis.doc.gov

Export Council of Oregon
www.exportcounciloforegon.org

Export Financial Assistance Sources

- Office of International Trade Export Assistance Program (*www.sba.gov*)
- Export-Import Bank Export Financial Assistance (*www.exim.gov*)
- SBA Export Working Capital Program (*www.sba.gov*)
- Oregon Capital Access Program (*www.oregon4biz.com*)
- Oregon STEP Program (*www.oregon4biz.com*)
- Oregon Entrepreneurial Development Loan Fund (*www.oregon4biz.com*)
- Oregon Trade Promotion Program (*www.oregon4biz.com*)
- Portland Development Commission Trade Programs (*www.pdc/us*)
- *www.Export.gov/OR*
- *www.Export.gov/WA*
- Export Finance Assistance Center of WA (*www.efacw.org*)
- Washington Export Resource Center (*www.exportwashington.com*)

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