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Aircraft Industry 2008

ABSTRACT: The global aircraft industry is healthy. Vigorous competition exists in all market sectors. With the exception of the relatively less mature unmanned aircraft systems sector, significant changes to the number and identity of competing firms are not likely in the next few years, although the mature military fixed-wing sector likely will see new joint ventures and other forms of cooperation between firms. Orders for commercial aircraft are soaring and should continue to remain high for years to come. Military aircraft manufacturing is also robust. The aircraft industry is globalized. Commercial and military aircraft manufacturers are using a variety of methods to enter into foreign markets, including the use of global supply networks and teaming with firms of the home nation. Despite its good health, significant challenges to the aircraft industry exist. Among other things, while facing the specter of skyrocketing fuel prices, the industry must face the problems of insufficient capacity, recruiting and retaining skilled aerospace workers, reducing the environmental impact of aircraft, and adapting to a globalized market. Given its strategic importance, the US government should, when appropriate, take certain public policy actions to help the industry cope with these challenges.

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Domestic:

- Aerospace Industries Association, Washington, DC
- Bell Textron, V-22, UH-1, and Armed Recon Helicopter, Arlington, TX
- Boeing Commercial Airplane Division, B-737/747/767/777/787 Production Facility, Everett/Renton, WA
- Boeing Integrated Defense Systems (IDS) Military Aircraft Division, St Louis MO
- Boeing IDS C-17 production facility, Long Beach CA
- General Atomics Aeronautical Systems, Inc., Predator UAV Flight Test Facility, Gray Butte, CA
- Lockheed Martin Aeronautics Company, F-16, F-22, JSF Production Facility, Fort Worth, TX
- Lockheed Martin Corporation Fighter Demonstration Center, Arlington, VA
- Northrop Grumman Integrated Systems, JSF, Global Hawk UAV, and B-2, Palmdale, CA
- Pratt & Whitney Aircraft Engines, Middleton, CT
- Sikorsky Aircraft Corporation, Stratford, CT

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- AgustaWestland, EH101 Production & Training Facility, Yeovil, United Kingdom
- Airbus S.A.S., A320/340/380 Production Lines, Toulouse, France
- BAE Systems, Eurofighter and JSF Production Facility, Samlesbury, United Kingdom
- BAE Systems plc Corporate Offices, London, United Kingdom
- Dassault Corporate Headquarters, St. Cloud, France
- Eurocopter, Marseille, France
- Rolls Royce Aircraft Engines, Civil and Defence Aerospace Divisions, Derby, United Kingdom
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INTRODUCTION

The 2008 Aircraft Industry Study (AIS) found the global aircraft industry in good health. Every firm visited by AIS is profitable and appears to have a sound financial future. Vigorous competition exists in every market sector, even those where a duopoly exists, such as the large commercial jet sector where Boeing and Airbus fight tooth-and-nail to win orders for their single-aisle airliners, the B737 and A320, while differentiating themselves through other products, such as the fuel-efficient 787 Dreamliner and the ultra-large A380. Significant order backlogs predominate in all commercial sectors of the industry. Despite soaring demand, there has been little effort among firms to increase productive capacity, perhaps because the *status quo* benefits aircraft manufacturers and customers alike. The industry, as a whole, is stable, but there is potential for significant changes in the immature unmanned aircraft systems (UAS) sector, which has a plethora of competitors and relatively low barriers to entry. Although it has four major competing firms, the structure of the rotorcraft sector looks stable. In the engine sector, firms continue to focus on the aftermarket for profit, but are considering the paradigm-shifting notion of servicing engines manufactured by a competitor. The regional jet sector will continue to be dominated by Embraer and Bombardier in the long-term, but new entrants from China and Russia are taking their first steps toward eventually becoming players. In addition, fuel costs may move some airlines to purchase more fuel efficient turboprops in lieu of regional jets. In 2007, the business/general aviation aircraft sector saw the first deliveries of "very light jets" (VLJs) from Eclipse Aviation. However, it remains to be seen whether Eclipse can take a bite out of the market shares of the established firms in the sector. In the military fixed-wing sector, globalization is especially evident as a relatively small number of manufacturers look to partner with foreign competitors or to use foreign suppliers as ways of entering new markets.

Despite the healthy state of the industry, rapidly rising fuel prices threaten to reduce demand for new commercial aircraft by driving up airfares and dissuading price sensitive customers from taking to the skies. The resurgence of the aircraft industry has brought back an array of major problems—insufficient capacity, recruiting and retaining skilled aerospace workers, reducing the environmental impact of aircraft, and adapting to a globalized market—that had temporarily subsided after September 11th, when air traffic and demand for new aircraft declined. The US defense budget, which is the largest factor driving demand for military aircraft, likely will take a downturn after years of record spending. This paper examines these problems in light of the current state of the aircraft industry. It also looks at the role that the US government plays in the industry and makes recommendations, when appropriate, for US public policy changes. Lastly, this paper examines three areas of special interest to the aircraft industry: surge capacity, strategic sourcing, and unmanned aircraft systems.

DRIVING FACTORS

To understand the global aircraft industry, AIS identified several major factors that drive demand for new aircraft. For new commercial aircraft, global economic growth, commercial air traffic trends, regulatory liberalization, and fuel costs are important. For new military aircraft, security concerns and budgetary constraints, rather than market forces, prevail. For both new commercial and new military aircraft, fleet replacement needs play a role.

Global Economic Growth. Commercial aircraft industry business cycles tend to mirror world economic cycles. In 2008, world GDP is forecast to measure a healthy four percent with the anemic US economy being offset by strong growth in Europe and Asia.[1] Over the next 20

years, analysts forecast the Chinese economy to grow at a robust annual average rate of 6.6 percent. Average annual world economic growth over this same period is predicted to be 3.1 percent.[2] These rosy projections bode well for the future health of the industry. Economic growth increases the number of people who can afford and have the need and/or desire to travel by air. As the pool of consumers expands, so does demand for new aircraft to transport them.

Regulatory Liberalization. In 1978, the US government began deregulating its domestic airline market allowing for easier market entry and exit, greater product differentiation, and market-determined fares.[3] Although the deregulation caused substantial turbulence in the US airline industry, over the last thirty years, fares have remained low and air traffic has increased enormously. Since then, the EU and others have followed suit and experienced similar increases in air traffic in their domestic markets. Since the early 1990s, the US in particular has sought to replace restrictive bilateral aviation agreements with liberalized "open skies" agreements that remove carrier designation, frequency, and gateway requirements.[4] In March 2008, an open skies agreement went into effect between the US and EU, which allows airlines of the party nations to fly between any city in the US and Europe without restrictions on the number of flights, routes, and fares charged.[5] The aircraft industry sees international route liberalization as a key component to stimulating the growth of international air traffic and, perforce, the demand for new commercial aircraft.[6]

Trends in Air Traffic & Flight Frequencies. To a great extent, the industry is buoyed by the large commercial jet and the regional jet sectors, whose customers are airlines, but whose consumers are passengers and shippers of cargo. Thus, the number of people traveling or wanting to ship cargo directly affects the demand for new aircraft. Since 2004, world air traffic has been growing.[7] Over the next 20 years, world air traffic is expected to triple with passenger traffic growing 4.9 percent annually and air cargo traffic growing 6.1 percent annually.[8] During this time, traffic within and to/from Asia will increase at a rate far above world averages.[9] One response to increased air traffic is to build larger aircraft with more seats. Another is to build smaller aircraft in greater numbers and fly them more frequently on routes that bypass hubs. Either response creates demand for new aircraft, such as the ultra-large Airbus A380, which holds 525 people in a three-class configuration, or the 200-300 seat Boeing 787 Dreamliner.

Fuel Costs. After September 11th, the global airline industry experienced six consecutive years of losses before turning a $5.6B profit in 2007.[10] However, this tenuous recovery is being threatened by rising fuel costs, which place pressure on airlines to cut in-flight amenities, reduce supply (measured in terms of available seat miles), and raise ticket prices. On May 13, 2008, the spot prices of crude oil and jet fuel were $125.83 a barrel and $3.93 a gallon, respectively.[11] In the fall of 2007, assuming a 2008 average oil price of only $78 a barrel, the International Air Transport Association (IATA) had reduced its preliminary airline industry profit forecast from $7.8 billion to $5 billion.[12] In the first four months of 2008 alone, skyrocketing fuel costs have already driven at least four US airlines out of business and driven up fares on other airlines. To cover $3B in unforeseen additional fuel costs, American Airlines recently announced that it would impose a $15 fee on the *first* checked bag. Some in the airline industry have even half-jokingly proposed weighing passengers at the ticket counter and charging *them* by the pound. The short-term result of high fuel costs will be to stunt the demand for air travel, as both business and leisure travelers look to other options, including staying home, rather than paying higher prices. The downstream effect will be cancellations by airlines of new aircraft orders.

In addition to affecting demand for new aircraft, rising fuel prices affect the design of new aircraft and new aircraft engines. For example, in response to customer suggestions, Airbus recently changed the fuselage frames of its proposed A350XWB from metal to lighter, more fuel efficient carbon fiber.[13] The A350 will be Airbus' response to Boeing's 787 Dreamliner, which touts its fuel efficiency as a major advantage over currently available aircraft of similar size. If fuel prices continue to rise, the Dreamliner and eventually the A350 will be even more attractive options for any airlines that can still afford to purchase new aircraft. Turboprop aircraft, which are generally more fuel efficient than regional jets, will also be more attractive.

Security Concerns/Governmental Budgetary Constraints. Demand for military aircraft, unlike demand for commercial aircraft, is not directly affected by market forces. Rather security concerns and governmental budgetary constraints prevail. The end of the Cold War, for example, caused many nations to believe that they faced reduced security threats and to seek a "peace dividend" in terms of lower defense procurement spending. The result in the US, which is by far the biggest customer for military aircraft, was the so-called "procurement holiday" in which acquisition spending dropped dramatically and US defense firms, including military aircraft manufacturers, were forced to either exit the market or consolidate (e.g. Boeing and McDonnell Douglas). In Russia, where certain types of military aircraft ceased being produced altogether, the effects of the Cold War's end were arguably even more dramatic. For the US, in particular, the wars in Afghanistan and Iraq and the general sense of national insecurity arising since September 11th have contributed to a reinvigorated demand for new military aircraft. However, even with heightened security concerns, the US, like other nations, has budgetary constraints that force it to cancel or delay purchases of new aircraft.

Aircraft Fleet Replacements. As airlines operate their aircraft more frequently, high utilization rates hasten the aging process and contribute to the need to replace old commercial aircraft with new ones. The average age of aircraft in the fleets of many major airlines, such as American and Northwest, is close to twenty years.[14] Replacement aircraft comprise a large percentage of the huge order backlogs of companies like Boeing and Airbus.[15] According to Boeing, the world's airlines will need nearly 29,000 new aircraft from 2006 to 2026.[16] Of these, more than 10,000 will be replacement aircraft.[17] The world's helicopter fleet is graying as well. According to a survey conducted by Honeywell, "around 80 percent of new purchases [in the next five years] will be made to replace older aircraft…."[18]

While the need for fleet replacement drives the demand for new military aircraft, the world's air forces often look at a variety of options, such as refurbishing old aircraft, to delay purchasing new ones. In this regard, the USAF is not atypical. In 2006, the average age of USAF aircraft was over 23 years. General Robert Keys of Air Combat Command states that "the [US] Air Force's fleet of warplanes is older than ever and wearing out faster because of heavy use in Iraq and Afghanistan."[19] Keys' focus on high utilization rates to explain the aged USAF fleet tells only part of the story. Another reason is an astronomically expensive and Byzantine procurement process that makes acquiring new military aircraft a daunting decades-long experience. In response to this process, the USAF has opted to extend the lifespan of many old aircraft, such as the C-5, through refurbishments and/or upgrades (see Appendix 1).

STATE OF THE INDUSTRY

AIS found the aircraft industry to be in good health. Both the commercial and the military aircraft markets are experiencing the first simultaneous upturn in over twenty years.[20]

In 2008, aerospace industry sales, with aircraft production accounting for the lion's share, are expected to grow to $210.6B with an order backlog of $360B.[21] Every firm visited by AIS is profitable and appears to have a sound financial future.

AIS focused on seven market sectors: large commercial jets (estimated sector size in terms of units to be produced and value of deliveries from 2008-2012: 5011 units totaling $500B), regional jets (1882 units totaling approximately $40B), business/general aviation aircraft (7,276 units totaling $94.3B), military fixed-wing aircraft (fighters, 1449 units totaling $71.1B; transports, 447 units totaling $36.4B), rotary-wing aircraft (military and civil: 10795 units totaling $65.3B), unmanned aircraft systems, and aircraft engines.[22]

Vigorous competition exists in all market sectors, even those characterized by duopolies. However, barriers to entry remain high in all sectors of the aircraft industry and significant changes to the number and identity of competing firms is not likely in the next few years, although restructuring may occur over the long-term, especially in the military sector as firms seek to define new competitive-partner relationships and in the UAS sector, which is the least mature sector and has low barriers to entry relative to the other sectors.

Currency exchange rates have a major impact on the global aircraft industry. Airbus, for example, pays its production costs in euros and, by industry convention, sells its aircraft in US dollars; therefore, Airbus loses money when the dollar is weak against the euro. Additionally, a weak dollar makes US-made aircraft cheaper for and therefore more attractive to non-US airlines, thus giving US aircraft manufacturers an advantage over non-US aircraft manufacturers. During visits to firms in the UK and France, AIS was repeatedly told that the weak US dollar is a major problem for them.

Technological innovations, including 3-dimensional design techniques and a greater reliance on composite materials, and improved "lean" productive processes are being adopted across the industry. While there are signs that some manufacturers are in effect becoming systems integrators, there are no signs of the impending appearance of any truly "transformational" technologies that would give one firm a market altering advantage over its competitors. New technologies that promise to reduce the cost of titanium should help aircraft manufacturers lower their costs, but shortages of other crucial substances, such as cobalt, could become a problem (see Special Interest paper, below).

Orders for commercial aircraft are soaring and should continue to remain high for years to come provided that world economic growth continues to be strong. However, air traffic and demand for new aircraft remain highly sensitive to political and other forces, such as wars, terrorist acts, epidemics, and, of course, fuel prices. The demand for military aircraft, which is driven by the US defense procurement budget is high and likely will remain so in the near future. However, after years of increases, a cyclical downturn in defense spending is due, which may cause some disruption in the structure of the military aircraft market, but nothing akin to that caused by the post-Cold War "procurement holiday." For one thing, there are already only a handful of firms competing in the military aircraft market. For another, firms have already done much to insulate themselves from procurement spending swings and glacially-paced DOD-driven product development cycles by forming intricate "competi-mate" relationships with other firms, where they are teammates with another firm on one project, for example, Boeing and Lockheed on the F-22, while competing against that same firm on another, for example, the Boeing-Lockheed battle for the F-35 Joint Strike Fighter (JSF). Although the US military market is still the domain of US aircraft manufacturers, the recent tanker-replacement award to Northrup Grumman-Airbus shows the willingness of DOD to look for foreign firms, provided

those firms team with a US prime contractor to perform a significant amount of work in the US. Thus, a Boeing-Airbus joint venture on some far-in-the-future military aircraft development project is not out of the realm of possibility.

Despite high demand for new aircraft across all sectors of the industry, there seems to be little concern among firms to increase productive capacity, perhaps because the *status quo* has benefits for manufacturers and customers alike. Unlike other industries in which a large backlog of unfilled orders might portend disaster for a particular firm as impatient customers take their business to other firms that can meet their needs more quickly, backlogs in the aircraft industry do not, as a general matter, appear to result in a loss of market share. Rather, aircraft manufacturers, especially those in sectors with a duopoly, are reluctant to risk investing in expensive additional production lines and, for labor and other reasons, prefer a steady production rate. Meanwhile, their customers, the airlines, which can easily augment their fleets by leasing or buying used aircraft in response to unforeseen upswings in air traffic, like the flexibility of being able to cancel orders (for a penalty) in response to unforeseen downturns.

Large Commercial Jet Sector. The large commercial jet sector, defined as jets over 140 seats, operates as a duopoly between Boeing and Airbus, a subsidiary of the European Aeronautic Defence and Space Company (EADS). This sector, as with other aircraft sectors, is measured by the numbers of new orders, deliveries of finished aircraft, and unfilled orders (backlog). In terms of estimated value of deliveries over the next five years, the large commercial jet sector ($500B) is expected to be approximately four to five times larger than the next largest sector, military fixed-wing ($107.5B counting only fighters and transports).

The large commercial jet sector is booming and analysts expect strong demand through 2026.[23] In 2007, Boeing received 1,423 new orders, pushing its order backlog to 3,427, and delivered 441 aircraft.[24] Assuming the 441 deliveries per year as its future production rate, Boeing will take 7.7 years to fill all of its orders. In 2007, Airbus received 1,458 new orders, pushing its backlog to 3,421, and delivered 453 aircraft.[25] Assuming 453 deliveries per year as its future production rate, Airbus will take 7.5 years to fill all of its orders. Inevitably, a substantial number of these orders will be cancelled or postponed, either in response to rising fuel prices or for other reasons. However, these backlogs are so large that both companies should be able to weather a downturn in the industry.

In 2007, Boeing reported revenues of $66.4B (commercial, $28.9B; defense $37.5B) and a profit of $4.1B.[26] In 2007, although Airbus reported a net loss of $684M on $34.2B in revenue due to the weak dollar, A380 production delays, and A350 development costs, EADS reported a profit for the first quarter of 2008, largely due to strong sales of Airbus products.[27] Although Airbus briefly overtook Boeing in terms of units delivered in 2003, over the next five years, Boeing is projected to hold a numerical advantage over Airbus in deliveries (2,776 vs. 2,235) and in value of production ($313B vs. $187B).[28]

Boeing and Airbus continue to fight tooth-and-nail to win orders for their B737s and A320s, respectively, while differentiating themselves with products such as the fuel-efficient 787 Dreamliner and the ultra-large A380. Notwithstanding the short-term delays in deliveries of the Dreamliner, Boeing has gained at least a temporary advantage over Airbus, which devoted vast resources to producing the A380, the market for which is proving to be relatively small, and whose direct response to the Dreamliner, the A350, is still years away from delivery. The Boeing-Airbus rivalry has also taken itself to the World Trade Organization where, in 2005, the United States Trade Representative filed a complaint on behalf of US-based Boeing alleging that European-based Airbus was receiving illegal government subsidies. Airbus responded by

asserting, among other things, that Boeing was receiving tax incentives and other forms of prohibited preferential treatment from the Washington State government and the US government. Regardless of temporary victories or set-backs, depending on perspective, AIS found in its visits to Boeing in Washington State and Airbus in Toulouse, France, that both are strong and impressive companies, whose competition benefits airlines and passengers in the form of better and cheaper aircraft.

Regional Jet Sector. Though much smaller than the large commercial jet sector in terms of projected value of deliveries over the next five years ($500B vs. $40B), the regional jet (RJ) sector is also booming. In 2007, according to the General Aviation Manufacturers Association (GAMA), this sector's estimated growth was 13 percent. However, this sector is particularly sensitive to rising fuel prices, which make similarly-sized yet comparatively more fuel efficient turboprop aircraft more attractive to airlines.

Two firms dominate the RJ sector, Bombardier of Canada and Embraer of Brazil. In 2007, Bombardier reported revenues of $9.6B and Embraer reported revenues of $5.1B.[29] Both companies reported large order backlogs.[30] Embraer E170/190 family, the largest of which has more than 120 seats, has the potential to draw customers away from the Airbus A318 and A319 and the smallest version of Boeing 737. Orders for larger 90-122 seat RJ's, such as the E195, are overtaking orders for smaller 30-50 seat RJs.[31] Over the next five years, Embraer is projected to hold a numerical advantage over Bombardier in deliveries (647 vs. 528) and in value of production ($20.5B vs. $16.2B).[32]

Entering the RJ sector is China Aviation Industry Corp I (AVIC I), which rolled out its 90-seat Advanced Regional Jet for the 21st Century (ARJ 21) in December 2007, and plans to produce 30 more jets by 2011.[33] Sukhoi Design Bureau, a Russian company, plans to deliver a 95-seat passenger called the Superjet 100 in 2008.[34] Both have the potential in the long-term to become major competitors in the regional aircraft sector, but have significant hurdles to overcome, including making and then *convincing* the world's airlines that they offer safe products of equal or superior quality to those already made by Bombardier and Embraer. China's large government-protected domestic market should provide a large complement of captive customers for any Chinese entrants into the regional jet sector.

Business/General Aviation Aircraft Sector. In terms of estimated value of deliveries over the next five years, the business/general aviation aircraft ranks third at $94.3B, behind the large commercial aircraft and military fixed-wing sectors. This sector is comparatively less sensitive to fuel costs than the other sectors because its products are used to transport less price sensitive passengers, such as high-net worth individuals and executives traveling at their companies' expense. In 2008, the big story in the sector was the first large scale deliveries to airlines of so-called "very light jets" (VLJs), which carry two to eight passengers. Over the next five years, Eclipse, the most prolific VLJ producer so far, is projected to deliver 1,095 aircraft for a 15% market share in terms of units produced. However, over this time, in terms of value of deliveries, Eclipse and other VLJ makers look to be far behind the established business/general aviation aircraft makers Bombardier ($20.5B), Gulfstream ($20B), Dassault ($16.3B), Cessna ($13.7B), and Hawker Beechcraft ($8.5B).[35]

Military Fixed-wing Aircraft Sector. In terms of estimated value of deliveries over the next five years, the military fixed-wing sector ranks second at $107.5B (counting only fighters and transports). This sector is fundamentally different from other sectors of the aircraft industry

because demand for its products is driven primarily by security and budgetary considerations, rather than economic forces. Especially with respect to fighter aircraft, relative to other sectors, there are high barriers to entry, very long product development cycles, and few product offerings in the military fixed-wing sector.

There are ten major global competitors in the military fixed-wing aircraft sector: three in the US and seven in other countries. In 2007, Boeing, which reported profits of $4.1B on total revenues of $66.4B, captured a market-leading 42 percent of the value of sales of military transports and finished with a third place 15 percent of the value of sales of military fighters.[36] In 2007, Lockheed Martin reported $3B in profits on $41.9B in revenues.[37] Lockheed Martin commands 30 percent of the fighter market's value, ahead of Eurofighter, a European consortium, with 25 percent.[38] Northrop Grumman, which recently teamed with the French aircraft manufacturer Airbus to win the USAF KC-45 tanker contract over Boeing, reported a profit in 2007 of $1.8B on $32B in revenues.[39] Should Boeing's protest of the tanker contract fail, Airbus will greatly strengthen its second place position in the military transport sub-sector, which is projected to grow to 32 percent by 2012 based on sales of its A400. The A400 has the potential to take competition from Lockheed's C130J. Other firms with significant but much lower market value in the military fixed-wing aircraft sector include EADS Casa (Spain), Sukhoi (Russia), Chengdu Aircraft (China), and Alenia Aeronautica (Italy).[40]

With over $9B in its FY2008 just for fixed-wing military aircraft, DOD is the world's largest customer for military aircraft.[41] Accordingly, the DOD budget has an enormous impact on the military fixed-wing sector. In 2007, the United States accounted for 44 percent of an estimated total global defense spending of $1.4T. In comparison to its NATO counterparts, the United States spent 2.5 times more on defense-related R&D and 1.5 times more on defense procurement.[42] However, DOD is likely to soon experience a cyclical downturn in its budget. In fact, the projected US defense budget is on a downward trend across the Future Year Defense Program (FYDP). In constant Fiscal Year (FY) 07 dollars, not including supplemental appropriations, defense spending is projected to decline by 14 percent to $455.6B in 2011.[43] The reduction in the 2011 defense budget reflects a 25 percent reduction in operations and maintenance (O&M) dollars, a five percent gain in procurement dollars, and a 10.5 percent reduction in RDT&E dollars over the 2005 budget.

The distribution of the defense budget across differing market sectors indicates turbulence ahead. For example, within the aircraft Major Defense Acquisition Programs (MDAP), the RDT&E budget is declining across the FYDP from $11 billion in FY 06 to $4 billion in FY 11, reflecting a 63 percent decrease.[44] Accounting for this decrease is the F-35 JSF transition from System Development & Demonstration (SDD) into production.

As noted above, the projected procurement funding will increase by only five percent between the FY 05 and the FY 11 budgets. Analysis of the defense procurement budgets between FY 06 and FY 11 project that Lockheed Martin will capture 40 percent, Boeing 30 percent, Northrop Grumman five percent, and Raytheon two percent of the procurement dollars.[45] The impact of the Boeing protest against the KC-45 contract award to Northrop Grumman/Airbus is yet unknown. The KC-45 tanker issue aside, the procurement projections in the out years show Lockheed Martin, Sikorsky, and Northrop Grumman are the only three US companies with programs in production for the next 20 years.[46]

With no sixth generation fighter in development and only approximately 170 Lockheed/Boeing F-22s slated for production, once foreign military sales of Boeing's F15 and F18 fighters end, the US could see Lockheed become its only prime contractor for fighter

aircraft. Similarly, if C17 production ends, Lockheed, with the C130J, will at least temporarily be the only US maker of large transport aircraft. US firms have ceased bomber production and are focusing on maintenance, refurbishment, and upgrades of existing aircraft to earn money and maintain their expertise. Because USAF tankers have historically been adaptations of commercial airframes, as long as Boeing is producing large commercial aircraft, the capability to produce tankers in the US is less likely to atrophy than the capability to produce other types of military aircraft.

Rotary-wing Aircraft Sector. In the last two years, global demand for rotorcraft has boomed. Over the next five years, if the estimated $65.3B estimated value of deliveries of both military and civil rotorcraft is correct, the rotary-wing aircraft sector will be the fourth largest aircraft industry sector, ahead of the RJ sector. Currently, manufacturers are saturated because of a flood of orders from new markets, including India and China, and the growing need to replace aging aircraft. As with the other sectors of the aircraft industry, emerging markets across Asia, Latin America, and Eastern Europe all promise new outlets for helicopter manufacturers.[47]

Four major manufacturers dominate the commercial rotorcraft segment: Eurocopter, Bell Helicopter Textron, AgustaWestland, and Sikorsky.[48] In 2007, Eurocopter and Sikorsky led the sector in market value because they had sufficient capacity in place to absorb more of the recent surge in demand. Unlike other sectors, there is anecdotal evidence within the rotary-wing sector that backlogs do result in loss of market share. Demand should remain high over the next five years with Sikorsky projected to garner 23.1 percent of the market, followed by Bell with 14.9 percent, Eurocopter with 13.9 percent, and AgustaWestland with 8.1 percent.[49]

With an FY budget of approximately $5B for helicopters, DOD is the largest military helicopter purchaser in the world.[50] Sikorsky recently won a US Army/Navy contract to build 537 H-60 Hawk helicopters worth $7.4B over the next five years. Sikorsky is also under a $3B contract with the US Marine Corps to produce the CH-53K helicopter. The US Navy fleet is slated to be all-Sikorsky by 2010. In 2007, in order to gain a toehold in eastern Europe, Sikorsky acquired Polish aircraft maker PZL Mielec to produce the International Blackhawk. Bell is developing the ARH-70 reconnaissance helicopter, which is 70 percent legacy and 30 percent new-build; 10 LRIP units are due in 2009 with 512 on order.[51] Bell H-1 programs are modernizing 100 Huey's and 180 Cobra's on order for the US Marine Corps. Eurocopter has a strong military presence lead by its Tiger and NH90 helicopters. Tiger initial deliveries began in 2004 and will continue in production over the next ten years. A four-country European consortium consisting of Eurocopter/France, Agusta/Italy, Eurocopter Deutschland/Germany, and Fokker/Netherlands produces the NH90. AgustaWestland anticipates that a large percentage of its business through 2018 will be military products, including its work with Lockheed Martin on the US Presidential Helicopter fleet.

Unmanned Aircraft Systems Sector. The UAS sector is youngest sector of the industry and the one most likely to experience significant structural change in the next five years. Currently, UAS customers worldwide are almost all governments. AIS believes that meteoric growth will occur in this sector once regulatory solutions are found for safety concerns and UAS are approved for large-scale private use (see Special Interest paper). In the meantime, military use of UASs by the United States and other countries continues a strong upward trend that began in 2003 with Operation Iraqi Freedom.

As in the military fixed-wing sector, DOD is the world's largest customer. The DOD budget for Fiscal Year (FY) 2008 includes approximately $2.5B dollars for UAS.[52] This amount

represents less than 0.5 percent of the total DOD budget, but accounts for over 70 percent of the spending worldwide on UAS. In comparison to manned aviation, the DOD budget for UAS is considerably smaller. UAS funding projections show continued increases in funding, but do not approach the levels for either helicopters or tactical aircraft within the next five years.

Of the five largest US defense contractors remaining following the industry consolidation of the 1990's, only Northrop Grumman has a significant presence in the UAS market. Established US aircraft manufacturers have had limited success with UAS. Doubts regarding the market's ability to support their investment and program cancellations have affected their ability to develop a market presence. DOD has over twenty different types of UAS in use, but only twelve programs of record.[53] The UAS provided for these twelve programs of record come from six different companies, but four companies really dominate the market: Aerovironment, AAI, General Atomics Aeronautical Systems, Inc., and Northrop Grumman. The remaining two companies, Honeywell and DRS Unmanned Technologies, are associated with much smaller UAS programs in terms of funding or production quantities. World-wide, Israeli manufacturers are the most established, however, major European firms, such as BAE Systems and Dassault Aviation, are developing systems as well.

Aircraft Engines. Engine manufacturers are not aircraft manufacturers *per se*. However, as suppliers of arguably the most complex aircraft system, any study of the aircraft industry would be incomplete without giving due attention to engine manufacturers. The aircraft engine industry is dominated by four companies: General Electric (GE) and Pratt and Whitney of the US, Rolls Royce of the UK, and SNECMA of France. All produce commercial and military aircraft engines. Competition among these four companies is fierce and will continue to be so for the foreseeable future. Historically, strong competition has driven engine manufacturers to take losses on initial engine sales, while recouping profits via aftermarket services and spare parts sales. Firms in this sector have also started employing a "power by the hour" compensation scheme in which they are paid for the hours that the engine is actually operating, rather than for the maintenance that they perform on the engine. Some firms have begun the limited practice of performing aftermarket services on engines manufactured by other firms. Should this become widespread, the *modus operandi* of the aircraft engine industry would be transformed.

Despite competition, all engine companies reported profits in 2007. SNECMA, which holds the smallest market share within this sector has partnered with GE to produce the successful CFM-56 engine. Pratt and Whitney is in the process of developing a Geared Turbofan (GTF) jet engine that it asserts will reduce fuel burn by as much as 12 percent and be substantially quieter than current engines used on RJs and single-aisle large commercial aircraft.[54] On the other hand, other engine manufacturers have long been aware of GTF technology, but have chosen not to pursue it.

INDUSTRY CHALLENGES

Globalization and Competition. For the aircraft industry, globalization is both fraught with pitfalls and replete with opportunities. Globalization has brought foreign competitors into domestic markets across the world, increased the universe of available aircraft part suppliers, and increased demand for air travel. For example, in the US, the "globalized" character of the aircraft industry is visible at every major airport: Airbus (Europe), Bombardier (Canada), and Embraer (Brazil) aircraft comprise large percentages of US airline fleets, while Bombardier, Dassault (France), and Embraer comprise large percentages of the fleets of US business/general

aviation aircraft operators. The recent USAF award of the KC-45 contract to Northrup Grumman and Airbus and the eight-nation partnership in producing the JSF exemplify how international competition has entered the US military aircraft market. Conversely, the US aircraft industry is boldly venturing abroad, as seen by Sikorsky's recent acquisition of Polish aircraft manufacturer PZL Mielec. Boeing aircraft now fly domestic routes in China and the former Soviet Union that were off-limits to Boeing during the Cold War and many formerly state-owned European airlines now give equal consideration to Boeing products when making their fleet decisions. Although the Boeing 787 Dreamliner final assembly plant is in Renton, Washington, components come from Australia, Sweden, Italy, France, UK, and Japan. For Boeing, globalization has had a downside: costly delays in delivering its Dreamliner are attributable in part to failures in its global supply chain.

Russia and China are seeking to join the booming global aircraft industry. Russia has produced good commercial aircraft for many years, but lacks marketing skills and production capacity needed to compete effectively. China, on the other hand, is new at building aircraft, but has accumulated capital through a decade of double-digit GDP growth. *ATWOnline* states that China is building on its limited regional jet production experience to launch a "jumbo aircraft" program in early 2008.[55] Although Chinese firms have the potential to have a significant impact on the commercial aircraft market, their presence is not likely to be felt in the next decade.[56]

On the military side, the globalization of aircraft production is also increasing. Foreign military sales (FMS) programs continue to be an important element of the trade in finished products. Low production numbers, high costs, and sales restrictions associated with the F-22, have opened the door to global competitors and spurred competition for global fighter sales. For example, no less than eight aircraft from five nations are vying to replace India's aging Mig-21s for the Multi Role Combat Aircraft (MMCA). These are the F-16, F-18 and JSF from the US; the Mig-29 from Russia; the Rafale or the Mirage 2000 from France; the Gripen from Sweden; and the Typhoon from the EU.[57]

Insufficient Capacity. "Capacity" refers to two broad areas. The first is industrial or productive capacity and the second is aviation infrastructure, comprised largely of airports and air traffic control systems. Currently, under both meanings, capacity is insufficient. A good example of insufficient industrial capacity is Boeing's backlog of orders for commercial jets. Boeing's recent loss of the USAF Tanker contract may have a silver lining, as it can now direct more capacity toward building commercial planes. Military aircraft programs have, at best, limited capacity to increase production rates or to surge (see Special Interest paper).

Regarding aviation infrastructure, runway and airspace usage will exceed current capacity in the near future if solutions are not found. In the US, a 2004 Federal Aviation Administration (FAA) study found that the nation's 35 busiest airports are suffering from problems caused by capacity constraints. These capacity issues cause delays, especially during inclement weather operation.[58] Ground capacity problems are not confined solely to the US: Heathrow Airport in London is the epitome of clogged ground operations.[59]

Regarding air traffic control services, capacity worldwide must increase to accommodate a tripling of air traffic over the next 20 years.[60] In the US, FAA estimates that traffic activity will increase steadily at about three percent annually until 2020.[61] Some fear that the arrival of VLJs, should they take-off in popularity, will greatly exacerbate the problem. Since 2000, airline flight delays have increased by more than 50 percent.[62] In 2007, nearly 25 percent of reported operations were delayed and nearly one-third of those were attributable to causes categorized under the rubric "national airspace."[63] Currently, air traffic congestion in the US costs the nation

an estimated $9.4B per year.[64] One solution proposed is the Next Generation Air Traffic Control System (NextGen), which would use satellite-based air traffic management, digital non-voice communication, and advanced networking to significantly reduce flight time and on-ground idle time. Dr. Paul Kaminski, former undersecretary of defense for acquisition technology, called developing and deploying NextGen one of the three major challenges facing our nation's future.[65] AIA calls it the key to facilitating flow. "NextGen is an all encompassing transformation of the entire national air transportation system, not just segments of it, to meet future demands and avoid gridlocks in the sky and at our airports."[66] Just as September 11th temporarily relieved the strain on the US air traffic control system, so too could rising fuel prices, which threaten to dampen demand for air travel.

Environmental Concerns. Various European firms told AIS of escalating demands that airlines become "greener", both in terms of noise and emissions. (On at least one UK airline, a passenger can now pay a voluntary surcharge that the carrier pledges to donate to worthy environmental groups, supposedly as a means of offsetting the passenger's *pro rata* share of the carbon footprint of his or her flight.) To a significant, though lesser, extent, AIS noticed similar calls that US airlines also lessen their environmental impact. Beyond gimmicks, airlines must demand that aircraft and aircraft engine manufacturers deliver more fuel efficient and quieter products. By replacing aging aircraft, airlines can save up to 30 percent on their fuel costs.

Skyrocketing fuel prices have a silver lining in that they place economic pressure, in addition to moral or political pressure, on airlines and manufacturing firms to reduce fuel consumption. However, aircraft manufacturers are in a dilemma because soaring air traffic growth and environmental impact vary directly: more traffic means more emissions and more noise, even if that traffic is carried on quieter, more fuel efficient aircraft. Nevertheless, for decades, the aircraft industry has been responding to environmental concerns by reducing the fuel consumption of its products. According to IATA, new aircraft are 70 percent more fuel efficient than 40 years ago and 20 percent more efficient than 10 years ago, airlines are aiming for a further 25 percent fuel efficiency improvement by 2020, and the A380 and B787 will likely burn fuel at a rate of less than a gallon per sixty passenger-miles, which is more fuel efficient than a compact car.[67]

New aircraft also are much quieter. IATA asserts that today's aircraft are 50 percent quieter than 10 years ago and that research initiatives target a further 50 percent noise reduction by 2020.[68] In addition, NextGen promises to provide better taxi procedures, routing, climb, and descent profiles, which would further reduce noise and emissions.

Workforce Management Issues. The aerospace industry in the US, of which the aircraft industry is the largest part, supports an estimated 642,000 direct labor jobs. Soaring demand estimates for aircraft in all industry sectors points toward continued employment growth over the next five years. Driving this growth will be demand for skilled "touch" labor, especially for individuals experienced in working with composite materials, complex computerized machines, and other precision machines.

High labor demand combined with a rapidly aging workforce poses a significant challenge to the aircraft industry as a whole, and US firms in particular. The average age of manufacturing employees now exceeds 50 years.[69] By 2009, 27 percent of the aerospace industry workforce in the US will be retirement eligible. Over the next decade, the number of employees with science and engineering degrees reaching retirement age will triple.[70] This trend is all the more troubling in light of forecasts that project US university graduation rates in

science, technology, engineering, and math (STEM) to decline. The Aerospace Industries Association (AIA) states that one of its member companies needs to hire 10,000 aerospace engineers per year over the next five years to replace retirees—a daunting challenge when one considers that US universities graduate on average only 44,000 engineers *of all types* per year.[71]

Attracting and retaining top-quality engineers is a particularly challenging task. Longer product life cycles, a decline in new product development, and a negative view of career stability has earned the industry low ratings for exciting and meaningful work and stable opportunities for professional growth.[72] In a survey of 500 US aerospace workers, 80 percent said they would not recommend aviation careers to their children.[73]

Workforce management challenges have created the incentive for innovative replacement programs to attract and retain highly skilled employees. Large companies, such as Pratt & Whitney, Sikorsky, BAE Systems (USA), offer generous education benefits to their employees. In addition, industry representatives emphasized to AIS their efforts to inspire children to undertake math and science studies. Programs such as the Team America Rocketry Challenge (TARC) run by the AIA help in this regard. US firms are also establishing programs at all educational levels that support research, funding pre-graduation internships, and implementing mentoring programs for new hires.[74] NASA's Space Camp for kids, the Boeing/International Association of Machinist and Aerospace Workers Technology Training Apprenticeship Program, Honeywell's School-to-Apprenticeship Program, and Rockwell Collins' Knowledge Management Program are examples of the aircraft industry's efforts to promote STEM education.[75]

Although aircraft manufacturers in UK and France are also facing workforce management challenges, particularly in the area of graying STEM employees, European firms visited by AIS did not express as much concern as their US counterparts. European aircraft firms have for decades used robust apprenticeship programs to develop steady high-skilled labor streams. For example, AIS met with two new aerospace engineers at Rolls Royce in the UK, whose association with Rolls Royce began during their second year in college and who are now in a multi-year program in which they rotate through various divisions of the company. Those EU-based firms in so-called "Schengen states" also have the ability to bring in labor seamlessly from other Schengen states without visa or other immigration requirements. AIS met with a tri-lingual German engineer employed in Marseille, France, by Eurocopter, who exemplified the benefits of free labor force movement.

UNITED STATES GOVERNMENT ROLES & RECOMMENDATIONS

Roles. The US government currently acts in numerous roles that affect the aircraft industry. A partial list includes customer, regulator, and advocate. The US government is the aircraft industry's largest single customer. As a customer, USG must comply with laws mandating that it give preferential treatment to domestic products when making procurement decisions, most notably the Buy American Act[76] (government-wide) and the Specialty Metals Provision[77] (DOD specific).

The Department of Transportation (DOT) licenses airlines and enforces limitations on non-US citizen ownership and control of US airlines.[78] DOT has jurisdiction over other economic matters pertaining to commercial air transportation, such as consumer protection and civil rights. The Department of Justice (DOJ) and DOT have jurisdiction over airline competition issues, including mergers. DOD has input on mergers and foreign investment in the US defense industry, including military aircraft manufacturers. FAA, an arm of DOT, regulates

general and commercial aviation safety, including the certification of airports, airlines, aircraft, airmen, and maintenance facilities. FAA also maintains and operates most parts of the nation's air traffic control system, including all en-route control services and, at major airports, local control services. DOD and the Departments of State (DOS) and Commerce (DOC) handle the transfer of military aircraft and aviation technology to foreign buyers. DOS, for example, enforces the International Traffic in Arms Regulations (ITAR), which establishes registration and licensing procedures for arms exporters, categorizes defense-related "articles and services," including certain types of aircraft, and sets penalties for non-compliance.[79] The Transportation Security Administration regulates aviation security and advises FAA regarding security features on aircraft, for example, reinforced cockpit doors.

The US government also serves as an advocate for the aircraft industry in the United States, chiefly in the areas of international airline route liberalization and foreign market entry and trade. Since the early 1990's, DOS and DOT have sought to replace restrictive bilateral aviation agreements with liberalized "open skies" agreements that remove carrier designation, frequency, and gateway requirements.[80] As previously discussed, international route liberalization is a major factor driving the industry by stimulating growth in international traffic and, perforce, the demand for new aircraft.[81] The Office of the US Trade Representative (USTR), which negotiates international trade agreements and interacts on behalf of the United States in global trade policy organizations, such as the World Trade Organization (WTO), plays a major role in ensuring fair market access for US aircraft manufacturers.

Although AIS looked at the aircraft industry from a global perspective, AIS did so with an eye toward the role that the industry plays in the defense of the United States. If a strategic industry is defined as an industry in which public policy toward it significantly affects national strategy, those US firms that manufacture aircraft do, in fact, comprise a strategic industry. The US aerospace industry, which consists predominantly of aircraft makers, directly and indirectly contributes about $600B annually to the US economy (5.4 percent of GDP). Although there are many different metrics that could be used to show the strategic importance of US aircraft firms, their impact on the US balance of trade is one of the clearest. In 2006, the US had a net trade surplus in aerospace products of nearly $55B, the largest of any export category.[82] Given this, a sharp decline in the health of US aircraft manufacturing firms would significantly worsen the US trade deficit, which, in turn, would further drive down the value of the US dollar, thereby adding to inflationary pressures, and hurting the US economy as a whole. From a defense standpoint, to meet its military aircraft needs, DOD needs a sufficient number of US aircraft makers, along with a healthy number of non-US competitors to inspire innovation and lower costs. Accordingly, the US government has a strategic interest in maintaining a healthy aircraft industry in the US. AIS has identified several areas where the US government may appropriately assist those firms to meet industry challenges.

Recommendations: Globalization & Competition. The US government has the ability to assist the US aircraft industry in adapting to globalization. The US aircraft industry would benefit by reforming protectionist measures, such as the Specialty Metals Provision, that drive up the cost of aircraft, and encourage other countries to erect their own protectionist policies. Allowing US military aircraft manufacturers to choose from the full panoply of world-wide specialty metals suppliers at world prices would reduce the cost of and production time for their aircraft.

ITAR should be streamlined. Specifically, a project-based "blanket" export license requirement, rather than the current "per transaction" export license requirement would eliminate

much administrative burden, thereby shortening production time. Liberalized sub-licensing procedures would allow foreign firms to provide competitive bids and ultimately reduce production costs of prime contractors. Curtailing restrictions on dual-use items would increase the incentive for US firms to invest in new technology.

While market access starts at home, the US government should continue to negotiate with other nations to remove their barriers to trade. DOS, DOC, and USTR should continue to play a vital role in this regard. Many US companies would prefer to sell their products directly to customers in other countries. However, trade barriers often force them to undertake less efficient means of selling their products abroad, such as licensing to foreign manufacturers, partnering with foreign firms, opening foreign-based production facilities, using sub-optimal foreign suppliers, or acquiring foreign companies. Free trade would make the choice of how a company enters a foreign market a decision based on market forces, rather than one influenced by a desire to circumvent trade barriers. DOS and DOT should redouble their efforts to liberalize international routes, especially with Japan, Brazil, China, and Mexico, the largest US-international markets currently not governed by open skies agreements.

Recommendations: Insufficient Capacity. AIS found evidence of insufficient capacity in two areas: 1) industrial productive capacity and 2) aviation infrastructure, primarily air traffic control services (ATC). Although firms in most of the commercial sectors of the aircraft industry are running substantial backlogs (e.g., Boeing and Airbus each have backlogs of more than seven years), firms appear reluctant to invest in new production lines. Rather, it seems that long backlogs benefit manufacturers and customers by allowing for a steady production/revenue flow and by providing flexibility to change or cancel orders in response to changing conditions.

In stark contrast, insufficient capacity in terms of ATC services benefits no one and therefore appears to be an area where the US government should consider policy changes. The 2003 FAA reauthorization bill established the Joint Planning and Development Office (JPDO), an interagency body tasked with coordinating public and private efforts to institute NextGen.[83] While NextGen is not a panacea for the capacity problem, it holds great promise. AIA estimated the cost to FAA of implementing NextGen by its fully operational target date of 2025 at between $15B and $22B, with a cost of equivalent magnitude to be borne by industry, which must adapt its equipment, training, and procedures to the new system.[84]

Increasing FAA funding and shifting the bulk of the source of its funding from "users" of the national airspace (NAS) to the general public would help ensure sufficient government and private funds to implement NextGen. Currently, FAA receives money from two funding streams: 1) the Airport and Airways Trust Fund (82 percent in 2006) (Trust Fund), which receives revenues from various ticket, fuel, and cargo "waybill" taxes levied on users of the NAS, and 2) the General Fund (18 percent in 2006).[85] (FAA's total funding in FY2006 was approximately $15B.)[86] This division has resulted in an effective tax rate on air travelers that exceeds that of consumers of just about any other US product or service, including, in some instances, cigarettes and alcohol.[87] The result is reduced demand for air transportation, which, in turn, negatively impacts, among other things, the aviation industry's ability to pay its NextGen-related costs.

NextGen is just one part of responding to insufficient capacity. Another is to improve and expand aviation infrastructure. The US government should embrace privatization as a means of generating additional capital for airport improvements. Currently, all major airports in the US are government-owned. In 1996, the US government implemented a pilot program that allows limited steps toward privatization at some of these airports.[88] This program should be expanded.

Recommendations: Workforce Management. The aircraft industry is deeply concerned with what it perceives as a shortage of trained engineers. However, other than anecdotal claims and general educational statistics, it does not appear likely that a shortage of engineers has or soon will cause a backlog of commercial aircraft orders, which exist in the industry already, but for other reasons. Indeed, to the extent that there is an engineer shortage, the private sector is taking steps to mitigate it.[89] Private sector efforts, market forces that increase salaries and technological improvements that increase productivity should provide the aircraft industry with adequate skilled labor streams for years to come. However, heightened immigration/visa requirements after September 11th have had a chilling effect on the number of foreign students taking their education in the US. The US government should streamline immigration procedures to increase their numbers and encourage more to remain in the US after earning their degrees. Also, the US government should allow the hiring of foreign nationals for work on defense contracts, provided such adequate security measures are in place. Regarding military aircraft, although US defense procurement funding might dip in the near-term, sufficient procurement dollars will likely be available to sustain a healthy industrial base that retains a large number of qualified engineers.

SPECIAL INTEREST AREAS

Surge Capacity. *Mr. Bengt Ekwall and Mr. Mark Heck.* Surge capacity in the aircraft industry is minimal. The Information Age industry is not configured to respond elegantly to warfare demands. Capacity constraints in labor and materials conspire to defeat such transitions. The availability of experienced engineers and machinists presents a potential limiting factor for the aviation industry. Information age strengths will allow the modification of production line assets to produce newer and more tailored products. Companies are concentrating on their core capabilities and outsourcing all other product manufacturing to either corporate affiliates or suppliers. Where production is retained in house, multiple shift work maximizes the application of capital intensive machine tools and facilities. Suppliers at lower levels experience similar pressures. Application of just in time techniques has reduced inventories.

Titanium availability also represents a severe constraint since the supply for this material has been predetermined for years in advance. Improved technology in the specialty metals industry is on the verge of providing improved availability and reduced costs. Modern manufacturing technologies allow for prioritization within current production lines as some products may be expedited at the expense of others. Surge of all lines concurrently is not possible. Likewise, mobilization of the industrial base will be accomplished either at the expense of non-critical product lines or through construction of entirely new facilities and training of additional labor currently not available to the market. Specific issues affecting surge capabilities are discussed below.

In the US, the retirement of the Baby Boomers marks a seachange in the workplace. Supplier consolidations have also driven down employment and other costs while concurrently increasing productivity.[90] Despite present gains, Boomer retirement continues to present challenges to the aircraft industry. Today, aerospace manufacturers are operating at full capacity which is defined as three shifts operating at 40 hours per week, a little over 80 percent of full mobilization. This leaves little room for surge or mobilization in the industry.

Maximum utilization of facilities to include floor space, machinery, and test facilities was accomplished through corporate specialization in core competencies, acquisition of complementing firms/facilities, and outsourcing non-critical assemblies and components.

Frequently, high value processes are retained at the home facility with specialized and lower value activities being farmed out to centers, plants, and suppliers better adapted for that work.[91] Meeting surge demands under these conditions requires that manufacturers prioritize product delivery schedules. Higher priority products receive expedited handling. Increased demand can only be met over the long term through acquisition or construction of additional facilities.

Overall, aerospace manufacturers have worked their processes and their facilities to generate maximum productivity. Outsourcing is one of the risk reduction methodologies that suppliers are using.[92] Suppliers provide a potential avenue to relieve capacity constraints. However, some of the same forces impacting prime manufacturers also influence the supplier base. Technological improvements are increasing productivity, requiring fewer suppliers to serve the sector. As with the primes, those suppliers that remain in the market are capital intensive.[93] For aerospace firms, the main question revolves not around location of suppliers, but whether they can get the materials necessary to deliver on time. In this, prime manufacturers have increased rather than reduced risk.

The application of special materials in major components drives considerable flex and risk in airframe production. Charts 1 and 2 (APPENDIX 2) demonstrate that composites and titanium are becoming increasingly important in the fabrication of advanced aircraft, comprising over 50 percent of total aircraft weight.[94] Demand for titanium is increasing as both commercial and military fleets are adding or replacing airframes over the next five years[95] Titanium shortages have delayed production schedules.[96] In the US, only one supplier produces the critical intermediate precursor for titanium products, titanium sponge. There are several non-US suppliers.[97] Above this level, the International Titanium Association counts over 170 firms among its membership.[98] Contrary to perceptions, titanium is a very common mineral. According to the US Geological Survey, the bulk, 95 percent of production, is used as paint pigment.[99] The conversion of the ores into titanium represents the production bottleneck. Productive capacity is starting to respond. Several manufacturers are increasing their sponge production capacity.[100] Whether this will meet, or exceed, increases in demand remains to be seen. In order to control near and long term availability and control raw materials costs, the aerospace manufacturers have negotiated five to eight-year supply agreements with their principal suppliers.[101] DARPA has a Titanium Initiative that seeks to dramatically improve availability for metallic titanium at dramatically reduced cost. This initiative seeks to reduce the number of manufacturing steps from raw material to finished product from five down to one through a changeover in processes. New production based upon the FFC Cambridge process could be arriving on the market around 2012. A measure of this technology's promise is DuPont's participation in Titanium Initiative.[102] Titanium's role as a limiting factor in aerospace surge capability may be fading. Other minerals may become a constraint.

A mineral that could become critical is cobalt. This is one of the world's essential mining and metals industry elements. Cobalt is essential in the production of jet engines, due to its strength and heat resistance. It has a strong demand, tightened supply, and growing importance to US national security interests. The cobalt outlook for demand and pricing supports a global trend towards greater use of high-tech products including laptop computers and jet engines. World cobalt resources predominantly come from Africa within the Copper Belt of the Democratic Republic of Congo (DRC) and Zambia. The US dependence on foreign nonfuel minerals like cobalt has caused concerns about US vulnerability to a disruption of these imports. Many of these minerals are held in the National Defense Stockpile, but the stockpile is incomplete and new acquisitions have not been made for several years. The US is almost totally

dependent upon imports for cobalt. This is increasing due to increased consumption and declining competitiveness of US mineral resources in international markets. Dependence on foreign cobalt creates risks for the US economy and for national security. Although the cobalt market is currently healthy with a steady balance of supply and demand, consideration should be given to the US strategy to improve availability. Vulnerabilities will increase the chances of supply disruptions and price manipulation of cobalt. Although many Africa nations are stable sources of cobalt, AIS recommends implementing a US policy option to increase the National Defense Stockpile to lessen cobalt supplier dependence.

Strategic Sourcing. *Lt Col David Koch, USAF, and LT COL Dan Snyder, USMC.* As large companies work strategic initiatives to stay competitive in a global market, many have tried to ensure proper control of sourcing and supply.[103] One such approach, strategic sourcing, has become common in industry circles, but research has shown that it does not have the same meaning to all organizations. Strategic sourcing can be interpreted as narrowly as consolidating purchases across an enterprise to a more broad view that includes enterprise purchasing, integrated supply chains, and enhanced supplier relationships. The Office of Management and Budget (OMB) defines Strategic Sourcing as "the collaborative and structured process of critically analyzing an organization's spending and using this information to make business decisions about acquiring commodities and services more effectively and efficiently."[104]

AIS conducted research for Defense Supply Center Richmond (DSCR) on Strategic Sourcing practices used by both the commercial aircraft industry and the Department of Defense. In today's globalized world, most firms do not own their suppliers. In fact, aircraft parts and assemblies are often acquired from across the globe with varying degrees of partnering with the purchasing organization. This diverse acquisition strategy is often required to share risk on large projects, increase production flow of assembly lines, and capitalize on cheaper labor pools. Strategic sourcing is touted as one of the most promising initiatives to integrate a company's supply chain, harness the power of enterprise purchasing, and garner significant savings for the firm. The study explored strategic sourcing from a commercial and governmental perspective to see what lessons could be shared among the two sectors.

To accomplish this task, relevant literature on strategic sourcing was reviewed. Several companies that appeared to be industry leaders in the strategic sourcing arena were selected for a more thorough review. Understanding that implementation of strategic sourcing may be different for a commercial and a government agency, one government organization was selected as a case study. As part of the aircraft industry curriculum, AIS traveled to various aircraft industry leaders in the United States and abroad. AIS sent a comprehensive survey to 14 different firms on industry strategic sourcing initiatives prior to its visits. The authors of this report interviewed relevant logistics, contracting, and supply chain personnel during these visits to learn about the aircraft industry's approach to strategic sourcing.

Defining success of strategic sourcing within organizations is not as easy as it may appear. Cost savings is an obvious measure for success, but it is not the only important measure. Air Force Materiel Command's (AFMC's) mission is the lifecycle sustainment of weapons systems, so it has used the mission capability (measured in hours) of weapon systems as one measure. This data has been collected for years, so it was readily available. Second, AFMC used the sheer number of contracts as a measure of success. Each contract has associated administrative costs in dollars and time, so decreasing the overall number of contracts is certainly process improvement. Third, minimizing the processing time to source an item is another key measure that has shown improvement. This can be seen in improved on time

delivery of needed parts. Finally, an overall reduction in inventory saves money and is a good measure of success of the program. If the customers have confidence that the right part will be available at the right time, they do not need to carry so much inventory on hand.[105] The benefits of strategic sourcing are many (see Appendix 3). Overall, success has paid dividends for the AFMC with estimated savings in excess of $260 million to date.[106]

Aircraft industry firms have identified numerous approaches to strategic sourcing. Reviewing these diverse approaches reveal several key components of industry Strategic Sourcing programs, to include: 1) integration of value strategy to process and metrics; 2) enterprise purchasing; 3) leveraging cross-functional commodity teams; 4) increasing supplier performance through supplier scorecard and feedback systems; and 5) providing a path for suppliers to increase the level of their products (e.g., moving from piece parts to entire assemblies or Line Replaceable Units (LRU))

In addition to the common process components of industry strategic sourcing efforts, there were several common government policies challenging strategic sourcing in the aircraft manufacturing industry. First, the protectionist policies of the Specialty Metals Provision and the Buy American Act presented obstacles to aircraft manufacturers. The firms indicated that these policies often forced them to supply defense contracts with higher cost materials. Also, the administrative costs of compliance adds to the challenges caused by these regulations. Aircraft industry firms have provided information to DOD and Congress showing the negative outcomes of certain regulations and possible solutions.

Second, the majority of aircraft manufacturing industry firms identified challenges stemming from government contract requirements for small, disadvantaged businesses also known as “set asides”. Most firms were confident that the intent of the set asides could be met while still delivering quality defense components. However, the firms proposed reforming the “set aside” accounting procedures to allow crediting prime contractors with “set aside” amounts for all funds that the prime and its subcontractors provide to small, disadvantaged businesses including suppliers at and below the tier 2 level.

Finally, the method of funding government contracts was identified as a challenge to strategic sourcing. Aircraft firms identified the limits imposed due to annual funding of contracts, as compared with the benefits of multi-year funding, which prevented suppliers from investing in capital improvements that improve cost and performance of manufactured components over time. Aircraft industry firms often commit to multi-year procurements as part of their strategic sourcing processes in order to encourage suppliers to invest their own capital in efficiencies, which will lower costs for both supplier and buyer.

Unmanned Aircraft Systems. *Mr. J. Richard Tyler, DA.* DOD is the world’s largest operator of Unmanned Aircraft Systems. DOD operates more than twenty different types of UAS ranging in size from small hand-launched systems such as the RQ-11 Raven to the RQ-4 Global Hawk which weighs over 32,000 pounds and operates at an altitude of 65,000 feet. Military commanders desire to use and employ these systems with the same freedom they have to employ manned aviation assets, but current regulations do not support this concept. The size and the variety of UAS provide operational flexibility, but create headaches for regulatory bodies trying to establish standards for these systems which are rapidly gaining in popularity and use. The quantity of UAS in use has also strained the limits of existing restricted military airspace to accommodate training. In addition, military commanders preparing to support Operation Iraqi Freedom or Operation Enduring Freedom desire opportunities to conduct realistic training for

their UAS crews. For these reasons and others, DOD has pursued "File and Fly" access to the NAS similar to manned aviation for appropriately equipped unmanned aircraft.

Though aware of the potentially widespread private applications of UAS, FAA rules restrict their use. DHS and FAA have signed a certificate of authorization (COA) to allow the DHS to use the Predator B by DHS. COAs are not optimal, as they are very restrictive in nature. For growth in the civil arena in the US, industry and government must work together to avoid stifling the civil and commercial UAS markets.

"File and Fly" capability for medium and high altitude UAS implies unrestricted access to national and international airspace. Both FAA and International Civil Aviation Organization (ICAO) are working to establish the rules and regulations to make this happen. There are six key characteristics that must be addressed before unrestricted access will be granted: air traffic management, airworthiness, see and avoid, training, reliability, and command, control and communication links. Until the public believes that UASs are safe and reliable, the FAA will keep in place restrictions on civilian use of UASs. In order to facilitate safe UAS access to the NAS, FAA intends to release Minimum Aviation System Performance Standards (MASPS) for UAS by 2012. Publication of these standards and the development of systems that comply will greatly increase the UAS market.

Export regulations prevent the sale of these systems to countries outside of the NATO alliance, Canada and Australia. This restriction is constraining the ability of US suppliers to compete globally. These restrictions need close examination to determine if they meeting the intent or merely preventing US suppliers from effectively competing in the global market.

CONCLUSION

AIS found the aircraft industry in good health with profitable firms and large order backlogs being the norm across the seven sectors of the industry studied. Strong competition is also the norm across the industry, which AIS believes will remain relatively static in terms of participating firms over the next few years. The immature UAS sector may be the exception, where there are abundant firms competing already and where the barriers to entry and exit are low relative to the other more mature sectors of the industry. Large backlogs of orders will continue to be the norm in the industry as there appears to be little fear among firms of losing market share and significant reticence toward taking the financial risks associated with expanding productive capacity.

Demand for new commercial aircraft is driven by several factors, including global economic growth, regulatory liberalization, increased air traffic and flight frequencies, fuel costs, and the need to replace aging aircraft in existing fleets. AIS found that four of these bode well for a healthy aircraft industry in the future. World GDP is steadily increasing and with rising wealth levels come hordes of new consumers who have the means and the desire and/or need to travel by air. As governments liberalize their aviation relationships, more airlines are offering more route choices to these potential consumers, which in turn, requires airlines to acquire more aircraft. On new and existing routes, increasing air traffic is causing airlines to respond by operating either increased flight frequencies or using larger aircraft, both of which spur demand for new aircraft. Demand for military aircraft is different from other sectors of the industry in that it is derived primarily from security concerns and subject to governmental budgetary constraints, rather than economic forces. Many of the world's air forces, including that of the United States, and many of the world's largest airlines are operating rapidly aging fleets of aircraft that are being flown at increasing rates. These operators are increasingly being forced to

turn to the aircraft industry to replace their fleets. There is also bad news regarding demand: fuel prices. Fuel prices are soaring and have the potential to dampen world economic growth in general and growth of the aircraft industry in particular. As fuel costs rise and airlines either go out of business or raise prices, prospective air travel consumers will look elsewhere. Also, a probable reduction in US military procurement spending would reduce demand for military fixed-wing aircraft and rotorcraft, but firms in these sectors, having survived the austere environment of the 1990s, should be well-positioned to adapt to such circumstances.

AIS believes that the aircraft industry will become increasingly globalized on both the commercial and military sides. Globalization is just one of the challenges facing the industry. Insufficient capacity, particularly regarding air traffic control, calls for more environmentally friendly aircraft, and a rapidly aging and shrinking pool of skilled aerospace workers also present significant challenges. The US government has an enormous interest in maintaining the health of the US component of this strategic industry, which plays a significant role in the US economy and supplies the bulk of the aircraft for US defense needs. Accordingly, there are certain steps that the US government should take to assist the industry to meet these challenges, including streamlining ITAR, limiting the impact of the Specialty Metals Provision, ensuring that adequate funding exists for NextGen-related costs, and continuing to press for liberalized airline markets.

Appendix 1

Impact of Limited Aircraft Replacement Decisions

Aircraft	Initial Requirement	Actual Buy (A) or Current Plan (P)	Impact
B-2[107]	133	21 (A) (1 destroyed 2008)	$2.2B per aircraft and B-52 (50+ years old) not retired. With only 20 B-2s, next bomber program already under consideration.
C-17[108]	210	@ 180(P)	270 C-141s retired but not sufficient amount of tails, C-5 now undergoing $80M per aircraft upgrade program.
F-22[109]	750	183(P)	Number of tails does not replace 520 F-15s (30+ years old), requires retaining 100s of F-15s well beyond expectations.
KC-X[110]	179	179(P) (Under Protest)	Not enough tails to replace 540+ KC-135 (50+ years old), Air Force acknowledges a 2nd aircraft required in near future.

Appendix 2

Chart 1:

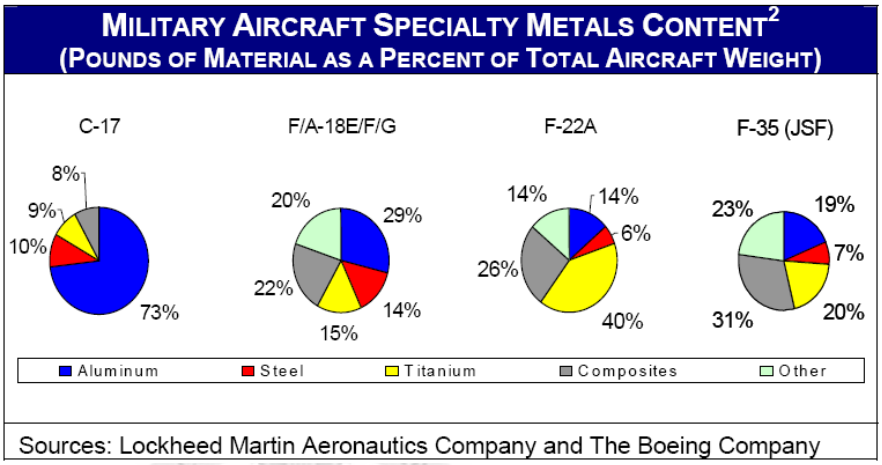


Chart Source: Office of the Under Secretary of Defense (Industrial Policy)[111]

Chart 2:

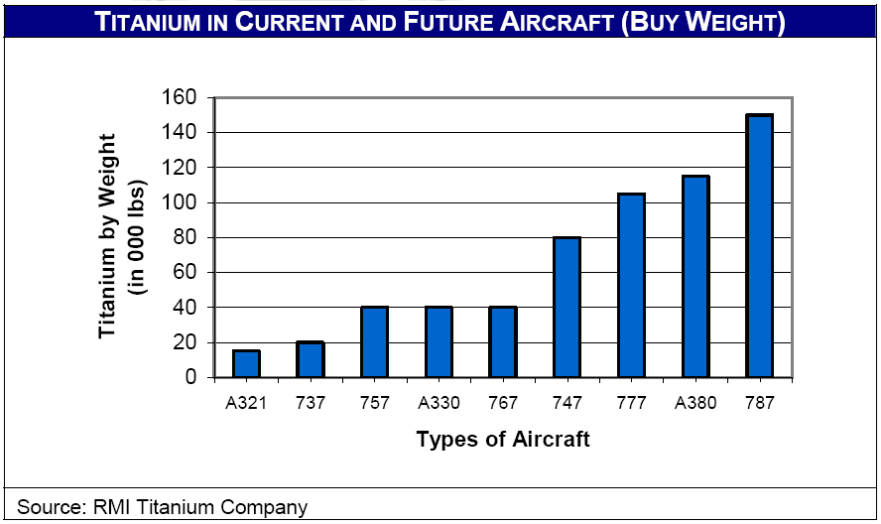
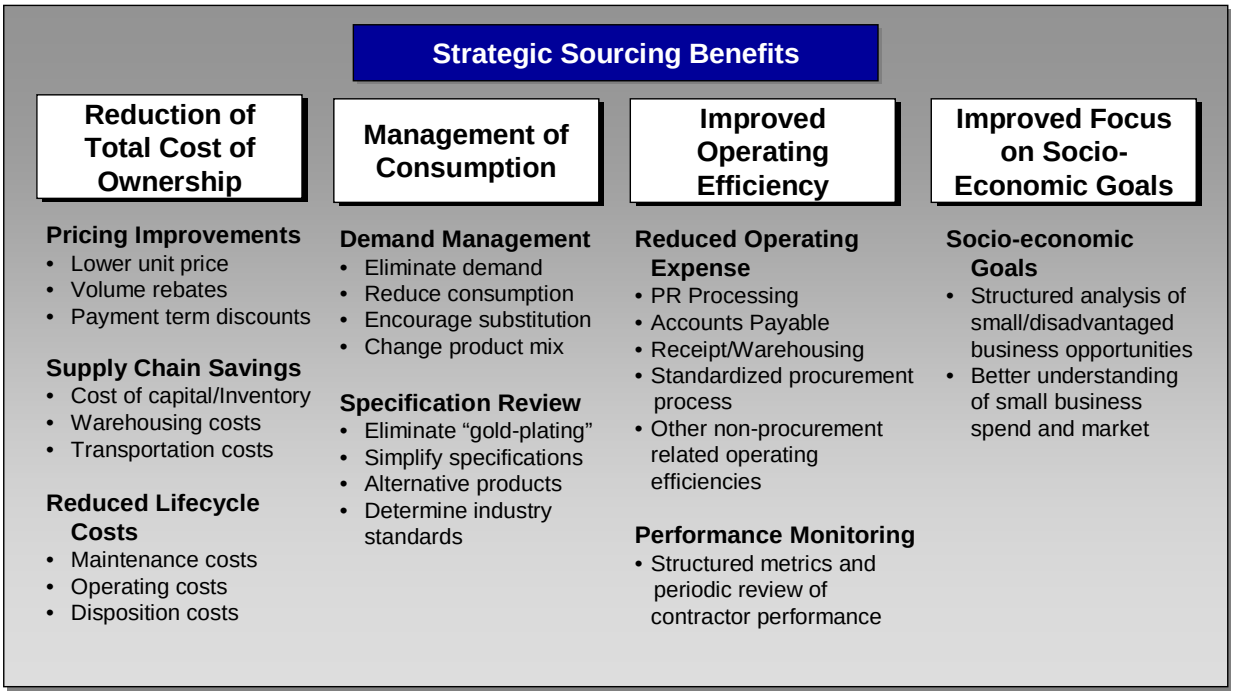


Chart Source: Office of the Under Secretary of Defense (Industrial Policy)[112]

Appendix 3

Benefiting from Strategic Sourcing



Source: Censeo Consulting and AQCA

IAT *Strategically Sourcing The Enterprise* 11

Source: AFMC Strategic Sourcing Briefing. February 7, 2008. Slide 11.

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