Flight Plan 2009:

Analysis of the U.S. Aerospace Industry

INTERNATIONAL
TRADE
ADMINISTRATION

Office of Transportation and Machinery
International Trade Administration
U.S. Department of Commerce
March 2009

Table of Contents

EXECUTIVE SUMMARY

The year 2008 was an eventful twelve months for the U.S. and global aerospace industry. After several years of sustained growth, capped by the largest upturn in the U.S. aerospace market since World War II, the U.S. and global aerospace industry are facing challenges from a number of factors, the largest of which is the current global economic downturn. In spite of the unquestioned effect of the downturn, the U.S. aerospace industry actually experienced modest growth overall in 2008. Although the near-term outlook for 2009 remains somewhat uncertain, the global economic fundamentals remain in place to support long-term, sustained industry growth.

Despite a number of factors driving down the overall global economy, the U.S. aerospace industry as a whole showed reasonable strength in 2008. When viewed in the context of recent record performance, the industry's 2008 financial results are encouraging. According to the U.S. Bureau of the Census, 2008 total sales of U.S. aerospace products and parts were $257 billion, an increase of 3.4 percent over 2007. After-tax profits on these sales were $15.3 billion, which represented a decline of 16.3 percent over 2007.[1] Aerospace industry exports remained relatively strong at $82.4 billion, which was a 5.2 percent decrease from 2007.[2] Although the corporate parents of a number of aerospace manufacturers experienced declines in income for 2008, in some cases the aerospace segment of these manufacturers not only booked a profit but actually realized a profit increase in 2008 over 2007. Most notably, GE, which is the corporate parent of aircraft engine manufacturer GE Aviation, realized a 2008 income of $17.4 billion, which was a 21.60 percent decrease from 2007. GE's stock value also fell in 2008, losing more than 50 percent of its market value by year end. For the same period, however, GE Aviation actually experienced a 14.3 percent profit increase.[3]

Aside from the global economic downturn, other factors impacted the U.S. and global aerospace market. As in 2007, continued weakness of the U.S. dollar against the euro and other major foreign currencies made U.S. products more affordable in foreign markets. Dollar-denominated goods such as large civil aircraft (LCA) manufactured by Boeing, aircraft engines from Pratt & Whitney and GE, rotorcraft produced by Bell/Textron and Sikorsky, and unmanned aerial systems (UAS) produced by numerous smaller aerospace companies, benefitted from a favorable exchange rate in comparison to competitors from Europe, Japan and elsewhere. The exchange rate advantage likely mitigated to some degree the effects of the global economic downturn on the U.S. aerospace market.

The rapid rise in oil prices during the first seven months of 2008, which capped a more steady increase since 2003, adversely impacted the global commercial aviation industry. Although oil prices moderated somewhat by the end of the year, the long-term impact of higher fuel costs on the global aerospace industry, which provides aircraft, parts and service for commercial aviation, is

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p[1] Total sales and after tax profit figures are from the category "Aerospace products and parts" located in Quarterly Financial Report, Table 31.0: U.S. Manufacturing, Mining, and Trade Corporations – Not Seasonally Adjusted Sales and Profits available at http://www.census.gov/csd/qfr/qfr08q4.pdf.

[2] U.S. International Trade Statistics Value of Exports, General Imports and Imports for Consumption by NAICS - 33641 available at http://censtats.census.gov/naic3_6/naics3_6.shtml

[3] GE Aviation's 2008 segment profit was $3.684 billion; 2007 segment profit was $3.222 billion. GE's 2008 net income was $17.335 billion; 2007 net income was $2.208 billion. See GE 2008 Annual Report available at http://www.ge.com//ar2008/pdf/ge_ar_2008.pdf

significant. As a result of rapidly increasing oil prices in the first half of the year, fuel expenses accounted for 32 percent of operating expenses for global aviation companies in 2008, which was almost double the 2004 level of 17 percent. Although fuel as a percentage of total operating expense is forecast to drop to 29 percent in 2009, the long-term upward trend is incentivizing civil aviation operators to look more aggressively for ways to reduce their fuel expenses.[4] This search is driving demand for more fuel-efficient aircraft like Boeing's 787 Dreamliner as well as new fuel efficient engines like Pratt & Whitney's PW1000G PurePower Geared Turbofan and GE Aviation's GEnx models. These new, more efficient aircraft and engines will help operators reduce fuel consumption and lower operating expenses. Finally, aircraft and engine manufacturers are engaged in research on use of alternative aviation fuels produced from a variety of non-petroleum sources. In the long term, these alternative fuels may also help operators reduce fuel costs and thus maximize profitability.

Another factor driving the global aerospace market is the ongoing trend towards consolidation. Both domestic and international ventures that facilitate market access, as well as cost, risk and information sharing, are becoming more numerous. U.S.-only joint ventures (JV) like the Engine Alliance, a 50/50 JV between GE Aviation and Pratt &Whitney as well as international ventures like Superjet International, formed by Italian aerospace company Alenia Aeronautica and Sukhoi Civil Aircraft to market and sell Sukhoi's Superjet 100, are representative of this trend. The largest and potentially most influential consolidation, however, is Russia's United Aircraft Corporation (UAC). UAC is a Russian government-owned joint stock company that consolidates the scientific and production potential of the Russian aircraft industry as well as the intellectual, industrial and financial resources for new aircraft development into a single state-owned and controlled entity.[5] UAC has already negotiated design and production agreements with a number of U.S. and European aerospace companies, and UAC senior leadership has set a goal of becoming the world's third largest aircraft manufacturer by 2015.[6]

As in years past, the issue perceived by the industry to have the largest impact on competitiveness is U.S. export control policy. Concerns about the ability to receive a U.S. export license for aerospace products, especially communications satellites, have caused foreign competitors to "design out" U.S. components, purchase products containing no U.S. parts, and strengthen partnerships with other countries in order to avoid the need to apply for a U.S. export license. Even though the U.S. State Department has worked diligently to process licenses faster and make the application process more transparent, the negative perception continues to encourage foreign counterparts to seek products elsewhere, thereby hurting U.S. competitiveness. The greatest impact has been felt by satellite components suppliers, but the impact of U.S. export control policies is widely shared by all aerospace sectors.

[4] IATA fact Sheet: Industry Statistics. Available at http://www.iata.org/NR/rdonlyres/8BDAFB17-EED8-45D3-92E2-590CD87A3144/0/FactSheetIndustryFactsMAR2009econmarkup2.pdf

[5] http://www.uacrussia.ru/en/

[6] Moscow International Aviation and Space Salon 2007 Show Program interview with Alexei Fedorov, President of United Aircraft Corporation

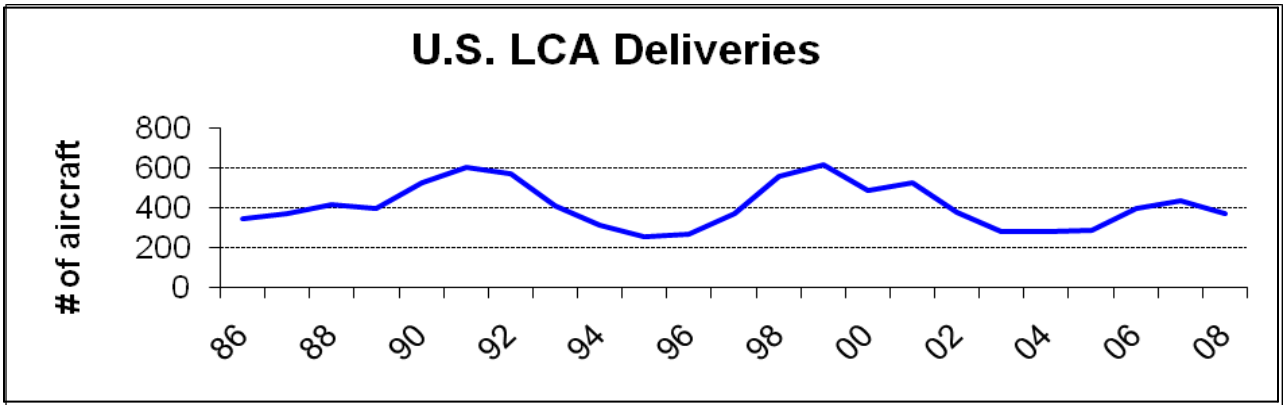
Taking the uncertainty of current economic conditions into consideration, it is difficult to predict overall aerospace industry performance in the near term. In the longer term, however, prospects are good for continued, steady growth. Large civil aircraft, rotorcraft, general aviation aircraft, regional and business jets, engines/powerplants, communications satellites, military unmanned aerial systems (UAS), and airport infrastructure and safety equipment should continue to experience steady growth. Other sectors, such as launch services, are experiencing lower but steady growth as they recover from market disruptions and/or adapt to commercial markets. The launch services sector could experience faster growth if the demand for satellite telecommunications services increases. The maintenance, repair and overhaul (MRO) market has finally recovered to pre-9/11 levels, and growth in this sector will be led by expanding aircraft fleets in India, Eastern Europe, South America and China. The market for civil/commercial UAS remains stagnant in the absence of civil regulations for certification and operation in the national air space; however, the Federal Aviation Administration (FAA) and civil aviation authorities in Europe and Asia are working towards rationalization of civil certification procedures. Key markets for U.S. aerospace exports remain India, China, Russia, Japan, and Europe.

Large Civil Aircraft

Following its acquisition of McDonnell Douglas in 1997, Boeing is now the only U.S. manufacturer of large civil aircraft (LCA), aircraft that are generally considered to have more than 100 seats or an equivalent cargo capacity. Boeing's Commercial Airplanes business unit, which manufactures the company's LCAs, had 2008 revenues of $28.3 billion dollars, which accounted for 29 percent of civil aircraft and parts shipments in 2008.[78]

Market Trends 2001-2008

U.S. (and global) LCA production is cyclical, experiencing peaks about every ten years in the number of aircraft delivered (with "valleys" about every other ten years).[9]



The terrorist attacks of September 11, 2001 economically shocked the civil aircraft industry. As demand for air travel plummeted sharply, airlines' demand for new transport aircraft also plunged. By mid-October 2001, airlines cancelled orders for 50 Boeing aircraft. At year's end, Boeing reported 2001 net orders (number of new orders less the number of existing orders that were cancelled during the same year) of 314 aircraft, a 47 percent decrease from 2000 net orders

[7] Commercial Airplanes Revenue from Boeing 2008 Annual Report available at http://www.envisionreports.com/ba/2009/12ja09001m/document_0/Boeing_AR_03-11-09_Preflighted_01.pdf.

[8] The value of shipments for 2008 of 96.6 billion was calculated from data in the category UNAPVS - "nondefense aircraft and parts" located in Table 1 "Value of Manufacturers' Shipments by Industry Groups" – Not Seasonally Adjusted Sales and Profits available at http://www.census.gov/indicator/www/m3/hist/naicsvsp.txt.

[9] Unless otherwise noted, the source for this and other data in this report regarding aircraft orders, deliveries, and sales volumes for Boeing and Airbus are the companies themselves. Although widely accepted by aerospace industry analysts, the data has not been independently verified.

of 589 aircraft. Stagnant demand continued into 2002, with net orders finally bottoming out in 2003 at 239 aircraft.

The U.S. LCA industry turned a corner in 2004. After hitting an eight-year low in 2003 of 281 aircraft delivered, Boeing posted a slight increase of aircraft delivered in 2004 to 285. Net orders also increased, to 272, marking an end to the market slide precipitated by September 11th. Market conditions continued to improve in 2005 and 2006, with demand for LCA in these two years stunning many analysts. Boeing announced net orders of 1,002 aircraft in 2005, an increase of 268 percent from the 2004 order figure of 272 aircraft. But even this dramatic surge in Boeing's order book was topped in 2006 with Boeing's net orders of 1,044 aircraft -- and yet again in 2007 with net orders of 1,413 aircraft. The year 2007 marks the largest number of aircraft net orders Boeing has ever received in a calendar year. Market demand for Boeing aircraft retreated in 2008, with annual net orders falling to 662, a decrease of 53 percent from the previous year.

Aside from the global economic downturn, several other events in 2008 contributed to Boeing's slowing sales. A 52-day strike by 27,000 Boeing machinists shut down the company's civil aircraft production lines for almost two months. Subsequent to the settlement of the work stoppage, Boeing reported fourth quarter revenue of $12.7 billion, a $4.8 decline from 2007. Boeing attributed the decline almost entirely to the effects of the strike.

Another difficulty for Boeing in 2008 concerned multiple production issues with the company's 787 Dreamliner. The first LCA to be produced largely from carbon composite materials (as opposed to aluminum and other metals), Boeing promises a 20 percent increase in fuel efficiency from the Dreamliner compared to similarly sized aircraft. The technical delays encountered in 2008, exacerbated by the machinists' strike, forced Boeing to push the date of first delivery of the 787 aircraft almost two years beyond the company's original projection of May 2008 to the first quarter of 2010.[10]

The highest annual revenues Boeing received from large civil aircraft sales were about $38.5 billion in 1999, when it delivered a record 620 aircraft. This is a significant difference from Boeing's LCA revenues in 2008, of about $28.3 billion on deliveries of 375 aircraft.[11]

U.S. air carriers' unwillingness to purchase new aircraft, which may be attributable in part to their recent collective financial difficulty, has boosted the importance of access to foreign markets for Boeing. With the exception of low-cost carrier Southwest Airlines, virtually all U.S. domestic carriers have either been through bankruptcy proceedings or narrowly avoided it in recent years. Regardless of whether there is a correlation between financial health and aircraft purchase decisions, U.S. domestic airlines have declined to make new fleet purchases at the time Boeing began taking orders for the 787 as well as other aircraft already in production.[12] As a result, over the next ten years, more than 70 percent of Boeing's LCA sales will likely be delivered to customers outside of the United States. Key foreign markets include China, Japan, and India.

[10] http://www.chicagotribune.com/business/chi-biz-boeing-787-dreaminer-delivery-march10,0,5150094.story
[11] 1999 and 2008 revenue figures are not adjusted for inflation.
[12] http://www.nytimes.com/2007/10/27/business/27planes.html

Competition

As a practical matter, Europe's Airbus is Boeing's only competitor in the LCA market. Other civil jet transport manufacturers with a significant global presence, such as Canadian manufacturer Bombardier and Brazil's Embraer, do not currently produce aircraft comparable in size and capacity to Boeing and Airbus offerings[13]. The competitive landscape may soon change, however. Russia's United Aircraft Corporation (UAC) is a Russian government-owned joint stock company that consolidates the scientific and production potential of the Russian aircraft industry as well as the intellectual, industrial and financial resources for new aircraft development into a single state-owned and controlled entity.[14] UAC has already negotiated design and production agreements with a number of U.S. and European aerospace companies, including Boeing and Airbus. In addition, UAC senior leadership has set a goal for UAC to become the world's third largest aircraft manufacturer by 2015.[15] See this paper's Russia Country Analysis for a more detailed description of UAC.

Created in 1970, Airbus Industrie was originally a consortium of four government-supported companies formed to compete with U.S. aircraft manufacturers. In 2001, Airbus Industrie was transformed into a single corporate entity, Airbus SAS and is today a wholly owned subsidiary of the European Aeronautic Defense and Space Company (EADS). As of December, 2008, 47.5 percent of the share capital of EADS was held by German corporation Daimler AG and partially state-owned French holding company Sogeade[16], which jointly control EADS through a Dutch law contractual partnership. SEPI, a Spanish state holding company, is also a party to the contractual partnership, and as such holds 5.5 percent of the share capital of EADS. The remaining 47 percent "free float" share capital is shared among a number of investors including the French government.[17]

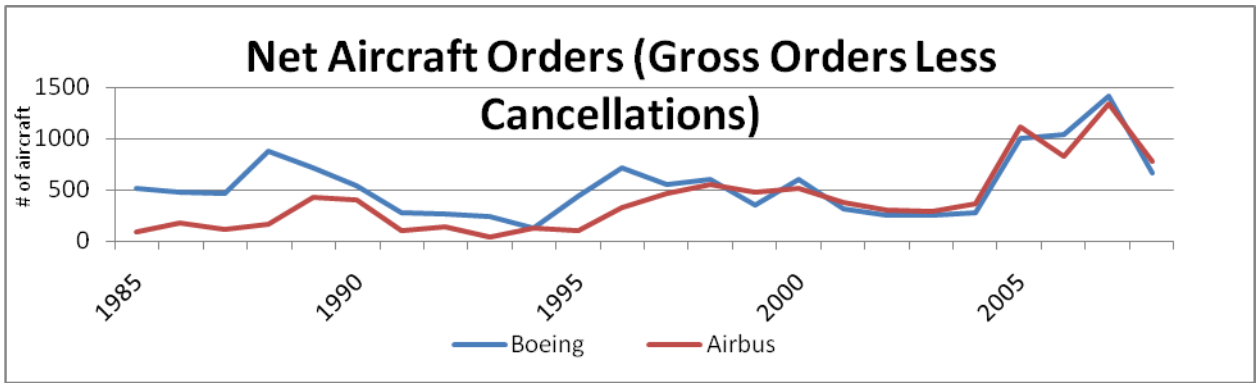
Throughout its history, Airbus has received substantial financial and other support from the governments of France, Germany, the United Kingdom and Spain. These governments have provided over $15 billion in "launch aid" to develop new models of Airbus aircraft. Airbus has benefited from government equity infusions, debt forgiveness, aircraft production support, and infrastructure development. Senior economic officials from the four Airbus governments[18] coordinate pan-European aerospace industry policy in their informal capacity as "Airbus Ministers".

[13] In July 2008, Bombardier announced the launch of a "C Series" large civil aircraft, with passenger capacities of 100-145 seats, depending on model configuration. Entry into service is scheduled for 2013.
[14] http://www.uacrussia.ru/en/
[15] Moscow International Aviation and Space Salon 2007 Show Program interview with Alexei Fedorov, President of United Aircraft Corporation

[16] Sogeade is a French holding company owned by wholly French state-owned holding company Sogepa and the Lagardere Group, a private French conglomerate with interests in publishing, retail and aerospace. Sogepa and Lagardere own equal 50 percent shares of Sogeade, and Sogeade collectively controls 22.5 percent of the share capital of EADS.
[17] http://www.eads.net/1024/en/investor/Stock_information/Shareholding_structure.html
[18] In October 2006, BAE Systems (United Kingdom) sold its 20 percent share in Airbus.

Boeing and McDonnell Douglas dominated the global LCA market in the 1970s and the 1980s. In the 1990s Airbus became a serious competitor, as it remains today. In 2008, Airbus's share of the market exceeded Boeing's as measured by three parameters. Airbus market share was:

- 56.3 percent of total aircraft delivered (483 vs. Boeing's 375);
- 54 percent of net aircraft orders (777 vs. Boeing's 662); and
- 54.5 percent measured of LCA revenues, estimated ($33.9 billion vs. Boeing's $28.3 billion).[19]



Boeing's orders before 1997 (when it acquired McDonnell Douglas) include aircraft ordered from McDonnell Douglas.

A difference in market projections

Airbus and Boeing differ in their visions of the future market for large civil aircraft. In Airbus' view, the future of the LCA market lies with very large aircraft capable of long flights that will fill a growing demand for "hub-and-spoke" airline operations. Airbus feels that larger aircraft are necessary to mitigate growing congestion at the finite number of gates that airports have available.

In keeping with this market view, Airbus developed the A380 "super-jumbo" aircraft in the early 2000s. Several versions are planned, with seating capacity ranging from 555 to 850 passengers.

[19] At this time this report was written, in February 2009, Airbus had not reported LCA revenues for 2008. We estimated its revenues based on Airbus' ratio of aircraft delivered and revenues received in 2007, as applied to the number of aircraft Airbus delivered in 2008. Our estimate will be incorrect to extent that, among other things, aircraft prices have changed and the mix of aircraft delivered (such as wide-body vs. narrow body) varied from year to year. Airbus reported 2007 revenues in euros. We used a conversion factor of €1.0 = $1.26 in estimating Airbus' 2008 revenues.

(By comparison, the Boeing 747-400, the latest version of Boeing's largest offering, typically is configured for a maximum passenger capacity of 416.)

In contrast, Boeing believes that the future of civil aviation lies with so-called "point-to-point" airline operations. In Boeing's view, passengers' demand for non-stop service will trump their interest in lower fares that may be achieved with one or more intermediate stops. Consequently, Boeing predicts airline fleets will be composed of large numbers of aircraft with relatively smaller passenger capacities, with a mix of models capable of short, medium and long-range operations.

In keeping with its market projection, Boeing developed its latest aircraft, the 787 Dreamliner, with fewer seats than the Airbus A380, and somewhat fewer than the last aircraft Boeing developed, the 777. Boeing anticipates entry into service in 2010 for the first version of the 787 (three versions are planned).

While the two LCA manufacturers have different views of the future market, neither Boeing nor Airbus has committed fully to either the hub and spoke or point-to-point model. In December 2006, the EADS Board of Directors approved the industrial launch (*i.e.*, decision to manufacture) of the Airbus A350XWB, aimed at competing against the Boeing 787. Boeing plans to produce a stretch version of the 747, designated the 747-8, that will add room for an additional 34 seats in a typical configuration of three passenger classes.

Adoption of a Systems Integration Manufacturing Process by Boeing

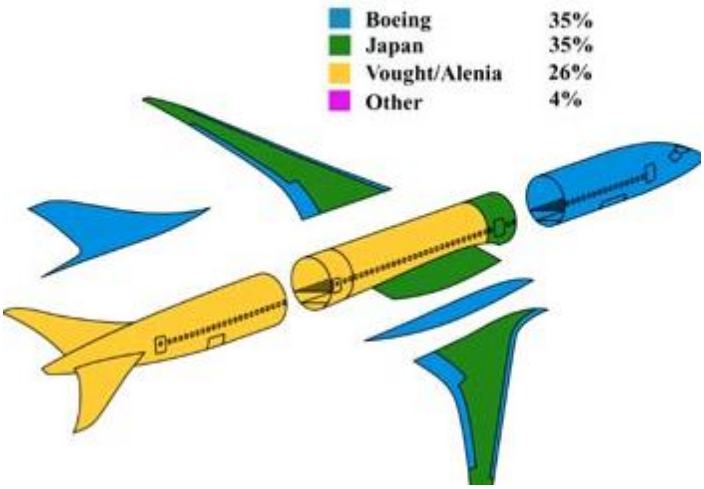
In a departure from its traditional manufacturing process, Boeing is using an assembly technique for the 787 that has been used by Airbus for decades. In this new, "systems integration" approach, instead of receiving parts from tens of thousands of suppliers, Boeing is working with a small number of companies to provide major sub-assemblies for the 787. Boeing requires that these suppliers assume the cost of integrating the sub-assemblies. Boeing claims that final assembly of the 787 at its facilities near Seattle will take three days, instead of the two to four weeks currently required for final assembly of similar aircraft.

In another departure from its traditional business model, Boeing is relying to a great extent on the participation of foreign companies to help develop and manufacture 787 components. For example:

- Alenia of Italy has designed and is manufacturing center and rear fuselage sections, representing 26 percent of the 787 "structures". Some fuselage sections will be assembled in Italy.

- The Japanese Aircraft Development Corporation (JADC), a consortium of the three largest Japanese aerospace manufacturers, has designed and is manufacturing both wings, representing 35 percent of the 787 structures.

787 Structures Work Share



Outlook

Industry observers seem unanimous in their expectation of a contraction in the market for large civil aircraft at least until early 2010. Although likely lesser in number than 2008, Boeing's sales in 2009 are likely to be dominated by the company's single-aisle 737, wide-body 777, and the new 787 Dreamliner.

Key factors in 2009 that could affect the future of the U.S. large civil aircraft manufacturing industry include:

- **Overall economic decline**: Airlines' demand for new aircraft depends on passengers and cargo shippers' demand for air transportation, which in turn is closely linked to patterns in economic growth. Many economists predict gloomy economic conditions in 2009. For example, the International Monetary Fund forecast world economic growth to be one-half of one percent in 2009, the lowest rate since World War II. In late January 2009, Boeing said that it plans to deliver 480 to 485 aircraft in 2009, revised downward from its July 2008 estimate of 500 to 505 deliveries.[20] In February, the head of a global airline trade group, the International Air Transport Association, predicted that airlines may defer taking delivery of more than half of the aircraft they were scheduled to receive in 2009, due to decreased passenger demand and credit difficulties.

[20] Boeing's actual deliveries of 375 aircraft in 2008 were below its estimate of 475 for the year.

- **Boeing 787 Dreamliner**: With almost 900 orders received since its launch in April 2004, the 787 Dreamliner is Boeing's most commercially successful new civil aircraft program ever. The program's success, however, has been challenged by a series of production difficulties, including some that may have resulted from Boeing's new "systems integration" approach involving overseas suppliers of major subassemblies. In early 2009, three customers cancelled orders totaling 33 787s, for reasons that may have involved a lack of credit as well as delayed delivery. Boeing's ability to resolve production difficulties for the 787 may signal the efficacy of the systems integration approach for future aircraft programs.

- **Litigation in the World Trade Organization (WTO)**: Despite expectations to the contrary, WTO dispute settlement panels did not issue decisions in 2008 concerning illegal government subsidies to Airbus as well as counter litigation initiated by the European Union alleging illegal subsidies granted to Boeing. In October 2008, the panel adjudicating the U.S. case regarding subsidies to Airbus reported that it expected to complete its work in 2009.

Regional Jets

Similar to the large civil aircraft sector, global production of regional jets (RJs) is dominated by two manufacturers—Canada's Bombardier and Brazil's Embraer. Regional jets are typically considered to be commercial jet transport aircraft with fewer than 100 seats. However, this traditional defining line is blurring as large RJs come closer to the smallest product offerings of Boeing and Airbus. Orders and deliveries of regional jets grew rapidly in the 1990s as airlines used them to fill a unique market niche. More recently, deliveries have slowed, and some analysts believe that the natural annual market for regional jets is around 200 aircraft. Despite the downward trend, three other countries—China, Russia, and Japan—are currently developing RJs.

Company	Products	2007 Revenue from Aircraft	2006-2007 % Change in Revenue
Bombardier	Regional jets and turboprops; business jets	$9.7 billion	17%
Embraer	Regional jets, business jets	$9.98 billion	20.8%

Market Trends

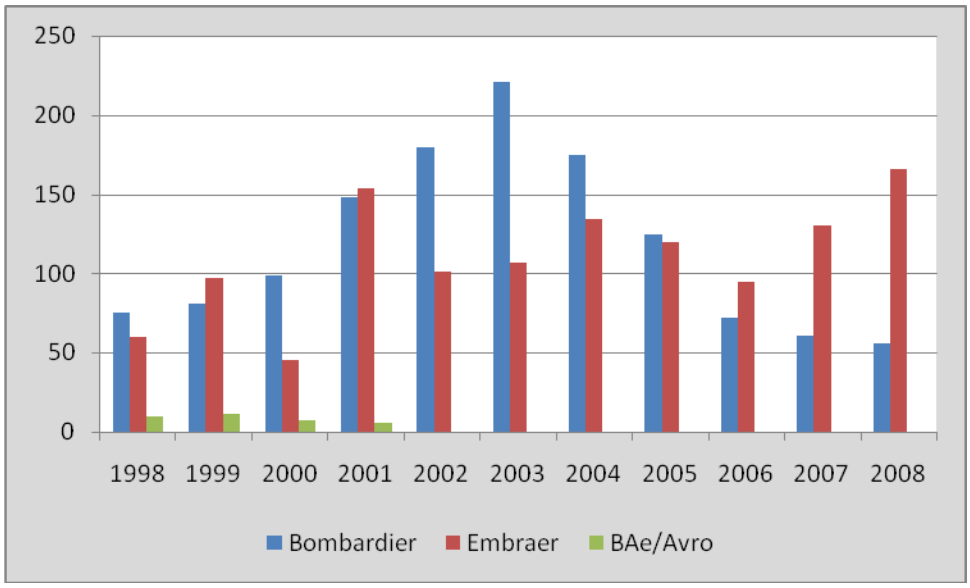
Together, Bombardier and Embraer have completely displaced European RJ manufacturers in the global market. The last RJ from the U.K.'s BAE Systems rolled off the assembly line in 2001. German company Fairchild/Dornier entered into bankruptcy and sold the rights to its aircraft programs to various investors in early 2003.[21] Although Fairchild/Dornier's 32-passenger 328 JET program was purchased by AvCraft Aviation, AvCraft itself went into bankruptcy in 2005.

Bombardier enjoyed a three-year head start over Embraer in delivering its first regional jet, but has not dominated the market. Embraer delivered more RJs in 1999, 2001, and 2006-2008 (see Chart 1, next page) and had a backlog 3 times as large as Bombardier at the end of 2008. Overall, however, the regional jet market has not enjoyed the same growth that the large civil aircraft market experienced over the last several years (see Chart 2. There were 1,568 new orders for large jets in 2008 but only 161 new orders for regional jets).

[21] "New Owner Expects To Begin Delivering 328 Jets Within 60 Days", *The Weekly of Business Aviation*, March 31, 2003.

Both of the regional jet manufacturers are moving to focus on larger aircraft models. Although the regional jet market began with an emphasis on 50-seat jets, currently the largest market is for aircraft with 70 seats or more. In fact, both manufacturers are offering or are exploring aircraft with more than 100-seats, which is traditionally the market segment dominated by Boeing and Airbus. Embraer's ERJ 190, which seats up to 114, was the manufacturer's best-seller in 2008, and currently accounts for 56 percent of Embraer's backlog by number of units. Bombardier is currently phasing in its larger "NextGen" line of aircraft, the largest of which will go up to 100 seats. Bombardier launched an even larger product line—the C Series—at the Farnborough Air Show in 2008. This aircraft would go up to 130 seats.

Chart 1: Regional Jet Deliveries, 1998-2008[22]



[22] U.S. Department of Commerce analysis of RJ data from *Speednews*.

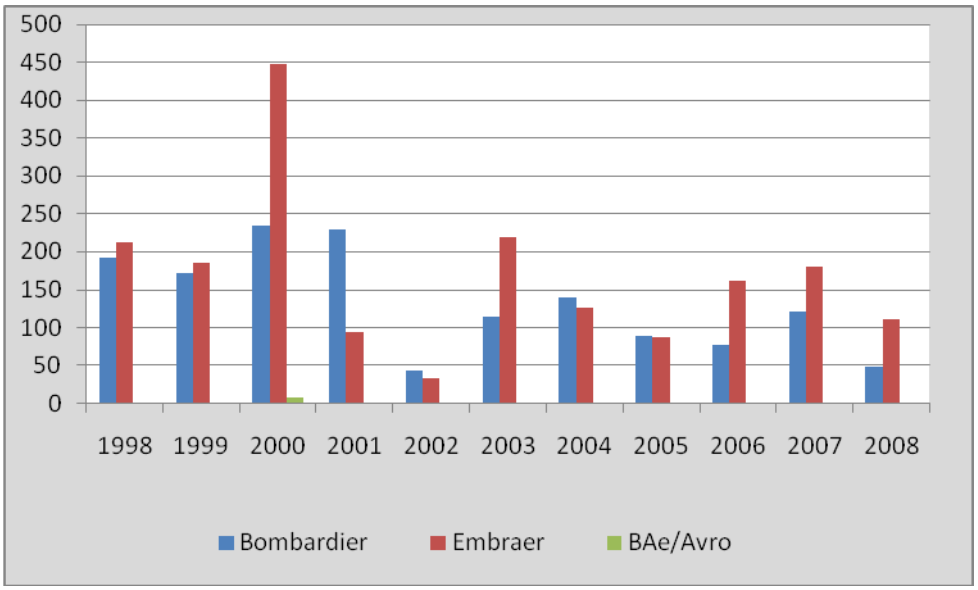


Chart 2: Regional Jet Announced Orders, 1998-2008

Outlook

Although the major manufacturers—including Boeing and Airbus—forecast using different aircraft-size categories, all seem to agree that demand for larger regional jets will outpace the demand for smaller regional jets in years to come. In particular, the greatest amount of growth is forecasted for the market over 100 seats, and this is spurring the development of larger aircraft by the regional jet manufacturers (see above). As yet unclear, however, is whether the four will all become direct competitors at the low-end of the single-aisle market, or whether Boeing and Airbus will focus on larger single-aisle aircraft.

Figure 1: Market Forecasts, 2007-2026

Airbus		**Boeing**	
< 100 seats, incl. turboprops	6,153	< 90 seats	3,700
≥ 100 seats, single-aisle	16,620	90-175 seats	15,090
Bombardier (all incl. turboprops)		**Embraer**	
20-59 seats	1,000	30-60	1,400
60-99 seats	4,300	61-90	2,600
100-149 seats	5,900	91-120	3,500

The United States has typically been the largest market for regional jet deliveries, accounting for approximately 68 percent of aircraft delivered by Bombardier and Embraer. Though North America should continue to be the largest market, industry forecasts predict that its market share will drop. Europe/Russia and China are expected to be the next largest markets for deliveries, though even combined their market share will account for less than North America's.

Regional jet development is becoming increasingly global, with new projects under way in China, Russia, and Japan. The Chinese and Russian jets are approximately the same size—the Chinese ARJ21 is 78-90 seats and the Russian SuperJet is 75-95 seats. A stretched version of the ARJ21 is planned that would increase its capacity to 105 seats. Both programs have been delayed, but are expected to come to market in the next two years. The Japanese Mitsubishi Regional Jet was formally launched in April 2008 and is expected to enter into service in 2013. All three aircraft will be seeking certification outside of their home markets.

The question of market share is an open one as the manufacturing field becomes more crowded. Even the most optimistic of the above forecasts predicts that, on average, only 300 aircraft will be delivered per year with fewer than 100 seats. The current regional jet manufacturers have been able to meet that level of production in the past. The Chinese market is expected to absorb somewhere around 640 aircraft with fewer than 100 seats by 2026 and Russia/CIS is expected to absorb less than 200. Even if each country's demand goes entirely to its domestic manufacturer, on-average that means that they will deliver 32 and 10 planes per year, respectively. Although that level of production may be sufficient as these programs start off, they will require foreign markets to be sustainable. Likewise, given the size of the Japanese market, it is unlikely that those aircraft could all be absorbed domestically. It is unclear whether or not there is enough global demand to make all of these programs economically viable.

Notable Developments

Although both the Chinese ARJ21 and the Russian Superjet rolled off the assembly line in the second half of 2007, both experienced flight testing delays in 2008. The MRJ was officially launched by Mitsubishi Heavy Industries in April 2008.

Rotorcraft

The rotorcraft industry produces aircraft capable of performing vertical take-off and landing (VTOL) operations and are powered by either turboshaft or reciprocating engines. The rotorcraft sector includes helicopters, gyrocopters, and tiltrotor aircraft. Helicopters, which employ a horizontal rotor for both lift and propulsion, are the mainstay of the industry. Gyrocopters are produced in much smaller quantities, primarily for use in recreational flying. Tiltrotor aircraft, such as the V-22 Osprey[23], can take off vertically and then fly horizontally as a fixed-wing aircraft.

Rotorcraft are produced in most industrialized countries, either of indigenous design or in collaboration with, or under license from, other manufacturers. U.S. manufacturers of civilian helicopters include Bell, Enstrom, Kaman, MD Helicopters, Robinson, Schweizer, and Sikorsky. However, Bell moved its civilian helicopter production to Canada, with the last U.S. product completed in 1993. European producers include AgustaWestland, Eurocopter, NHIndustries, and PZL Swidnik. American Eurocopter—a subsidiary of the European manufacturer and subsidiary of EADS NV—has progressed to full production of EC-145-based Lakota helicopters for the U.S. Army, as well as AS350s, in Columbus, Missouri.[24] Russian helicopter manufacturers Mil Moscow, Kamov and Kazan, as well as a number of other rotorcraft related companies, have been consolidated under the Russian government majority-owned OAO OPK Oboronprom.[25] See this paper's Russia Country Analysis for a more detailed description of Oboronprom.

[23] The V-22 Osprey was developed by Bell Helicopters and is manufactured by Bell in conjunction with Boeing Rotorcraft Systems. See http://www.boeing.com/rotorcraft/military/v22/

[24] Aviation Week ShowNews Briefing, February 22, 2009, p.22.

[25] http://www.oboronprom.com/en/show.cgi?/corporation/structure.htm

U.S. Manufacturers

Company	**Products**
Bell Helicopter	civil & military helicopters, tiltrotors, unmanned aerial systems
Boeing Rotorcraft Systems	military heavy & attack helicopters, tiltrotors, UAVs
Enstrom Helicopter	piston & light turbine-powered helicopters
MD Helicopters	NOTAR®-equipped turbine-powered helicopters
Robinson Helicopter	light piston-powered helicopters
Schweizer Aircraft	piston & light turbine-powered manned & unmanned helicopters, fixed-wing airplanes & airframe components
Sikorsky Helicopter	civil & military medium & heavy turbine-powered helicopters

Foreign Competitors

Company	**Products**	**Country**
Eurocopter	civil turbine-powered helicopters	Europe
PZL Swidnik	Single-engine, twin-engine light & light-medium turbine-powered helicopters	Poland
OAO OPK Oboronprom	Mil Moscow, Kazan, Kamov turbine-powered light, medium and heavy helicopters, rotorcraft related companies	Russia

Joint Ventures

Company	**Products**	**Country**
AgustaWestland	civil & military turbine-powered helicopters	Europe
Bell/Agusta Aerospace	civil tiltrotors	U.S.-Italy
NHIndustries	military large turbine-powered helicopters	Europe

Market Trends

Helicopter manufacturers generally agree that backlogs are still healthy and that 2008 was a good year in terms of deliveries and orders. However, some helicopters already ordered may not be delivered in 2009 as customers may be unable to obtain the necessary credit due to the global economic downturn. Honeywell Aerospace is forecasting that deliveries—amounting to 3,500 to 4,500 during the period 2009-2013—of civil turbine-powered helicopters are expected to remain steady in 2009, but could decline in 2011 and 2012.[26] Rolls-Royce's forecast is more upbeat—expecting there to be a slight slowdown in 2009, then a return to increasing demand through 2013—for a total of 9,600 deliveries during the period 2009-2018.[27]

Outlook

While the global economic downturn has adversely affected the ability of some customers to secure credit to purchase new equipment, the global rotorcraft industry is optimistic about future orders in the long term. This optimism is based in part on the relative average age of the current fleet of operating helicopters, which is nearly thirty years old. Major customers such as emergency medical service (EMS) providers and operators supporting offshore oil and gas exploration and production are seeking new, replacement aircraft that meet the latest standards for design and safety. Additionally, the rotorcraft market is much broader than it was during the last market downturn in the 1970s, so a decline in one sector of the market is less likely to trigger a steep decline in helicopter demand.

Moreover, *Forecast International* in 2008 predicted:

> "within the next 10 years, military and commercial rotorcraft production is expected to top 18,700 units worth some $121 billion, with European and American manufacturers in stiff competition for market share. Bell is trying to mount a serious challenge to Eurocopter, which has made significant market inroads in recent years, particularly in North America. Meanwhile, Enstrom, Eurocopter, MD Helicopters, Schweizer, and Sikorsky all have formed or are setting up joint ventures with China's industry in a trend that will only grow in the years ahead."[28]

Industry analysts and manufacturers are hopeful that Chinese airspace restrictions that are hindering development of general aviation, including helicopter operations, will be loosened now the 2008 Beijing Olympics have concluded.

[26] Aviation Week ShowNews Briefing, February 24, 2009, p. 10.
[27] Aviation Week & Space Technology, March 2, 2009, p. 23.
[28] *Forecast International*. https://www.forecastinternational.com/fistore/prod.cfm?ProductID=16445

Commercial Space

The commercial space market is dominated by a small number of large companies that provide launch services and manufacture commercial communications satellites. Commercial remote sensing satellites are emerging within this market, but have seen limited growth internationally. The companies comprising this market are also major suppliers to U.S. Government (USG) programs, where demand has remained stable during the commercial aerospace downturn and global economic downturn that have occurred since 2001.

U.S. and Foreign Manufacturers

Launch Company	Vehicles/Products	2008 Commercial Launches	2008 Total Launches
Boeing	Delta II, Delta IV, Sea Launch	8	10
Lockheed Martin	Atlas V	1	2
Arianespace	Ariane 5	5	6
International Launch Services	Proton	6	6
Orbital Sciences Corporation	Pegasus, Taurus (light-weight) Minotaur	1	2
SpaceX	Falcon 1	2	2

Four major companies dominate the launch market: Boeing, Lockheed Martin, Arianespace (Europe) and International Launch Services (Russia). Boeing and Lockheed Martin also provide launch services to USG customers on their Delta and Atlas rockets, through the United Launch Alliance (ULA) joint venture. ULA uses the same Atlas 5 rockets that are marketed commercially, as well as the Delta 4 rockets that could re-enter the commercial market if commercial launch prices rise globally. ULA is structured as a 50/50 joint venture and is estimated to provide an annual savings to the USG of approximately $100-150 million.

Since Lockheed Martin's 2006 sale of its interests in International Launch Services (ILS) to Space Transport, Inc., ILS no longer offers marketing or technical assistance for U.S.-built Atlas launch vehicles. ILS now offers assistance only with Russian-built Proton launches. Space Transport is seeking to return some of its stake in the venture to Russia's Khrunichev, the manufacturer of the Proton launch vehicle.

In addition to providing light-weight launch vehicles, Orbital Sciences has carved out a niche in the small to medium-sized communications satellite sector and attracts mid-range customers who do not require the power and capability of a large, state-of-the-art satellite. It is likely that this market niche will continue to grow over the next few years.

Several entrepreneurial companies, such as SpaceX, Air Launch, KT Engineering, and Bigelow Aerospace are developing new launch vehicles and satellites intended to lower launch costs and support NASA's Vision for Space Exploration. Since most entrepreneurial ventures have only minimal financing and have been unable to move beyond the initial program design stage, numerous entrepreneurial firms have exited this market in the past two years. However, SpaceX is an American entrepreneurial firm that is experiencing growing success through its privately developed Falcon family of launch vehicles. SpaceX currently has contracts or options for up to 24 launches.[29]

Market Trends

In 2008, 69 total orbital launches took place globally, of which 28 were commercial launches.[30] Six of the commercial launches were performed by U.S. ventures. Boeing's Russian-built Sea Launch conducted five launches and Boeing's U.S.-built Delta II conducted the other two. Arianespace launched 10 satellites on 5 commercial launches.[31] Russia's Proton rocket launched six commercial satellites on six launch vehicles, one of which failed (AMC14). These figures demonstrate the stiff competition between European- and Russian-manufactured rockets in the commercial market and the recent focus on government launches for U.S.-built rockets. Data have begun to indicate that recent increases in Russian and European commercial launch prices are nearly high enough to make U.S. commercial launch prices competitive again internationally. Commercial launch revenues totaled nearly $1.97 billion in 2008, an increase of $360 million, or approximately 22 percent, over 2007.[32]

The 69 total global launches carried 106 spacecraft into orbit in 2008. Of those 106 spacecraft, 42 provide commercial broadcast and communications services, while the remaining spacecraft perform other scientific or government functions.[33]

In the commercial communications satellites sector, U.S. companies captured approximately 40 percent of the commercial market over the past 5 years, with European companies striving to gain market share.[34] U.S. market share could decline due to export control concerns and European technological advancements. In response to export control concerns, Europe's Thales has developed a satellite that contains no U.S. components, thereby avoiding U.S. export control regulations, and allowing it to be launched from China at a price lower than current Western market prices. While the United States maintains a small production cost advantage, aided in

[29] http://www.spacex.com/
[30] "2008 Year in Review", Federal Aviation Administration, Office of Commercial Space Transportation, January, 2008.
[31] Ibid.
[32] Ibid.
[33] Ibid.
[34] Satellite Industry Association.

part by a weak dollar, this advantage has been shrinking as Europe produces a greater number of satellites and gains more technological expertise. Boeing, Lockheed Martin, Orbital Sciences, Thales-Alcatel, Astrium, and Loral Space and Communications dominate the market. Several factors will impact the demand for telecommunications services over the next 5-10 years including overall economic conditions, new market applications, competition with other non-space-based services (such as cable television), data compression technology, regulatory barriers, emerging competitors and the new trend towards investment firms' ownership of services companies.[35]

In the commercial remote sensing satellite sector, the major communications satellite manufacturers listed above as well as Ball Aerospace and Northrop Grumman have the capability to build state-of-the-art imaging satellites. Even though the 2004 national policy on remote sensing encourages trade in this sector, no U.S. company has sold one of these satellites to an international customer. Export control concerns and/or a lack of funding from foreign customers are the main reasons for the slow emergence of this market.

Domestically, two U.S. companies--GeoEye and Digital Globe--own and operate imaging satellite systems and sell their data commercially. The companies' success, however, still hinges on purchases from their main customer, the USG. This government-customer focus will not change in the near term, but it will slowly diminish as new applications are developed for commercial use, such as commercial mapping, mineral exploration, insurance appraisals, journalism/news media, and agriculture.

The satellite radio sector saw steady growth over the past few years, but the global economic downturn and competition from other sources has slowed subscriptions and weakened this sector. When the Justice Department approved the merger of Sirius and XM Radio in March, 2008, businesses were easily able to roll-over debt—a business model nearly impossible to operate during the past year's credit crisis. A downturn in auto sales also has slowed the number of new satellite radio subscriptions, leading Sirius XM Radio towards possible bankruptcy in March, 2009. Industry analysts now highlight Sirius XM Radio's attempts to avoid a takeover.

China has possessed the ability to launch commercial satellites since the late 1980s but has focused solely on Chinese government launches since the late 1990s, mainly due to difficulties with export controls. In 2008, China conducted a record high 11 orbital launches for the Chinese government. More specifically, due to Tiananmen Square sanctions that remain in place, U.S. satellites shipped to China for launch must receive a waiver from the President before shipment. When faced with such a difficult requirement, satellite customers have typically chosen other launch providers instead. New "ITAR-free" European satellites are allowing China to re-enter the commercial market, and several contracts have already been signed. With the appearance of these satellites, China likely will link low-cost launches with its satellite sales in Asia. In fact, although the launches were not commercially competed, China built and launched two satellites for commercial customers in 2008, one of which was in Asia. Given the continued strong competition in the satellite market, China will only win these contracts with extremely low prices, thus negatively impacting U.S. manufacturers. China has also worked with Brazil and

[35] "2008 Year in Review," Federal Aviation Administration, Office of Commercial Space Transportation, January, 2009.

Europe to develop advanced satellite technology and is expected to begin offering low-cost, mid-size satellites on the international market within five years. China also performed its third human space flight, hosting three taikonauts, two of whom conducted China's first space walks.

India has expressed a strong interest in entering the commercial launch services market. In 2008, India performed three successful launches for the Indian Government on its Polar Satellite Launch Vehicle (PSLV).[36] Because of Indian launch vehicles' limited capabilities and size, India likely will not gain a significant portion of the market in the short term. India intends to enter the commercial communications satellite market and has already manufactured several communications and remote sensing satellites for Indian government use. India is now actively seeking international customers and has begun working with Russian and European companies on several programs. India has also explored joint ventures with U.S. and European companies to build communications satellites. The U.S.-India High Technology Cooperation Group (HTCG) is exploring areas in which cooperation in the space sector can be increased between the two countries. Areas being considered are space research and development, joint satellite production and the ability to launch U.S. satellites and/or components on Indian rockets.[37]

Japan conducted one launch in 2008 for the Japanese government but hopes to become a commercial participant in the future. Reliability problems with the H-2A rocket and high costs of production have kept Japan from being competitive in this market to date.

A few U.S. states continue to explore building commercial "spaceports", for commercial launches and space tourism flights. The FAA is currently reviewing safety factors impacting such facilities. States that are interested include New Mexico, California, Florida, Virginia and Oklahoma, among others.

Trends

Satellite manufacturers are benefiting from a sudden turnaround in the market, which has included a return to historic satellite order levels. To meet customers' increasing demand for all types of satellite services, satellites are being built larger and heavier in order to provide greater capability and longer satellite lifetime. In turn, these satellites require larger, heavier launch vehicles. Greater size reduces the likelihood of launching two satellites on one launch vehicle, a practice that was more common in the 1990s. However, the greater size has initiated a resurgence of demand for heavy launch vehicles—which are now developing backlogs and increased prices. Prices for intermediate to heavy class launches on several recent competitions have increased from approximately $50 million to nearly $100 million in the last three years. On the other hand, Orbital Sciences has carved out a niche market providing small- to medium-sized satellites to customers requiring a smaller amount of capacity.

[36] "2008 Year in Review," Federal Aviation Administration, Office of Commercial Space Transportation, January 2009.
[37] http://www.bis.doc.gov/InternationalPrograms/IndiaCooperation.htm

Even though the commercial market is recovering, USG satellite and launch purchases will remain very important for U.S. companies who rely upon government business to balance the highs and lows of the commercial sector. However, the unreliable schedule associated with government launches and the 2006 move from "lot buy" purchases to annual awards for launches will negatively impact second and third-tier suppliers. The result is that the overall price associated with those launch vehicles will be higher because of an inability to take full advantage of rate and quantity discounts from critical suppliers. Additionally, the merger between Pratt & Whitney and Rocketdyne, the country's major suppliers of rocket engines, limits the ability of U.S. launch vehicle manufacturers to negotiate better prices for propulsion unless a lot buy is arranged.

There are several factors that may stimulate growth in the launch market. For instance, NASA's decision to rely mainly upon the use of commercial suppliers to deliver cargo and supplies to the International Space Station should supply a significant annual boost. With contracts awarded to SpaceX and Orbital Sciences in December 2008, numerous missions have been added to both companies' launch manifests.

During the early to mid 1990s, the telecommunications boom encouraged a large number of entities around the globe to enter the market, but the late 1990s downturn created large oversupplies in the launch and satellite sectors which in turn eliminated normal profit margins through 2005 and resulted in reduced launch prices. Over the past four years, those prices have nearly returned to the mid-1990s prices due to a resurgence of demand for satellite telecommunications services. Prices are expected to continue to rise slightly before stabilizing. Prices could continue to increase sharply if another launch failure were to occur and/or Russia limits access to its vehicles (Proton, Zenit for Sea Launch and Land Launch, and Soyuz).

Oversupply and extremely low launch prices also pushed some U.S. manufactured launch vehicles out of the commercial launch business. As launch prices returned to higher levels, U.S.-built rockets have again become more competitive internationally. This may provide Boeing an opportunity to offer its Delta 4 rocket in commercial competitions. Following the telecom market crash, only two telecommunications behemoths (composed of many entities) remained: SES Astra-GE Americom-New Skies and Intelsat-PanAmSat-Loral Satellite Services. Moreover, this sector continues to compete with non-space based solutions which can meet the same high-technology needs, such as cellular phones, cable television and other information technologies.

Investors generally remain leery of space due in part to the sector's high risk and low returns on investment. However, investments in telecommunications satellite systems in 2008 pointed towards a return in investor confidence in this sector, and investment in some systems is increasing. As demand for these services increases, emerging launch providers such as India, China and small entrepreneurial ventures may find opportunities to enter the launch and satellite markets.

Another trend having an impact on the market is the increased interest from entrepreneurial manufacturers to develop low-cost alternatives to the established launch providers and/or opportunities for space tourism. This sector has been reenergized as a result of the successful flight of Virgin Galactic's Space Ship One and its 2008 release of Space Ship Two, and the

ongoing competitions sponsored by the FAA and private organizations to develop new technologies. However, huge investments are still required to turn these demonstration launches into successful suborbital and/or orbital space tourism operations. The sector will also require the development of new safety and operational guidelines and the ability to use new technologies regularly and at a reasonable cost. With Virgin Galactic's space tourism flights currently priced at $200,000 per person per flight, space tourism is quickly becoming accessible to more than just millionaires.[38] This market will remain small for several years, but advances in innovation will spur further research and development.

The more stringent enforcement of U.S. export control policies in the late 1990s and the international perception that U.S. export licensing laws would negatively impact a customer's ability to acquire a U.S. satellite appears to have hurt the ability of U.S. satellite manufacturers to compete internationally. U.S. market share appears to be holding steady at approximately 40 percent, but it is not increasing. This is mainly due to export control concerns and the development of satellites that contain no U.S. components. Even though larger companies have learned to manage export control requirements, they remain a heavy burden for smaller companies and entrepreneurial ventures that lack expertise in this area. As mentioned above, Europe's response to U.S. export control policies has been to develop communications satellites that do not contain any U.S. components. Several of these satellites have been sold, highlighting international concern about buying from the United States. Europe's response has probably had the greatest impact on second- and third-tier suppliers who are no longer supplying to European customers while simultaneously watching U.S. market share decline.

Another factor influencing the industry is the desire for national security spacecraft to have the ability to be launched "on demand". The Department of Defense and the commercial industry are working together to develop guidelines that would encourage "operationally responsive launch". Given that manufacturing a launch vehicle and/or a satellite requires 12-18 months, this goal will not be achieved for at least 10 years and will take substantial investments in inventories and production lines, which is unlikely in the near term given the current limited investment climate.

Between 2004 and 2006, President Bush signed five policies supporting the space sector, including an overarching National Space Policy (NSP). The NSP provides guidance to all space sectors on overarching functional and policy issues. Examples of such issues are acquisition management, strengthening the industrial base, competitiveness and a healthy workforce. The policies address remote sensing, space-based positioning, navigation and timing (also known as GPS) and space transportation. The Vision for Space Exploration directs NASA to return humans to the Moon by 2020 as a stepping-stone to explore Mars. Each of these policies states that the USG will not develop systems that will directly compete with the commercial industry and that the USG should seek to rely upon commercial solutions when possible. The policies also state that USG satellites and spacecraft should be launched upon U.S. launch vehicles, except under specific international cooperation situations. Enforcement of these and other similar policy guidelines will be essential to promoting the health and growth of this industry,

[38] http://www.virgingalactic.com/en/when.asp

especially while the commercial market remains flat. Due to the change in Administration, updates to these policies will likely begin within the next 2-3 years.

Outlook

Due to the limited size of the launch market, and the small nature of contracts, there are no ongoing competitions that would have a fundamental impact upon the international commercial market. However, within the civil space sector, the Commercial Orbital Transportation Services (COTS) program is having a strong impact on the small, entrepreneurial launch sector. In late December, 2008, NASA signed contracts with two winners, SpaceX and Orbital Sciences. These companies are developing the Cygnus and Dragon cargo vehicles (respectively), systems which will deliver to and return cargo from the International Space Station. NASA plans to use the commercial providers to resupply the International Space Station with cargo following the planned 2010 retirement of the Space Shuttle. Depending upon how NASA decides to work with U.S. and foreign industry partners on this and other aspects of the Vision for Space Exploration programs, U.S. companies could receive a large amount of work, which would have a substantial impact on the health of the sector, though not the "commercial" market. Currently, the contracts include a minimum of 12 missions for SpaceX and eight missions for Orbital Sciences, although the contract is being protested by PlanetSpace.

Arianespace is expected to remain the leader in the commercial launch services sector, due to competitive pricing and a reliable service. In addition to heavy-lift Ariane 5 launches, in 2009 Arianespace will begin conducting launches of the medium-lift Russian Soyuz rocket and the light-weight Vega rocket from its spaceport in French Guiana.[39] The Soyuz project is co-funded by the European Space Agency, the European Union, Arianespace and Russia.

[39] http://www.arianespace.com/site/news/news_sub_release_index.html

General Aviation

Due in part to a 20.8 percent decrease in piston engine aircraft shipments, total general aviation (GA) shipments were down for the first time since 2003.[40] In addition, the worldwide economic downturn has led to increasingly dismal forecasting for the sector. While current order backlogs may allow many manufacturers to weather 2009, new orders are expected to drop significantly. As a result, as of March, 2009 around 12,000 layoffs had been announced industry wide, with more expected. Finally, the fledgling very light jet (VLJ) industry, which has received significant attention over the last several years, suffered major setbacks due to the bankruptcy filings of both Adam Aircraft and Eclipse Aviation, as well as the demise of DayJet, a startup air taxi service in the southeast United States.

Though North America is expected to remain the top market for aircraft sales, over half of all GA aircraft deliveries are now made to overseas customers. The European Union remains the next biggest market, but growth in other areas, particularly Asia and the Middle East, is expected to be significant in years ahead. [41]

Market Trends

The year 2008 brought mixed news for the GA market, with billings reaching an all-time high of $24.8 billion worldwide while total shipments declined 7.1 percent to 3,969. By number of units, piston airplanes remained the largest segment of the market, but its market share has declined dramatically--only 53 percent of aircraft shipped in 2008 had piston engines compared to 63 percent in 2008. Shipments of business jets and turboprops continued to rise, however, with business jets setting a new record of 1,315 jets and turboprops experiencing the best year for deliveries since 1981 with 535 aircraft. Fourth quarter shipments in all three market segments were down from 2007 levels.[42] According to the General Aviation Manufacturers' Association (GAMA), shipments of piston aircraft are more quickly affected by economic downturns, perhaps attributable in part to smaller backlogs for that segment.

U.S. GA market share rose slightly last year, from just under 77 percent in 2007 to 77.6 percent in 2008. U.S. market share had been declining since 2001, and the average growth rate of U.S. shipments during the period 2001-2008 was 2.9 percent. By contrast, the average growth rate for the rest of the world during that time period was 14.4 percent.

As with large aircraft sales, economic growth is the major factor in the health of the GA industry. Given the costs involved, businesses tend to purchase a new aircraft or replace an old one when

[40] Unless otherwise indicated, all data is taken from GAMA's 2008 General Aviation Statistical Databook and Industry Outlook. Available at: http://www.gama.aero/.

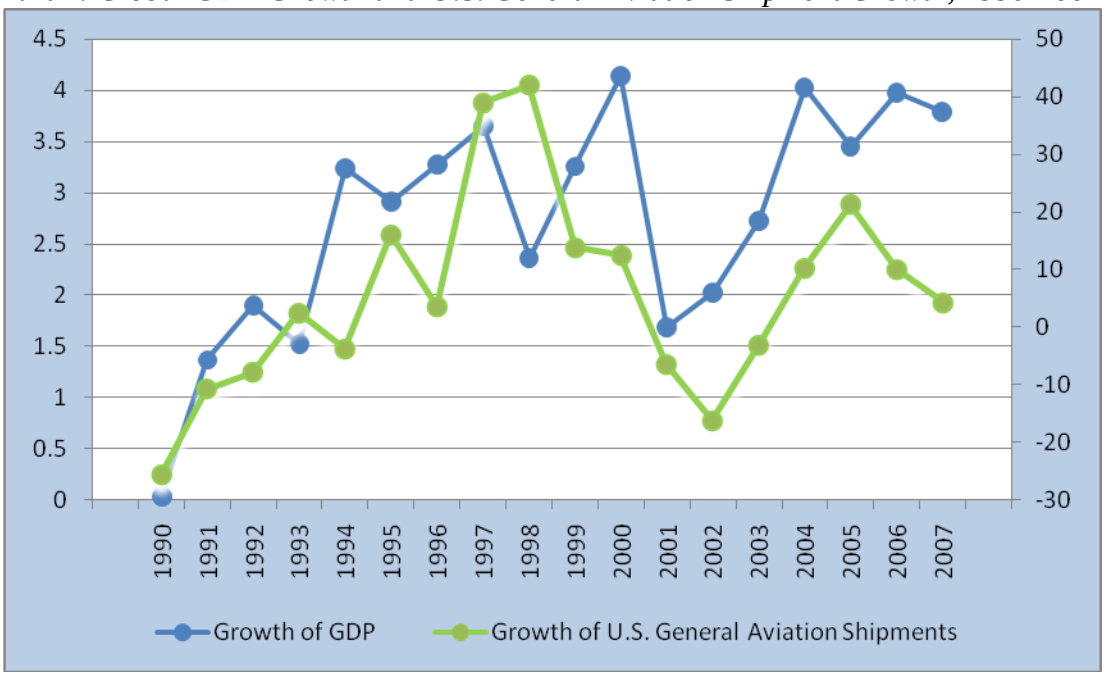
[41] Company data from the General Aviation Manufacturers Association (GAMA). GAMA estimates their data covers over 90 percent of the total market.

*Eclipse is included in this list because it delivered aircraft in 2008. As of January 22, 2009, a judge had approved the same of Eclipse to a U.S. affiliate of ETIRC, a Dutch firm.

[42] Based on data from GAMA's 2008 3rd Quarter Shipment Report and its 2008 End-of-Year Shipment Report.

the economy is strong and profits are up. The chart below indicates that in recent years, changes in the GA market tend to lag economic growth by one year. GA shipments thus suffered during the recessions in the early 1990s and early 2000s and recovered when the economy grew during the second half of the decade.

Chart 1: Global GDP Growth and U.S. General Aviation Shipment Growth, 1990-2007[43]



Outlook

Unlike in 2007, when forecasters were optimistic despite the sluggish U.S. economy, forecasters have started to become more pessimistic about the GA market. Chief reasons for the increased pessimism include: 1) dwindling corporate profits, 2) fewer financing options, and 3) decreased demand for fractional and air-taxi services. Aside from the layoffs mentioned above, industry analysts are also seeing an increase in cancellations and in the number of clients seeking to sell or defer their production slots. For example, Cessna reported 23 cancellations for the 4th quarter of 2008, with only 30 new orders. [44] According to financial services company UBS, the used aircraft inventory is at its highest rate since 2002, with 16 percent of the fleet up for sale.[45] Companies that have announced layoffs as of March 2009 include Gulfstream, Cessna, Hawker Beechcraft, Bombardier, Piper, Cirrus, and Mooney.

[43] Data points represent percent changes over the previous year. GDP data from the National Accounts Main Aggregates Database, United Nations Statistical Division. (Search terms World, GDP (constant 1990 dollars), and years 1990-2007). Available at: http://unstats.un.org/unsd/snaama/selectionbasicFast.asp.
[44] Bob Tita. "Textron's Cessna Struggles with Order Cancellations." *Dow Jones Newswires.* January 29, 2009.
[45] Molly McMillin. "Report: Business Jet Market Slowing." *The Wichita Eagle.* January 10, 2009.

The FAA's last forecast for the United States, made public in March 2008, predicted continued growth in the overall GA fleet.[46] The FAA estimated that the U.S. business jet fleet will grow at an average of 5.6 percent per year through 2025 and that growth in the turboprop market will be a moderate 1.6 percent. Since the actual growth rate for the turboprop market has been declining (5.7 percent per year during the period 2000-2006 versus 5.2 percent during the period 2000-2007), presumably the expectation is that some old turboprop customers may turn to smaller jets. The FAA also predicted a stagnant piston-aircraft market (at 0.3 percent growth), though even that small amount of growth was not expected until 2010. Mirroring GAMA's statistics, the FAA shows that this market segment actually experienced a decline of 0.6 percent from 2000-2007. Since these predictions were based on the economic modeling data available at the time, it is likely that these figures may be revised downward.

Figure 2: Fixed-wing Turbine Corporate Aircraft Fleet by Region, 2008[47]

Region	Number of Planes
North America	18,128
Europe	3,288
Latin America	2,685
Rest of World	1,479

Historically, the United States has made up the bulk of the GA market, but in recent years a significant number of orders were placed by overseas customers. The changed market presents a challenge for forecasters, who are unsure how the new customers will react to worsening market conditions. At the present time, it is not entirely clear if the order cancellations received so far are geographically concentrated or if they are disbursed evenly across the globe. In addition, in the United States business jet sales are one of the first purchases made by corporations during an economic recovery. It is unclear whether foreign buyers would follow suit.

Notable developments

Business aviation made headlines in late 2008 when it became part of the political backdrop of the automotive industry bailout hearings. After being criticized for taking corporate aircraft to Washington, D.C. to ask Congress for money, both the Ford Motor Company and General Motors opted to sell their corporate aircraft fleets as part of the industry's bid to receive a multibillion dollar loan package from Congress (Chrysler's Chairman/CEO travelled via chartered jet, as Chrysler did not own any aircraft). In January 2009, Citibank, also a recipient of

[46] FAA Aerospace Forecasts 2008-2025. Table 27. Available on the web at: http://www.faa.gov/data_statistics/aviation/aerospace_forecasts/2008-2025/

[47] Flight International's 2008 corporate aircraft census. Available on the web at: http://www.flightglobal.com/articles/2008/09/30/316583/business-aviation-census-winds-of-change.html

government funds, made headlines for going ahead with plans to purchase a Dassault Falcon 7X. Citibank quickly reversed course however after coming under intense public criticism as well as pressure from the U.S. Treasury.[48] A provision to require companies to divest their aircraft if they receive money from the government was initially included in the Troubled Assets Relief Program Act of 2009, but the proposal was reportedly dropped before it was passed by the House of Representatives.

In addition, in January 2009, the Transportation Security Administration issued a notice of proposed rulemaking to change security requirements for aircraft with a takeoff weight exceeding 12,500 pounds. The Large Aircraft Security Program (LASP) has been met with concern by the business aviation community. For more information, see the Security section of this paper.

[48] Josh Fineman and Roger Runningen. "CitiGroup Reverses Itself on its Decision to Buy Jet." Bloomberg.com. January 27, 2009.

Engines/Powerplants

The large civil aircraft jet engine market is dominated by a few individual manufacturers and several joint ventures comprised of one or more of these players along with a smaller company or companies. With one exception, the major engine manufacturers are a part of diversified corporations[49] producing engines for both civil and military aircraft, either alone or as part of one or more joint ventures.

U.S. and Foreign Manufacturers

Three major manufacturers dominate the large commercial jet engine market.

Company	Products	2008 Revenue (million)	2008 Income (millions)	2007-2008 % Change in Income
General Electric (Parent of GE Aviation)	Turbofan, turboprop, and turboshaft engines for a variety of civil and military aircraft	$182,515	$17,335	(21.94)
United Technologies Corp. (Parent of Pratt & Whitney)	Turbofan and turboprop engines for a variety of civil and military aircraft	$58,681	$4,689	11.01
Rolls-Royce PLC	Turbofan, turboprop, and turboshaft engines for a variety of civil and military aircraft	£ 9147 ($13,167)*	£ 970 ($1,396)*	10.10

*At an exchange rate of £1 = $1.4395, which is the Federal Reserve Bank of New York spot exchange rate in effect on December 31, 2008 at 12:00 PM. See http://www.federalreserve.gov/releases/h10/hist/dat00_uk.txt

Of the three companies listed above, General Electric Aviation (GE Aviation) and Pratt & Whitney (P&W) are the two largest U.S. manufacturers. The United Kingdom's Rolls-Royce PLC is the largest non-U.S. producer.

[49] In FY 2008, Rolls Royce civil and defense aerospace segments comprised a combined 68 per cent of the company's total revenues and 81 per cent of its total income. See Rolls Royce PLC 2008 Preliminary Results, available at http://www.rolls-royce.com/Investors/financial_reporting/financial_results.jsp

Joint Ventures

The dominant engine manufacturers also participate in various joint ventures. These ventures are formed to capitalize on emerging market demand for engines, while at the same time allowing partners to share development and production costs along with risk.

Company	**Partners and Ownership Percentages**
The Engine Alliance	GE Aviation – 50% Pratt & Whitney -50%
CFM	GE Aviation – 50% Snecma Moteurs – 50%
International Aero Engines (IAE)	Rolls-Royce – 32.5% Pratt & Whitney – 32.5% Japanese Aero Engines Corporation – 23% MTU Aero Engines -12%
PowerJet	NPO Saturn JSC – 50% Snecma Moteurs – 50%

CFM International, a joint venture of GE Aviation and Snecma Moteurs of France, produces the CFM56, which is used in various Boeing and Airbus aircraft and is the sole engine option for the Boeing 737. International Aero Engines AG, a consortium comprised of P&W, Rolls-Royce, German engine manufacturer MTU Aero Engines GmbH and the Japanese Aero Engines Corporation, produces the V2500 engine for use in the Airbus A319/A320/A321 aircraft. The Engine Alliance, a 50/50 joint venture between GE Aviation and P&W, was formed to produce an engine for the Airbus A380.

A more recent entrant in the engine joint venture competitive landscape is PowerJet, a 50/50 joint venture between Snecma Moteurs and Russian engine manufacturer NPO Saturn JSC. PowerJet's entry into the jet engine market is significant as it is representative of the Russian civil aviation/aerospace industry's efforts to compete with U.S., EU and Japanese manufacturers as a viable alternative for commercial aircraft, engines and other components. PowerJet's initial offering, the SaM146 engine, is being developed for use initially in Russian aircraft manufacturer Sukhoi's Superjet 100. PowerJet is marketing their engine as part of an overall package of customer support and maintenance services for the entire propulsion system to

include long-term engine maintenance, parts management by the hour, and engine leasing and exchange programs.[50] In addition to the Sukhoi Superjet 100, PowerJet plans to develop additional engine variants as well as find additional regional jet customers for their engine.[51]

With the exception of Rolls-Royce, EU and Japanese engine manufacturers compete mainly through their holdings in joint ventures. Most notably, as a 50/50 partner with GE Aviation in CFM International, Snecma Moteurs of France maintains a significant market presence. In addition, MTU Aero Engines GmbH of Germany, along with the Japanese Aero Engines Corporation, maintains a presence via its equity holdings in IAE.

Since no Russian engine manufacturers currently produce engines for use on Boeing or Airbus aircraft, the impact of Russian jet engines on the LCA jet engine market is negligible at the time of this report. As discussed above, however, Russian manufacturers are looking to participation in joint ventures in order to gain access to the global aircraft engine market.[52]

China possesses a growing market of small domestic aircraft engine parts manufacturers, along with a number of established major manufacturing entities. However, since only a small percentage of Chinese aircraft parts manufacturers are capable of manufacturing parts that meet international aviation quality standards, at this time Chinese manufacturers have no measurable impact on the LCA jet engine market.[53]

Market Trends

By definition, market trends in the aircraft engine market are linked to aircraft sales. With the notable exception of Boeing's 737, Boeing and Airbus typically have two engine options for each model offering. The same arrangement exists for most regional jet aircraft. Therefore, an end user-customer could, and often does, purchase a U.S.-manufactured Boeing 747 aircraft and equips it with UK-manufactured Rolls-Royce engines. Similarly, customers may choose to equip Airbus aircraft such as the A330 and A320 with P&W and CFM56 engines respectively. The end result of this de-linking of aircraft and engine selections is a market with no clear line between U.S.-made and foreign-made products.

General trends in the large civil aircraft market remained largely unchanged in 2008 from previous years. In the delivery segment, GE Aviation, Rolls-Royce and CFM[54] currently lead

[50] http://www.powerjet.aero/?id=222&selt=1

[51] "Franco-Russian Venture Will Seek To Evolve Into World-Class Engine Player" Aviation Week and Space Technology, August 1, 2004. Available at http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=awst&id=news/08024air.xml

[52] Industry Analysis of Aircraft and Aircraft Parts Sector in Russia, U. S. Department of Commerce October, 2002, available at http://www.bisnis.doc.gov/bisnis/isa/021001RusAir.htm.

[53] Aerospace Industry Market Brief 2005 – China, U.S. Department of Commerce, November 29, 2005, available at http://www.buyusainfo.net/docs/x_7566162.pdf .

[54] For purposes of this analysis, CFM deliveries are counted separately from those of GE Aviation, which owns 50 per cent of CFM. However, revenue from CFM deliveries is shared on a 50/50 basis by GE Aviation and Snecma Moteurs.

the LCA jet engine market on both a unit and total value basis. CFM's strength in the market is driven by current and projected continued high unit sales of the CFM56 engine. The CFM56 is the sole engine choice for the entire Boeing 737 series, and it is also used in a number of Airbus aircraft. As neither Boeing nor Airbus have divulged any plans to replace their single-aisle (e.g. 737, A320) aircraft in the near term, the large number of 737 and competing Airbus aircraft in service means deliveries of the engine should remain high for the foreseeable future.

By comparison, GE Aviation and Rolls-Royce's current strength and projected growth are predicated upon higher per unit engine prices. GE Aviation's market share is largely built on deliveries of its CF6 and GE90 engines, which power the Boeing 747, 767, and 777 as well as multiple Airbus aircraft. Rolls-Royce's market position is based upon sales of the company's Trent series of engines, which are used in the Boeing 747, 757, 777 and 787 Dreamliner and Airbus A330, A340, and A380. Rolls-Royce is also developing the Trent XWB engine for the redesigned A350XWB.

P&W's position as the second largest aircraft engine manufacturer in the United States is increasingly based on its revenue from military sales as well as its commercial aftermarket services. Two of the company's most promising aftermarket services offerings are its Global Material Solutions business unit, which offers maintenance, repair and overhaul (MRO) services for the CFM56 engine offered by its competitor CFM, and EcoPower, a closed-loop, environmentally friendly engine wash service that yields improved engine fuel economy and performance.

P&W's most promising new product is its geared turbofan (GTF) engine, designated the PurePower PW1000G. The PW1000G offers significant fuel consumption savings over similar size engines, and the company is working with NASA to demonstrate the engine's ability to use alternative, non-petroleum based aviation fuels.[55] In addition, P&W has completed extensive ground and flight tests on the company's own Boeing 747 test bed aircraft as well as in cooperation with Airbus on the company's A340 test aircraft.[56] The PW1000G should help offset decreasing sales of commercial engines and commercial engine spare parts, with the most notable loss being its non-selection as one of the two companies (GE Aviation and Rolls-Royce) selected to build engines for the Boeing 787.

Regarding the number of engines in service, P&W is currently the market leader, but the company's lead is projected to give way to competitors as newer engine models begin service and older model aircraft are retired. The effect of this competition is mitigated somewhat by P&W's partnership in both the Engine Alliance and IAE. From these cooperative efforts, P&W still stands to benefit from the introduction of new aircraft and engines. Having already secured two launch customers for the PW1000G GTF engine as well as looking to find additional

[55] "Pratt & Whitney's Geared Turbofan(TM) Engine Demonstrates Alternative Fuel Capabilities" available at http://www.portfolio.com/resources/company-profiles/UTX/press/2008/02/19/pratt--whitneys-geared-turbofantm-engine-demonstrates-alternative-fuel-capabilities

[56] "P&W Completes Testing of PurePower PW1000G Geared Turbofan Engine" available at http://www.asd-network.com/press_detail/19281/P&W_Completes_Testing_of_PurePower_PW1000G_Geared_Turbofan_Engine.htm

customers, P&W hopes to position itself as a continuing major engine manufacturer.[57] As the only engine suppliers for the Boeing 787, GE Aviation and Rolls-Royce have an opportunity to capitalize on their position if their respective engines perform as expected.

Outlook

The overall outlook for the global jet engine market is for increasing cooperation across manufacturers, resulting in more joint ventures and, in the case of EU-based/Euro-denominated manufacturers, production shifts towards lower-cost, dollar-denominated countries.

The prevalence of joint ventures in the aircraft engine industry will continue. As mentioned previously, aside from a few large manufacturers, the industry is comprised of a number of joint ventures amongst the large manufacturers and smaller competitors. New mergers like the PowerJet venture between Russian manufacturer NPO Saturn JSC and Snecma Moteurs of France will continue to form as the next generation of narrow-body aircraft come online, augment and ultimately replace existing aircraft. In addition, P&W will use its own joint venture channel to market its PW1000G engine through membership in IAE. German manufacturer (and fellow IAE member) MTU is working closely with P&W on product testing.[58] P&W is also looking to add additional partners to the team developing the PW1000G engine. Most recently, P&W signed an agreement with Volvo Aero in July, 2008 to assist in turbine and exhaust case design.[59]

Another emerging trend relates to sales of Airbus aircraft. Anecdotal evidence from various U.S. engine manufacturers indicates that Airbus has begun linking aircraft sales to engine selection. More specifically, Airbus has begun to rely on a "package" of Airbus aircraft and Rolls-Royce engines. The package price is contingent on the end-user/customer selecting Rolls-Royce engines in conjunction with the Airbus aircraft at the time of purchase. Previously, engine selections were not typically linked to the aircraft selection and purchase, and the customer was free to make the engine selection on factors such as acquisition cost, fuel efficiency, MRO availability and life-cycle costs. Generally, Rolls-Royce's aircraft engine sales proposals focus more on acquisition cost and less on the downstream expenses involved with MRO and overall life cycle. Therefore, an EU aircraft and engine pair (e.g. Airbus/Rolls-Royce) provides the pair with bargaining leverage, both from a country-of-origin and acquisition cost perspective. Although the same opportunity may exist for packaging U.S.- made aircraft and engines together, this trend will almost certainly prove more challenging to U.S. engine manufacturers, as U.S. engine manufacturers are much more focused on the downstream cost benefits of their engines and typically do not compete solely on an acquisition cost basis.

[57] "June first flight anticipated for P&W geared turbofan" available at http://www.ainonline.com/news/single-news-page/article/june-first-flight-anticipated-for-pw-geared-turbofan/?no_cache=1&cHash=9c3cb80990

[58]" Pratt & Whitney Begins Final Assembly of Geared Turbofan Demonstrator Engine" available at http://www.pratt-whitney.com/vgn-ext-templating/v/index.jsp?vgnextoid=2e35288d1c83c010VgnVCM1000000881000aRCRD&prid=fb5988c63af33110VgnVCM100000c45a529f____

[59] "Volvo Aero signs deal with Pratt & Whitney" available at http://www.neurope.eu/articles/88938.php

Notable Developments

The most notable development that could influence the global jet aircraft engine industry is the creation of an open joint stock company by the Russian Federation consolidating many of the state-owned aerospace companies under a single entity. This consolidated entity, the United Aircraft Corporation (UAC), has moved quickly to transform and revitalize the Russian aviation industry and has positioned itself as both a formidable competitor and potential partner in the global aviation market. Partnerships such as the PowerJet joint venture, as well as future cooperation between the United States, EU and UAC on development of next generation civil aircraft will certainly open up new business opportunities for the aircraft engine industry.

Over the longer term, development of a Chinese large civil aircraft industry will certainly have an impact on the global aircraft engine business. Chinese aviation industry and government officials have stated that they plan to produce an indigenously designed and manufactured civil aircraft by 2020 that will be powered by Chinese-designed and -produced engines. The Chinese do not currently produce a suitable engine in the size and thrust range for an LCA application, so the possibility exists for collaboration and/or joint ventures similar to those described above.[60]

Aside from ascendancy of competitors outside the United States and EU, the most significant development with potentially long-term impact is monetary in nature. Although the U.S. dollar has strengthened against the British pound in the last several months, the general downward trend of the dollar against the pound and the euro has compelled Rolls-Royce to shift its industrial base away from the United Kingdom to lower-cost, dollar-denominated markets. On the effect of a weaker dollar on Rolls-Royce's manufacturing, CEO Sir John Rose noted:

> "Ninety per cent of our revenue comes from outside the UK, and the manufacturing balance will continue to move that way... Over time we will increasingly ensure that our supply chain is either dollarized or low-cost so that we can get a hedge against the dollar." [61]

Although Rolls-Royce has not announced any specific plans with regard to production shifts or plants closings, the move toward dollar-based production is already in progress. Aside from probable job loss in the United Kingdom due to plant closings, the more important impact of the shift is that it will make Rolls-Royce products increasingly price competitive against U.S. manufactured engines and less exposed to currency fluctuations.

[60] "China to develop large commercial aircraft by 2020" available at http://www.iht.com/articles/2007/03/12/business/jet.php

[61] "Rolls-Royce to shift production away from Britain" available at http://findarticles.com/p/articles/mi_qn4158/is_20080208/ai_n21280488?tag=content;col1

Unmanned Aircraft Systems (UAS)

Unmanned Aircraft Systems (UAS) are air vehicles and associated equipment that do not carry a human operator, but instead fly autonomously, or are remotely piloted. UAS must be considered in a systems context (Figure 1). A UAS "system" includes the remote human operator(s), a command, control and communications (C3) system as well as the air vehicle, or multiple vehicles.

There currently is no widely accepted common classification system for UAS vehicles or systems due to the wide variety of capabilities, size, and operating characteristics of different systems. Most UAS are described in terms of weight, endurance, purpose of use, and altitude of operation. For the purposes of this report, broad categories and uses are as follows[62]:

Name	**Altitude**	**Typical flight duration**	**Typical Uses**
High Altitude	Over 60,000 ft (above class A airspace)	Days/weeks	Surveillance, data gathering, signal relay
Medium Altitude	18,000 – 60,000 ft (class A airspace)	Days/weeks	Surveillance, cargo transportation
Low Altitude	Up to 18,000 ft (class E airspace)	Up to 2 days	Surveillance, data gathering
Very Low Altitude	Below 1,000 ft	A few hours	Reconnaissance, inspection, surveillance

[62] Ibid.

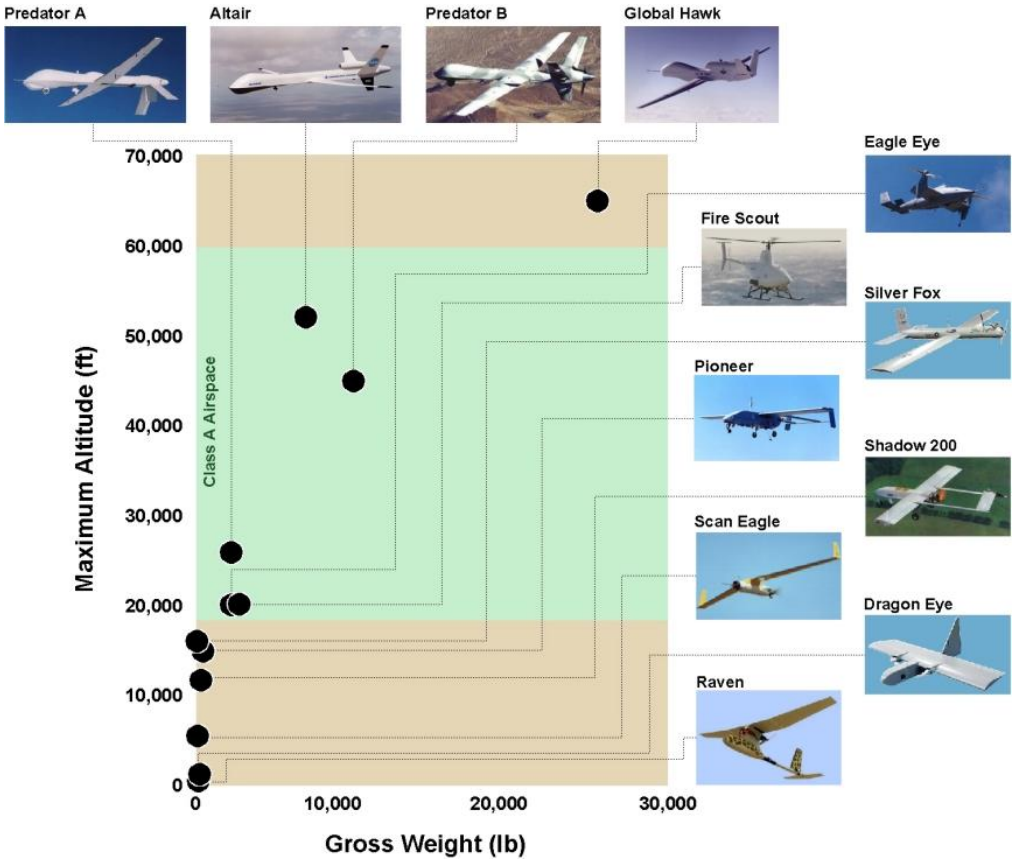


Figure 1. Current U.S. Operational UAS[63]

Market Trends

Almost all UAS operations and vehicles around the world today are for military purposes. The absence of standards, regulations and procedures to govern the safe integration of civil-use UASs into civilian air space are key factors limiting growth in the non-military UAS sector. Existing military UAS manufacturers likely will dominate civil-use UAS markets in the near-term if they are able to leverage their capabilities and technologies in the adaptation of existing platforms or development of new systems for civil purposes. However, they will likely face stiff competition from new entrants to the market in the long run.

Military

The U.S. Department of Defense (DOD) continues to lead the development, ownership, and operation of UAS globally. As of May, 2008, DOD had more than 6,000 unmanned aircraft in

[63] "The Impact of Unmanned Aerial Vehicles on the Next Generation Air Transportation System: Preliminary Assessment", Unmanned Aerial Vehicle National Task Force, October 22, 2004

its inventory, compared to fewer than 50 in 2000. The majority of these aircraft are currently being used in support of ongoing operations overseas and range in size from small, handheld UAS to large units similar in size to manned general aviation aircraft.[64] In particular, smaller, shorter range UAS have seen dramatic usage increases. Today's operational military UAS encompass a wide range of sizes, gross weights, speeds, and operating altitudes (Figure 2). The smallest operational UAS is the four-pound Raven that flies for about an hour at 50 knots and normally below 1000 feet. The largest is the Global Hawk, which weighs 25,600 pounds, and flies at 400 knots for over 30 hours at 65,000 feet.

In recognition of the broad use of unmanned, ground and maritime systems and the need to facilitate the integration among platforms as well as with manned systems, DOD released the first integrated "Unmanned Systems Roadmap 2007-2032" (Roadmap) in December 2007.[65] For the first time, this roadmap identifies a DOD-wide vision for all unmanned systems, identifying critical capabilities, obstacles and priorities for the next 25 years. In November, 2008 the General Accounting Office released a report on the effectiveness of DOD efforts to integrate UAS operations department-wide, including the Roadmap. The report recommended DOD

1. Designate a single entity accountable for integrating efforts related to UAS;
2. Define roles, responsibilities, and relationships among UAS-related entities; and
3. Develop a UAS strategic plan to align and integrate efforts and funding with long-term goals.

DOD partially concurred with the GAO recommendation 2 and did not concur on the other recommendations, claiming that actions to date had already addressed these issues.[66] Despite this difference in opinion between GAO and DOD, DOD continues to move forward in implementing the Roadmap.

The DOD Quadrennial Defense Review, released in February, 2006, called for increased reliance on UAS by nearly doubling the DOD UAS capacity, and tasking a rationalization of UAS development and use among the armed services. The QDR called for 45 per cent of future Air Force long-range strike capability to be met by unmanned systems. In addition, the QDR called for establishment of a UAS squadron under the U.S. Special Operations Command (SOCOM) in Fiscal Year 2007. This recommendation became a reality in October, 2007 with the activation of

[64] "Unmanned Aircraft Systems: Federal Actions Needed to Ensure Safety and Expand Their Potential Uses within the National Airspace System – GAO-08-511, May 15, 2008, p. 1. Available at http://www.gao.gov/new.items/d08511.pdf

[65] http://www.acq.osd.mil/usd/Unmanned%20Systems%20Roadmap.2007-2032.pdf

[66] Unmanned Aircraft Systems: Additional Actions Needed to Improve Management and Integration of DOD Efforts to Support Warfighter Needs - GAO-09-175, November 14, 2008, p. 1.

the 27th Special Operations Wing and reassignment of the 3rd Special Operation Squadron to the Wing. The 3rd SOS operates the MQ-1B Predator UAV.[67]

Most governments around the world are seeking to integrate UAS capabilities into their defense forces, either through acquisition of foreign systems or through development of indigenous systems. Many coalition forces are using UASs in Iraq and Afghanistan, as well as in security operations around the world.

For instance, Israeli manufacturers have influenced UAS development programs around the world, entering into industrial partnerships, and marketing and co-production agreements. Elbit Systems' Silver Arrow subsidiary is currently the Israeli Defense Force's principal supplier of UAS with the Hermes family of vehicles, and has worldwide business relationships. Israel Aircraft Industries' Malat division (IAI-Malat) has produced a broad range of UASs including the Searcher, Heron and Hunter lines.

According to the Association for Unmanned Vehicle Systems International (AUVSI), the European UAS market is expected to be worth around $6.8 billion within the next four years, providing the world's second largest market for UAS and unmanned combat vehicles.[68] Although many European companies are developing indigenous capabilities and technologies, some have entered into joint agreements with U.S. companies to develop and/or build new and derivative aircraft. For example, European Aerospace Defense and Space (EADS) and Northrop Grumman established a joint venture to develop the Euro Hawk, a derivative of the Global Hawk.

Civil

There is large potential for civil applications by private and public entities, ranging from surveillance and reconnaissance to scientific data gathering or delivery of services (crop dusting, telecom relays, etc.) However, the absence of standards, regulations and procedures to govern the safe integration of civil-use UAS into civil airspace are key factors limiting growth in the non-military UAS sector. As a result, most civil operations of UAS in 2008 were related to test or demonstration flights.

The FAA has imposed strict limitations on UAS operations in the national air space (NAS) until sufficient standards and regulations can be developed. In February 2007, the FAA published policy guidance to clarify exactly which authorities exist for UAS operations in the NAS.[69] At the same time the FAA continued work to develop domestic certification regulations that will address all relevant technology, policy, regulatory and infrastructure issues necessary to safely integrate UAS into the NAS. The Unmanned Aircraft Program Office (AIR-160), responsible for coordinating all FAA certification and operational policy activities related to UAS, is expected to publish a UAS roadmap to clarify the path toward normal certification and operation

[67] 3rd Special Operations Squadron Fact Sheet, available at http://www.cannon.af.mil/library/factsheets/factsheet.asp?id=12751

[68] Unmanned Aerial Vehicle Market Brief, U.S. Commercial Service-Germany, March 21, 2005; http://www.buyusainfo.net/docs/x_2891343.pdf

[69] *Federal Register*: February 13, 2007 (Volume 72, Number 29), Rules and Regulations, Pages 6689-6690; available at http://www.gpoaccess.gov/fr/retrieve.html .

of UASs in the NAS. Publication of the roadmap is delayed awaiting FAA management review and approval.[70] In the interim, civil UAS certification is granted by the FAA through AIR-160 under a special airworthiness certificate (experimental category) for operation within specifically prescribed areas. For public operation, UAS certification is granted under a Certificate of Authorization (COA) or Waiver.[71]

Current access to national air space in the United States is predominately granted through special COAs issued by the FAA for public UAS operation. Even under a COA, UAS operations are granted only for specific times, locations and operations. The number of COAs issued by the FAA has grown significantly in recent years, reflecting growing demand by military and civil users. Fifty-four COAs were issued in 2005, and this number averaged 80-100 per year from 2006-2008.[72],[73] UAS also may be operated in restricted airspace. In July 2007, the FAA introduced an on-line COA application system for federal users to reduce processing and approval time for COA applications.

Competitors

The U.S. UAS industry is undergoing a major transition. Unlike a decade ago, almost all major U.S. aerospace prime contractors are involved in UAS programs and are expected to remain working on UAS for the foreseeable future. Numerous small and mid-sized companies also entered the market in the 1990s. Some small companies failed or withdrew from the UAS market, others were acquired (part of the industry consolidation), and a few new companies entered the market. Industry consolidation is expected to continue for the next several years.

U.S. manufacturers are a mix of public and privately owned companies. Five of the twelve U.S. manufacturers of UAS that have operated in Operation Iraqi Freedom and/or with systems that have received experimental civil certification from the FAA are part of publicly traded corporations (AAI Corporation was acquired by Textron, Inc. in December 2007.) For each of the publicly traded companies, UAS development, manufacture and operation make up a relatively small percentage of overall corporate revenues. Most privately held U.S. UAS manufacturers are not widely diversified out of this market segment, although they may produce a variety of UAS. A number of U.S. manufacturers have established partnerships with non-U.S. companies to strengthen their market presence and to supply UASs to the U.S. military. In addition, some foreign companies have established subsidiaries in the United States.

Given the wide range of UAS companies in the United States and abroad, the absence of a measurable civil-use UAS market today, and the prevalence of international partnerships to develop, manufacture and operate UAS, a comprehensive assessment of competitors in the civil-use UAS market is extremely difficult. There are a number of publicly available, authoritative studies by other federal agencies and private organizations about the military UAS manufacturing industry, which provide details about the military UAS market structure and

[70] http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/air/hq/engineering/uapo/map/
[71] http://www.faa.gov/aircraft/air_cert/design_approvals/uas/cert/
[72] Remarks by Tony Ferrante, Director for Air Traffic Safety Oversight Service, Federal Aviation Administration, at AUVSI Unmanned Air Systems Program Review, February 9, 2007.
[73] www.faa.gov/news/conferences_events/2008_eu_us_conference/media/FAA_EASA_Join_UAS_FINAL.ppt

competition.

Accordingly, the following listing of companies is intended only to provide a representative snapshot of the UAS industry through 2008. The following U.S. companies manufacture UAS currently in use in Operation Iraqi Freedom (excluding very small "micro/mini" UASs) and/or have been granted experimental airworthiness certification by the FAA.

Table 2. U.S. UAS Manufacturers*

Company	**Products**	**2008 Revenue (thousands)**	**2008 Income (thousands)**	**2008-2007 % Change in Income**
Advanced Composite Research	Silver Fox, Manta	N/A		
Aerovironment	Raven, Pointer, Dragon Eye	N/A		
Aurora Flight Sciences	GE-50*	N/A		
Cyber Defense Systems Inc.	CyberBug*	N/A		
General Atomics	Predator*, Altair, Sky Warrior*	N/A		
Honeywell	gMAV*	$36,556	$2,792	14.24%
Insitu	Scan Eagle, GeoRanger	N/A		
Lockheed Martin	Desert Hawk	$42,731	$3,217	6.07%
Northrop Grumman	Global Hawk, Fire Scout	$33,887	($1,262)	(58.65%)
Raytheon	Cobra*	$23,174	$1,672	(35.14%)
Textron	Bell Eagle Eye*, AAI Shadow*	$14,246	$486	(47.00%)
Telford Aviation	SkyBus 30K*	N/A		

* Has received some sort of civil experimental airworthiness certification

Most other countries also do not have civil certification regulations that permit the operation of non-military UAS in civil air space. However, extensive civil-use UAS operations exist in Japan, where there is widespread use of unmanned rotorcraft for agricultural uses (primarily spraying). In 2005, there were an estimated 2,000 unmanned helicopters and over 8,000 certified UAS operators in Japan, compared to a total of 730 non-government-operated manned helicopters and 3,600 professional helicopter pilots. Yamaha Motors Company currently supplies over 60 percent of the Japanese market for unmanned agricultural spraying applications. Yanmar Agricultural Equipment Co., Kawada Industries, Inc. and Fuji Heavy Industries share the rest of the market.[74]

Outlook

In 2009, military use of unmanned systems is expected to grow as new systems are fielded and new capabilities are tested. The U.S. military is seeking new UAS capabilities to enable new war-fighting doctrines and operations. DOD is seeking improved payload capabilities, adding the number and types of sensors available on different platforms. For example, they are pursuing new operational capabilities such as autonomous mission operations, multi-vehicle systems and aerial refueling, as well as increased modularity to enable "plug-and-play" systems and maintenance. They also are evaluating options for weaponized unmanned combat air vehicles (UCAV) as force multipliers for fighter and bomber aircraft. Previous year estimates of growth across all sizes and classes may be impacted by current economic conditions. Absolute growth in UAS numbers notwithstanding, small UAS likely will see the greatest increase in use in 2009 as more systems are deployed in active combat at the unit level.

U.S. federal agencies plan to expand their use of non-military UAS as well in 2008:

- NOAA established three UAS test centers in 2008 to further explore opportunities to use unmanned systems.
- NASA will conduct further tests with existing systems and prepare to initiate flight tests with newly acquired Global Hawks in 2009.
- DHS will take delivery of a fourth UAS for border patrol activities, and continue to use
- Various law enforcement agencies will continue additional demonstration tests.

The FAA has initiated development of special regulations to govern operation of small, low-flying UAS within visual line-of-sight that are used for commercial purposes. Such guidance could enable small UAS users to initiate or continue operations that do not present a safety threat to the public or to other aircraft prior to the finalization of complete certification regulations for all classes of UASs. These special regulations are not likely to be issued until at least 2010.

At the same time, FAA will continue to develop standards and policies for all UAS systems, drawing on technical recommendations from RTCA Special Committee-203[75], coordination with other civil aviation authorities directly and through the International Civil Aviation Organization (ICAO), and interagency collaboration as a member of the Department of Defense Joint

[74] "UAV Systems: The Global Perspective 2005", UVS International
[75] http://www.rtca.org/comm/Committee.cfm?id=45

Integrated Product Team (JIPT) for UAS. However, little appreciable increase in UAS operations will occur in the United States in 2009, based on the cumulative number of experimental airworthiness certifications estimated by the FAA to date.

Given the rapid growth of UAS operations for governmental purposes, there appears to be tremendous potential for U.S. industry in the evolving commercial UAS sector. However, it is extremely difficult to determine actual commercial market size in light of the many regulatory and technological obstacles to be overcome before UAS can be integrated into civilian air space. Various studies have been conducted regarding the future market opportunities for civil UAS sales worldwide. Many analysts are bullish on market growth, although there is wide variance in views about the actual market size, ranging from a healthy 10-15 percent per year to order of magnitude growth in civil market opportunities. According to the Teal Group, a Virginia-based aerospace and defense market analysis firm, the resolution of UAS airspace issues will likely slow the growth of the global civil UAS market for the next several years. Until then, the civil UAS market will be concentrated around government organizations requiring surveillance systems similar to military UAS, such as coast guards, border patrol organizations and similar national security organizations. Once the airspace issues are resolved, a commercial, non-governmental UAS market should then emerge.[76]

[76] http://www.tealgroup.com/component/option,com_docman/task,doc_view/gid,24/

Maintenance, Repair, and Overhaul

Aircraft maintenance, repair and overhaul (MRO) has become somewhat controversial over the past several years, as the FAA's ability to oversee repair stations has come under scrutiny from Congress and the media. The issue of contract maintenance has become particularly contentious, with airline union representatives claiming that the use of non-airline maintenance facilities poses a risk to the safety and security of U.S. aircraft. Though use of contract maintenance is clearly on the rise, most of the work is contracted to firms in the United States rather than to foreign firms. Some industry analysts believe that rising global labor costs may ease pressure to outsource maintenance to lower wage regions.

Major Airframe MRO Providers, by man-hours, 2006[77]

1. Singapore Technologies Aerospace	8.10 million
2. Lufthansa Technik	6.80 million
3. Air France Industries/KLM E&M	6.40 million
4. HAECO/TAECO/STAECO	5.88 million
5. TIMCO Aviation Services	3.90 million
6. Bedek Aircraft/Empire Aero	3.30 million
6. VEM/TAP M&E	3.30 million
8. Goodrich Aviation Technical Services	2.70 million
9. ACTS	2.40 million
10. AAR Aircraft Services	1.98 million

Market Trends

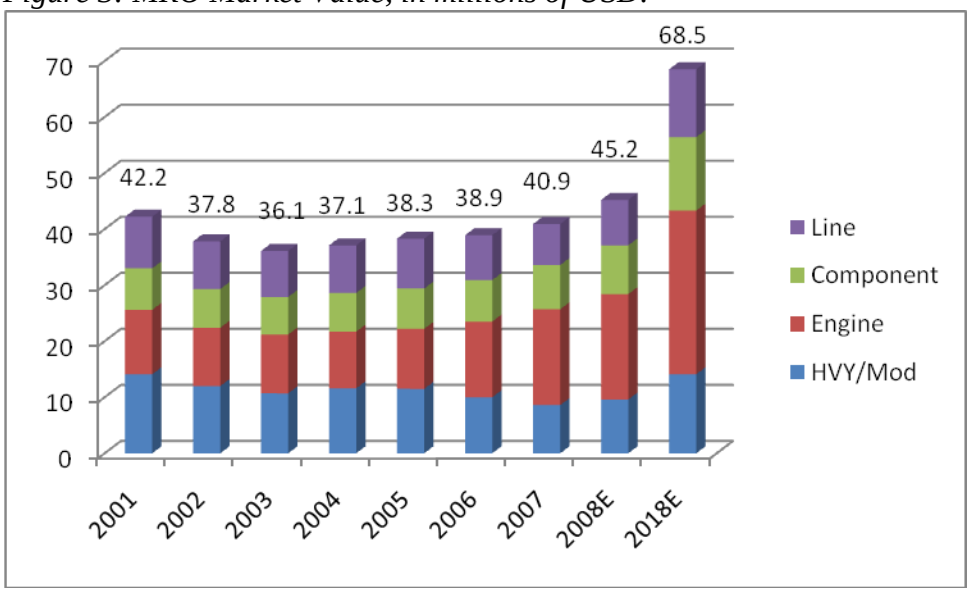
The global market value of MRO services has been slowly growing since 2004 and has recently recovered to pre-9/11 levels (see figure 1, next page). Changes in fleet composition, labor costs, and customer demand have led to a general decrease in the cost of maintenance services and the time required to perform maintenance. For example, although the global fleet size has increased, the introduction of new aircraft with more composite parts has decreased the amount of maintenance work required. This, combined with the retirement of older aircraft, helped lower overall maintenance costs.[78]

In addition, industry pressure to increase efficiency in the MRO process has led firms to make organizational changes that have reduced the time required as well as cost of repairs. Finally, pressure to reduce labor costs contributed to a shrinking market (in terms of expenditures) for

[77] Lee Ann Tegtmeier. "Top 10 Airframe MRO Providers." Overhaul and Maintenance. June 13, 2007.
[78] David Marcontell, TeamSAI. "Engine MRO Industry Growth." Presentation at the Aero-Engine Cost Management Conference, Hollywood, FL. February 6, 2006.

MRO services as firms sought lower-wage options. However, rising wages overseas, a weakening dollar, and a general shortage of mechanics has begun to reverse this trend.[79]

Figure 3: MRO Market Value, in millions of USD.[80]



MRO firms fall into three main categories: Original Equipment Manufacturers (OEMs), airlines, and independent contractors. For years, a majority of maintenance work was completed by the first two categories of firms—OEMs would negotiate maintenance and overhaul arrangements as part of sales packages, and the airlines employed significant staff to conduct everything from daily line maintenance to major airframe overhauls. Over the past decade, the rise of low-cost carriers and general industry pressure to decrease costs has led to the rise of maintenance outsourcing. Outsourcing in this context means that the work is not performed by airlines or OEMs and is not synonymous with off-shoring. According to the Department of Transportation (DOT), U.S. airlines outsourced 64 percent of their maintenance in 2007, as compared to 37 percent in 1996.[81] DOT also found that 27 percent of U.S. heavy airframe maintenance was performed outside the United States.

Backlash against outsourcing has become politically charged over the last several years, as labor unions working for in-house airline MRO facilities are alleging increased risks to safety from outsourced MRO. Maintenance, and component maintenance in particular, has always been completed by independent repair stations, but an increasing number of airlines are now

[79] Frank Jackman. "MRO Spending: Unit Costs to Rise Sharply." Overhaul and Maintenance. April 2008.
[80] Christopher Doan. TeamSAI. "The Global MRO Forecast-A Look Forward 2008-2018." Available on the web at http://www.teamsai.com/newsfiles/2008_TeamSAI_Global_MRO_Forecast_FINAL_080416.pdf.
[81] Department of Transportation, Office of the Inspector General. Memorandum dated September 30, 2008. Includes data for 9 major U.S. airlines (AirTran, Alaska Airways, America West, Continental, Delta, Jet Blue, Northwest, Southwest, and United).

outsourcing heavy maintenance (71 percent in 2007 as compared to 34 percent in 2003).[82] Though the unions include all independent repair stations in their critique, they specifically criticize foreign facilities, citing inexperience and language barriers as contributing to risk. The labor unions and FAA safety inspectors' union believe that there is inadequate oversight of outsourced repair work, both on the part of the airline, which is ultimately responsible for assuring the safety of its own aircraft, and the FAA, which some believe lacks the resources to adequately monitor foreign facilities. Supporters of outsourced MRO argue that improved oversight, including more vigorous vetting of facilities and a physical presence by airline maintenance experts, would go a long way towards addressing any risks.

Outlook

Over the next decade, North American demand for MRO services is expected to decline and experience a lower rate of growth than other regions. According to aviation business consultants TeamSAI and Ascend, the ten-year compound annual growth rate for MRO demand in North America will be 1.8 percent, while the rates for Eastern Europe, South America, and Asia-Pacific (excluding China and India) are 10.5 percent, 7.0 percent, and 6.4 percent, respectively.[83] Demand growth rates in India (11.5 percent) and China (6.8 percent) are also quite high. These projections reflect the overall expansion of the aviation industry in both of these countries—Boeing expects India to acquire 380 new aircraft by 2025[84] and China to acquire about 2,600 new aircraft in that timeframe.[85]

On the supply side, MRO capacity in Asia is likely to grow, as companies set up new facilities catering to fleet expansion. A significant number of western companies have MRO joint ventures in the region, in part to facilitate growth in the region or to protect market share. Boeing, Sabena Technics, and Lufthansa Technik have all invested in facilities in India, and Boeing, Lufthansa Technik, SR Technics, and Air France/KLM have invested in facilities in China. In addition, western engine manufacturers have facilities throughout the region.[86] Firms from Singapore, a longstanding hub for MRO in Asia, are also expanding their reach to other Asian markets, with SIA investing in India and ST Aerospace investing in China. Ninety percent of heavy maintenance on Asian fleets is performed in Asia[87], and Asia is a net exporter of airframe maintenance services.[88]

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[82] Ibid.
[83] Jackman. "MRO Market is Up and Down." *Overhaul and Maintenance.* April 2007.
[84] U.S. Commercial Service. "Air and Air Parts." Market Research Report. August 31, 2005. Available on the web at: http://www.buyusainfo.net/docs/x_4342293.pdf .
[85] The Boeing Company. "2005 Current Market Outlook." p. 28. Available on the web at: http://www.boeing.com/commercial/cmo/index.shtml .
[86] Jonathan M. Berger. "MRO Industry & Emerging Markets." Presentation at the 21st Annual Geneva International Aviation Forum, February 2007. Available on the web at: http://www.sh-e.com/presentations/berger_feb07.pdf.
[87] Marcontell. TeamSAI. "The Global MRO Forecast-A Look Forward 2007-2017." Presentation at Aviation Week's MRO Europe Conference. November, 2007. Available on the web at: http://www.teamsai.com/ November 2007.
[88] Kevin Michaels. AeroStrategy. "MRO Market Outlook—Forecast and Key Trends." Presentation at MRO Asia, September 2006.

It should be noted that demand for MRO services is directly related to the size of an operating aircraft fleet as well as the workload carried by that fleet. In the last two years, many carriers have declared bankruptcy, announced capacity cuts, or taken aircraft out of service. In mid-2008, TeamSAI issued a revised forecast figure for 2009, lowering the expected expenditure on MRO to $45.5 billion, down from $46.8 billion in 2008. Most of the projected expenditure reduction was due to capacity cuts in the United States.

Notable Developments

On October 31, 2008, a judge overseeing the bankruptcy of Frontier Airlines ruled that the airline could not outsource its heavy maintenance operations except as a last resort.[89] The judge also ruled that Frontier could set aside its agreement with the Teamsters Union. Frontier was considering outsourcing its heavy maintenance to MRO provider Aeroman in El Salvador. Aeroman also performs maintenance for JetBlue and US Airways.

[89] Aviation Today. Judge: "Frontier can Outsource Mx as last resort." November 3, 2008.

Airport Infrastructure/Aviation Security

The Airport Infrastructure and Aviation Security markets are experiencing rapid growth due to a number of factors. Steady air traffic growth across all regions, post-9/11 security concerns, and expected growth in the next 20 years are major contributors to this surge. Worldwide airport capital expenditures grew from $40 billion in 2007 to $50 billion in 2008.[90] Although constrained by local, state, and federal regulations, U.S. airports will need to expand capacity to meet future demand. Moreover, the evolving security needs both within the United States and throughout the world will ensure long-term viability of the market for aviation security technologies.

U.S. Infrastructure Manufacturers

Airport Infrastructure		**Aviation Security**	
Magnetic Automation Corp.	Parsons Transportation Group	Battelle SRS Technologies, Inc.	SRA International/Galaxy Security
Daktronics, Inc.	ESRI	TransCore	SecureScan
ARINC	URS Corporation	Raytheon/McNeil Security	ARINC (Verified Identity Pass/Clear)
Arconas	Airports Seating Alliance		
Penta Corporation	NEC Display Systems	Nabco, Inc.	Matrix Systems, Inc.
Vidtronix	Unimark, Inc.	URS Corporation	Zortek Systems
FMC Technologies, Inc.	Trident Computer Corp.	Honeywell Aerospace	UTC
Vaculex	Unisys	MITRE/CAASD	TransSecure, Inc.
FMC Technologies, Inc.	Dewbridge Airport Systems	I.D. Systems, Inc.	DefenderTech
Elgin Sweeper Company	Zortek Systems	Pure Tech Systems	ICx Technologies
Tymco International, LTD.	Oshkosh Truck Corporation	GE Security	Privaris
Global Ground Support, LLC	Vanderlande Industries	American Science and Engineering, Inc.	L-3 Communications, Security and Detection Systems, Inc.
All Weather Inc.	Bradford Airport Logistics		
	NBP Corporation		

[90] Airports Council International. "New Airport Economics 2008 Report." Press Release. December 23, 2008.

Market Trends

Both industry and government analysts predict and are preparing for significant increases in demands on the commercial air transportation system. Through the auspices of the Joint Planning and Development Office (JPDO)[91], the USG is working on a multi-agency basis to develop policy and technology roadmaps that will support up to a tripling of air traffic by 2025. Privately owned airports and aviation infrastructure manufacturers are participating in this effort, both independently and in partnership with the JPDO through the NextGen Institute.

Airport Infrastructure

Large numbers of new airports throughout Europe and Asia are "either planned or under construction to accommodate global air traffic, which is expected to double by 2020."[92] Some analysts expect China alone to build up to 50 new airports in the next decade.[93] Furthermore, existing airports continue to renovate and expand in order to handle future increases in passengers and cargo traffic as well as larger aircraft such as the Airbus A380. In the United States, construction of new airports and expansion of existing airports must take into account local, state, and federal regulations (managed by entities such as the FAA, the Environmental Protection Agency, and the Transportation Security Agency) as well as standards and strictures issued by the International Civil Aviation Organization (ICAO). That being said, the JPDO and U.S. airports continue to develop plans for new construction, airport expansions, and modernization initiatives that will in turn create numerous opportunities for manufacturers of airport infrastructure equipment and technologies. From landside passenger services (e.g., check-in and baggage handling) to cargo operations (such as inter-modal transfers and just-in-time delivery to runways) to basic infrastructure (passenger terminal facilities, access control, information displays, and boarding bridges), the global business of building and maintaining airports could potentially be worth $400 billion a year.[94] This business is projected to grow at a rate of 9 percent a year over the next few years.[95]

The need for new and/or expanded airport capacity as well as current and potential job growth have, of course, been tempered by the effects of the global economic downturn. Preliminary 2008 traffic results show that, for the full year, worldwide passenger traffic remained flat while freight traffic decreased.[96] Despite the downturn in passenger and freight traffic, according to Airports Council International and the Air Transport Action Group, 4.3 million persons were employed on airport sites worldwide in 2008.[97] In 2007, Amsterdam's Schiphol Airport alone

[91] The JPDO was established through the enactment of the 2003 VISION 100 — Century of Aviation Reauthorization Act [P.L. 108-176] in order to oversee the development of the Next Generation Air Transportation System (NextGen).
[92] Kevin Brass. "Dubai turns focus to airports." *International Herald Tribune*. March 29, 2006.
[93] *Ibid.*
[94] *Ibid.*
[95] *Ibid.*
[96] Airports Council International. "Global Airport Traffic Undercut by World Economic Turmoil." Press Release. January 30, 2009.
[97] Airports Council International. "New Airport Economics 2008 Report." Press Release. December 23, 2008.

employed approximately 61,691 people on its grounds each day.[98] This effect is further multiplied by the evolution of the "aerotropolis" in which international airports increasingly serve as magnets for commercial development and combine office, retail, entertainment facilities, and even some housing with airports to create "airport cities".[99] In fact, many of the largest airports derive up to 50 percent of their revenue from non-aviation sources, such as shopping areas and restaurants.[100]

Given this new status as economic catalysts, existing airports (or "aerotropoli") will need to build new capacity both to meet the expected growth in passenger and cargo traffic and to maintain economic momentum. To do so, airports, airport infrastructure manufacturers, and government entities such as the JPDO are working to remove regulatory and political obstacles to building new capacity. This effort is necessary to avoid severe congestion that could restrict the economic dynamism of airports by suppressing trade, investment, and traffic flows.[101]

Aviation Security

In the post-9/11 air transportation system, the aviation security paradigm continues to evolve. In fact, security concerns, though hardly an afterthought in the past, have become an even more essential part of airport and aviation operations. The 1988 terrorist bombing of Pan Am Flight 103 and the explosion of TWA Flight 800 in 1996 contributed to the creation of the White House Commission on Aviation Safety and Security headed by Vice President Gore (Gore Commission).[102] The Gore Commission presented a number of recommendations to enhance security at U.S. airports in its initial report to President Clinton in September 1996, as well as in its final report in February 1997.[103]

The Bush Administration produced a number of plans, including the Transportation Security Operational Plan, the National Infrastructure Protection Plan, and the National Strategy for Transportation Security, to address various aspects of transportation security. Most recently, the Bush Administration drafted a National Strategy for Aviation Security (NSAS).[104] Within the NSAS, a supporting plan regarding the Aviation Transportation Security System was created to help manage the development and implementation of new and improved security measures

[98] Dutch News.nl. "More Jobs at Schiphol." February 5, 2007. Available on the web at http://www.dutchnews.nl/news/archives/2007/02/more_jobs_at_schiphol.php

[99] Urban Land Institute. "Will the 'Aerotropolis' Replace the Metropolis? In Today's Real Estate Environment, Easy In-Easy Out is Key Factor." November 7, 2002. Available on the web at http://www.uli.org/AM/Template.cfm?Section=Home&CONTENTID=21387&TEMPLATE=/CM/ContentDisplay.cfm

[100] Kevin Brass. "Dubai turns focus to airports." *International Herald Tribune*. March 29, 2006.

[101] Airports Council International. "Airports Stimulate Employment and Economic Growth." Press Release. April 11, 2006.

[102] Statement of Keith O. Fultz, Assistant Comptroller General, GAO, before the House Committee on Science. "AVIATION SECURITY—Technology's Role in Addressing Vulnerabilities." September 19, 1996. Available on the web at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=gao&docid=f:rc96262t.pdf

[103] White House Commission on Aviation Safety and Security. "Final Report to President Clinton." February 12, 1997. Available on the web at http://www.fas.org/irp/threat/212fin~1.html

[104] National Security Presidential Directive 47/Homeland Security Presidential Directive 16 (NSPD-47/HSPD-16). Available on the web at http://www.dhs.gov/xprevprot/laws/gc_1173113497603.shtm

throughout U.S. airports and the National Air Space (NAS). Moreover, the Airports and Security Integrated Product Teams of the JPDO partnered with industry and worked with the governmental agencies involved in drafting the NSAS. This partnership ensured that costs, efficiencies, economic impact, and the changing nature of air transportation (e.g., the expected increases in air traffic) were considered and reflected in the Strategy.

In conjunction with the drafting of the Strategy and Plans, the aviation security industry has moved forward with a number of possible solutions and technologies. These new technologies will address both security concerns and the need to reduce congestion (and thus not interfere with the business of airports and aviation transportation). For instance, a number of U.S. airports are participating in pilot "Registered Traveler" (RT) programs. RT programs grant frequent air travelers, who have subscribed to the program and submitted to background checks, the opportunity to use expedited check-in and security services.[105] These pilot programs provide airports and security technology manufacturers with a means of testing various identification and screening technologies, such as biometrics, radio frequency identification (RFID), and prototype explosives/baggage screening devices. Ideally, expanding usage of RT programs would reduce the burden on non-RT screening positions within airports and thus reduce congestion. The goal of RT and other initiatives is to minimize the security impact on the stream of safe commerce while developing and maintaining a layered and adaptive aviation security system.

Outlook

The market for airport infrastructure and aviation security products will continue to expand in the foreseeable future as plans for implementing the Next Generation Air Transportation System and the NSAS go forward. Moreover, the expected growth in air traffic, the economic catalyst effect of large airports, and the demands of air travelers will pressure airports and vendors of infrastructure and security technologies to pursue greater efficiency.

While many of the world's airports have been government-owned enterprises, the paradigm is shifting towards commercially operated businesses, as is the case in the United States.[106] Current and planned new airports and expansion projects will therefore provide numerous opportunities for providers of airport infrastructure products. Granted, government-owned airports will continue to favor local or regional providers. Even so, the paradigm shift towards commercial operation as well as current government-to-government negotiations regarding procurement indicate that opportunities will continue to expand.

U.S. providers of aviation security technology hold a leading position in the market. Almost all U.S. aviation security technologies are used internationally. Over the past 15 years, international visitors seeking security technology have averaged over 30 visits per year to the FAA/TSA/DHS Security Laboratory near Atlantic City, New Jersey. These visits have yielded numerous purchases of state-of-the-art U.S. security technology. The next generation of technologies will be smaller, faster, cheaper, and lighter and will be able to detect a greater array of threats. These

[105] ARINC. "Clearing the Way Through Airport Security." *ARINC Airport News*. Pg. 2. Issue Number 4. January 2006. Available on the web at http://www.arinc.com/news/newsletters/airportnews04.pdf

[106] Kevin Brass. "Dubai turns focus to airports." *International Herald Tribune*. March 29, 2006.

new systems will be more user-friendly and have less impact on civil liberties. Further, these new systems and technologies will be more adaptable to the airports in which they will be placed. In addition, harmonized security requirements will allow cohesive systems of passenger management, baggage handling, and cargo shipments to be built around available and future technologies.

Again, given the dynamic economic nature of airports and the demand that expected growth in air traffic will engender, the airport infrastructure and aviation security markets will continue to grow and expand as new airports and expansion projects are planned and implemented.

Environment

Many foreign countries are considering additional actions to limit the environmental impact of aviation, particularly with respect to Green House Gases (GHG). The International Civil Aviation Organization (ICAO), a 187-member country U.N. Specialized Agency, is the global forum for civil aviation. ICAO members work together to establish consensus-based standards and recommended practices to achieve sustainable development of civil aviation through cooperation. The Kyoto Protocol recognized ICAO's role as the principal forum for dealing with international aviation emissions, and ICAO established a strategic objective for environmental protection to minimize the adverse effect of global civil aviation on the environment. G-8 member countries have proposed inclusion of aviation in a post-Kyoto Protocol work program to address GHG emissions policies. However, some countries are considering unilateral measures to limit GHG emissions from aviation that may not be aligned with international consensus. The European Union proposes to include foreign airlines in the EU emissions trading scheme (ETS), a cap-and-trade system, in the absence of mutual consent from foreign governments. This proposal would be in violation of ICAO principles and could result in significant negative economic harm to U.S. airlines. A number of countries also are considering regulations related to the environmental impact of manufactured products, such as hazardous substances used in the manufacture of electronic components. Although European regulations in this area contain safety-related exemptions for aerospace equipment, other countries to date have not proposed similar exemptions, in spite of the absence of certified replacement materials suitable for aviation.

In addition to noise and emissions-related activities, a consortium of government agencies, academia, manufacturers and operators have established the Commercial Aviation Alternative Fuels Initiative (CAAFI). CAAFI is developing a roadmap for the development of non-petroleum based aviation fuels with the goal of enhancing energy security and environmental sustainability. Technical hurdles and high costs currently limit use of alternative fuels in aviation. South Africa is the only country that regularly uses non-petroleum based fuel in commercial aircraft, although limited quantities of alternative fuels are available. An objective of CAAFI is to identify key obstacles (R&D, safety certification, environmental impact and economic issues) to a viable commercial market for alternative aviation fuels.

Country Studies: India

India has stated a strong interest in the development of space technologies. The Indian Space Research Organization (ISRO) is the primary (government) vehicle for research and development, procurement and the provision of space-related services. ISRO built and operates the INSAT satellite system to provide television, meteorological, and telecommunications services. ISRO's Indian Remote Sensing (IRS) Satellite System provides satellite-imaging data for resource monitoring, infrastructure development, and exploration.

India has also developed two launch vehicles, the smaller PSLV rocket and the larger GSLV rocket, and is interested in partnering with foreign companies to expand its satellite technology. Once India enters the commercial launch market, India is likely to win an average of one launch per year, mainly through promotional pricing, package deals, partnership programs with Europe, etc.[107] Because of India's launch vehicles' limited capabilities and size, India likely will not gain a significant portion of the market in the short term. India will be able to enter the commercial market once it has signed two Memorandums of Understanding with the United States: one that oversees technology transfer and a commercial space launch trade agreement. By guaranteeing the protection of U.S. technology, these agreements will allow India to work with U.S. products, something that currently is prohibited.

India intends to expand its communications satellite production capabilities to capture some of the commercial market. The Indian Government has already manufactured several communications and remote sensing satellites for its own use. India is now actively seeking international customers. India is exploring joint ventures with U.S. and European companies to build communications satellites. The U.S.-India High Technology Cooperation Group (HTCG) is exploring areas in which cooperation in the space sector can be increased between the two countries. President Bush and Indian Prime Minister Vajpayee agreed in 2001 to establish the HTCG to spur cooperation in this sector and to address ways to increase trade in dual-use goods and technologies. Some areas likely to be considered in the future are space research and development, joint satellite production and the ability to launch U.S. satellites and/or components on Indian rockets.

In aviation, India expects to have significant demand for aircraft over the next twenty years. Domestic passenger traffic is expected to grow at 12.5 percent per year as the large and growing Indian middle class spends more money on air travel. To feed this growth, several new domestic airlines have been started in India over the past several years, most following the low-cost business model. These airlines helped fuel a buying binge starting in 2005, with Indian carriers ordering 327 new aircraft.[108] The expected growth in the Indian market has generated considerable competition amongst foreign firms. According to Boeing's Current Market Outlook 2008-2027, India will need approximately $86 billion worth of aircraft over the next 20

[107] "2007 Year in Review", Federal Aviation Administration, Office of Commercial Space Transportation, January, 2008.
[108] http://www.buyusainfo.net/docs/x_4342293.pdf

years.[109] Subsequent to the release of this report, Dinesh Keskar, Boeing's Senior Vice President for Commercial Aircraft Sales, revised this estimate upward to 1,001 aircraft worth $105 billion over the next twenty years. Mr. Keskar added that as long as the market fundamentals remain strong, this upturn should survive the current market downturn.[110]

Overall, India imports a majority of its aerospace products, with approximately 80 percent of aircraft and parts coming from foreign sources. Domestic production has largely centered on military aircraft, with the state-owned Hindustan Aeronautics Limited (HAL) anchoring the aerospace hub in Bangalore. In recent years, many of India's aircraft have been derived from foreign technology, particularly from the Soviet Union; the Light Combat Aircraft (LCA), which had its first flight in 2001, was the first indigenous fighter produced in India in nearly 40 years.[111] As it did in the IT sector, India is attempting to grow its domestic industry by promoting it as a low-cost outsourcing site. In addition, the Indian government imposes a minimum 30 percent offset requirement on all defense and state-owned enterprise civil aviation acquisitions valued over 300 crores ($61.8 million at current exchange rates).[112][113]

In response to complaints over a lack of transparency in the defense acquisition process, the Indian Ministry of Defense published the Defense Procurement Procedure 2006 (DPP) regulations in June 2006. The DPP provides comprehensive policy guidelines for all capital acquisitions for the Indian Armed Forces (IAF) to include Requests for Proposal (RFP), a notional schedule for the acquisition cycle, offset requirements, a list of acceptable Indian defense vendors for fulfilling offset requirements and a schedule of penalties for noncompliance with offset arrangements. The DPP therefore codifies not only the offset policy but the overall acquisition process. While India possesses significant market opportunities in both civil and defense aviation sectors, capitalizing on these opportunities requires millions of dollars of investment by foreign companies and strict adherence to the government's procurement procedures.

Perhaps the single most critical factor that could limit growth of the domestic aviation industry is infrastructure, as the current infrastructure is inadequate to address the needs of the growing system. Problems persist across the system—air traffic control equipment is old and unreliable, there is not enough space to park airplanes or store cargo, and there are not enough area control centers to provide complete coverage of the airspace. Indian government officials have launched several multibillion dollar programs over the last several years to address problems throughout the country. One of these programs, announced in 2004, would include $4 billion to upgrade the facilities at India's two main hubs, Mumbai and New Delhi along with $5 billion for 23 other non-metro airports.[114] A second program, announced in 2006, would invest $12.5 billion in

[109] http://www.boeing.com/commercial/news/2008/q1/080206c_nr.html
[110] http://www.financialexpress.com/news/boeing-ups-india-aircraft-order-forecast-by-10/339466/
[111] Sukumar R. Iyer. "LCA: Impact on Indian Defense." Bharat Rakshak Monitor. Vol 3(5) March-April 2001. http://www.bharat-rakshak.com/MONITOR/ISSUE3-5/sukumar.html
[112] http://mod.nic.in/dpm/dpp2006.pdf
[113] At an exchange rate of $1 = 48.58 rupees, which is the Federal Reserve Bank of New York spot exchange rate in effect on December 31, 2008 at 12:00 PM. Available at http://www.federalreserve.gov/releases/h10/Hist/dat00_in.txt
[114] See U.S. Commercial Service Market Research. http://www.buyusainfo.net/docs/x_866852.pdf

regional airports through 2009.[115] Most recently, the U.S-India Aviation Cooperation Program (ACP), a public-private partnership between the U.S. Trade and Development Agency (USTDA), the FAA and U.S. aviation companies, was established to provide a forum for unified communication between the Government of India and U.S. public and private sector entities in India. The ACP is designed to work directly with the Indian Government to identify and support India's civil aviation sector modernization priorities and serves as a mechanism through which Indian aviation sector officials can work with U.S. civil aviation representatives to highlight specific areas for technical cooperation.

[115] "India Pushes $12.5 billion Overhaul of Secondary Airports." *Aviation Daily.* February 24, 2006.

Country Studies: China

The People's Republic of China is investing significant resources to become a competitor in the civil aircraft industry. With its regional jet program in the flight testing phase, the Chinese are embarking on a new program to develop a 150 seat narrow-body aircraft that would compete with aircraft currently sold by Boeing and Airbus. The effort to create a competitive civil aircraft production program in China is in part motivated by growth in domestic demand for air transportation, which should generate demand for over 3,200 new aircraft by 2027.[116] Attempts to capitalize on this demand have led established manufacturers to engage Chinese manufacturers in various joint ventures while simultaneously eyeing the Chinese as future competitors.

In 2008, China undertook a major reorganization of its aerospace manufacturing enterprises. In May 2008, China established the Commercial Aircraft Corporation of China (COMAC) to oversee the development and production of large civil aircraft.[117] This new corporate entity also includes AVIC I Commercial Aircraft Co. Ltd. (ACAC), developer of China's first regional jet, the ARJ-21. In October 2008, the central government merged China's two large aerospace entities, AVIC I and AVIC II, creating one business unit with ten aerospace subsidiary companies.[118] The new company, which took the name AVIC, was formed from various pieces of the former AVIC family. AVIC is a partial shareholder of COMAC and ACAC. In late 2008 through early 2009, enterprises dedicated to aircraft engines, helicopters, composites, and general aviation were announced or rumored. A strategic agreement on specialized steel for the large civil aircraft was signed between Baosteel (China's largest steel producer and a COMAC shareholder) and COMAC in January 2009.

The ARJ21 regional jet project is near completion, though it has been delayed several times. The first ARJ21 rolled off of the assembly line in December 2007, but flight testing was delayed until November 2008. The first delivery is now expected to occur in 2010. COMAC hopes to sell 500 regional jets in 20 years and is interested in FAA certification to facilitate exports. The large passenger aircraft was first mentioned in China's 11th 5-Year plan, released in March 2006. The goal is to produce the plane for military and civil purposes by 2015, with entry into commercial service in 2020.[119] The aircraft will be assembled in Shanghai but, like the ARJ21, will have parts sourced globally.

Technological advancement of China's aviation industry has been directly related to cooperation and investment from international firms. On the one hand, western companies have sourced parts from China for several decades, including the recent move by Boeing to source the 787

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[116] Boeing Current Market Outlook 2008. p. 30. Available on the web at: http://www.boeing.com/commercial/cmo/pdf/Boeing_Current_Market_Outlook_2008_to_2027.pdf.

[117] enAvBuyer.com. "General Introduction of Commercial Aircraft Corporation of China, Ltd.." May 20, 2008. Available on the web at: http://www.avbuyer.com.cn/e/2008/24316.html.

[118] enAvBuyer.com. "China's new aviation giant targets 1 trln yuan revenues by 2017 – official." November 13, 2008. Available on the web at: http://www.avbuyer.com.cn/e/2008/30511.html.

[119] Peder Andersen. U.S. International Trade Commission. "China's Growing Market for Large Civil Aircraft." p. 12. http://www.usitc.gov/ind_econ_ana/research_ana/research_work_papers/documents/ChinaLCA2-14-2008final.pdf.

rudder from Chengdu Aircraft Industrial Corporation. On the other hand, non-Chinese firms have played a significant historical role in the development of aircraft by Chinese firms, up to and including the ARJ21. Many of China's early aircraft were based on Russian designs, though that cooperation stalled with the downturn of Russia's aviation industry. Later, U.S. and other western companies partnered with Chinese companies to incorporate western engines and components on Chinese aircraft. For example, starting in the late 1980s and into the early 1990s, Pratt & Whitney established joint ventures with Chinese firms to manufacture turboprop engines for several of China's Y-series transport aircraft. More recently, at least 19 U.S. and European aerospace companies have supplied major components on the ARJ21, including the engines (GE Aviation), avionics (Rockwell Collins), flight control systems (Honeywell, Parker Aerospace), and landing gear (Liebherr Aerospace).[120]

Western companies have also partnered with Chinese manufacturers to co-produce aircraft in China, though these programs have had mixed results. One of the most extensive U.S.-Chinese civil manufacturing partnerships was a program started in 1985 with McDonnell Douglas to assemble MD-82 aircraft in China. Thirty-five of these aircraft were produced, five of which were sold in the U.S. market.[121] In 1994, McDonnell Douglas finalized an agreement to coproduce MD-90s in China, but only three of the planned 40 aircraft were ever assembled, and the project was cancelled in 1998.[122] Plans announced in 1996 by Chinese and Airbus officials to jointly build a 100 seat "Asian Express" aircraft that would be added to the Airbus product line[123] never came to fruition. Despite this history, in October 2006 Airbus signed a "Framework Agreement" with a Chinese consortium to build an A320 aircraft in Tianjin, China, with production designed to serve the Chinese market. Airbus has scheduled the first test flight for a Tianjin-built A320 for May 2009.

For coproduction of regional jets, Chinese companies have found a willing international partner in Embraer. AVIC owns 49 percent of a joint venture with Embraer to manufacture, assemble, sell, and provide after-sales support for the ERJ 135/140/145 family of aircraft in Harbin, China. The enterprise delivered its first plane in 2004. Slow order fulfillment, however, has raised doubt over the long-term viability of the project.[124] The Harbin plant delivered no aircraft in the fourth quarter of 2008.[125]

China's transition to a competitive producer of commercial jet aircraft and engines will be aided by its large and growing domestic aviation market, providing a ready market for new indigenous aircraft. China's has the world's fastest growing domestic aviation industry, with air traffic increasing at a rate of 7.9 percent per year.[126] Given that there are only about 1,325[127]

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[120] Andersen. p.11.
[121] *The Changing Structure of the Global Large Civil Aircraft Industry and Market: Implications for the Competitiveness of the U.S. Industry*, ITC Publication 3143, Investigation No 332-384, November 1998.
[122] Andersen. p. 8.
[123] Diane Brady and Charles Goldsmith. "Airbus is Set to Help China Build Jetliner." *The Wall Street Journal.* November 20, 1996.
[124] Nicholas Ionides. "ERJ-145 deal earns reprieve for Chinese assembly line." *Flight International.* Jan 24-30, 2006.
[125] Mary Kirby. "Harbin Embraer in the Fray after no Deliveries in 4Q." February 15, 2009. Available at http://www.flightglobal.com/articles/2009/01/15/321097/harbin-embraer-in-the-fray-after-no-deliveries-in-4q.html.
[126] Boeing Current Market Outlook 2008. p. 30.

commercial jets operating in China (compared to roughly 7,000 in the United States), industry analysts predict that Chinese airlines will need to add over 3,000[128] large and medium-sized aircraft to their fleets over the next two decades to meet this demand.

Not surprisingly, Boeing and Airbus have identified China as the single most important market for sales over the next 20 years, and both companies are working hard to win orders from Chinese airlines. Traditionally, the Chinese government (through the China Aviation Supplies Corporation [CASC]) directs the purchase and distribution of imported aircraft among the various Chinese airlines. This practice started to change as Chinese airlines became more independent. However, it is likely that the Chinese government will mandate that Chinese airlines purchase the ARJ21.

Business opportunities in China are not limited to sales of large aircraft. Fleet expansion has been accompanied by infrastructure improvements, with 24 new airports added and 50 airports upgraded between 2001 and 2005.[129] CAAC expects the number of airports serving scheduled flights to increase from 142 to 190 by 2010. CAAC also expects to make improvements to its air traffic management system, including improving its meteorological services. In April 2006, CAAC and the FAA established a Joint Next Generation Air Transportation Steering Group to collaborate on deploying new air traffic management technologies and procedures.

In the end, future U.S. and European export prospects may be dampened if Chinese companies are able to satisfy some of this growing demand with indigenously produced aircraft and other equipment. U.S. and European companies also may face new competition outside of China as Chinese manufacturers seek to expand their share of the global aircraft market. For now, aerospace companies are exercising cautious optimism while pursuing business opportunities in China.

[127] Boeing Current Market Outlook 2008. p. 30.
[128] Consolidated estimate from Boeing, Airbus, CAAC, and industry analysts.
[129] Presentation by CAAC Deputy Director General Sha Hongjiang, at the U.S.-China Aviation Summit, Washington, D.C., September 18, 2006.

Country Studies: Japan

Japanese aerospace companies have established themselves in the global aerospace industry as important manufacturers of a wide range of civil, military, and corporate aerospace products. They supply components and structures for a broad spectrum of commercial aircraft (especially Boeing and Airbus jet transports) and aircraft engines. Although they are respected as suppliers, Japanese firms have not been able to successfully produce a commercial transport aircraft. Despite its long history in aerospace manufacturing, Japan does not currently produce its own commercial aircraft and has never produced a commercial jet. The last successful commercial aircraft produced in Japan was the YS-11 turbo-prop, which was discontinued in 1973.[130] As a result, Japanese airlines import their aircraft, mostly from the United States.[131] Japan has been the largest market for U.S. aerospace exports since 2003, accounting for $35.14 billion in exports from 2003-2007.[132]

The Japanese aerospace industry is dominated by the four "heavies": Mitsubishi Heavy Industries (MHI), Kawasaki Heavy Industries (KHI), Ishikawajima-Harima Heavy Industries (IHI), and Fuji Heavy Industries (FHI). These four companies, together with a wide range of smaller Japanese companies, employ around 31,154 aerospace workers.[133] Aerospace products make up only about 20 percent of total sales (in fiscal year 2002) of these companies, which are widely diversified among strategic businesses such as industrial machinery, shipbuilding, electrical machinery, and automobiles.[134]

The expansion into new civil aerospace markets has been aided significantly through financial support from the Japanese government, through groups like the International Aircraft Development Fund (IADF) made up of the four heavies and the Ministry of Economy, Trade, and Industry (METI).[135] For example, in 1996 the Japanese government provided ¥2.9 billion ($24 million) to assist with Japanese participation in the Boeing 777 program, and ¥1.6 billion ($13 million) for the International Aero Engines V2500 engine project.[136]

More than 91 Japanese companies, including the four heavies, are program partners, subcontractors, or suppliers to Boeing across its commercial-airplane product lines.[137] Japanese-manufactured parts and components make up significant portions of the Boeing 777, and Japanese companies have been identified as significant risk-sharing partners in Boeing's new 787 program. Boeing also has extensive relationships with Japanese airlines. According to Boeing's website, since the 1950s, Japan has ordered 796 Boeing airplanes worth approximately

[130] Kevin Done. "Mitsubishi to Market New Regional Jets." *The Financial Times.* October 9, 2007.
[131] Japanese customers have ordered 845 aircraft from Boeing compared to about 105 from Airbus. Data from Boeing and Airbus websites.
[132] International Trade Administration analysis of Census data. Available on the web at: http://trade.gov/static/aero_stat_top20exp.pdf.
[133] "Aerospace Industry in Japan." The Society of Japanese Aerospace Companies (SJAC). 2008.
[134] The Society of Japanese Aerospace Companies (SJAC), 2003.
[135] The Japanese Ministry of International Trade and Industry (MITI) was the Japanese Government agency responsible for this activity prior to being reorganized into METI in 2001.
[136] The Society of Japanese Aerospace Companies (SJAC), 1998.
[137] "The Boeing Company and Japan," Updated June 2005. Available on the web at: http://www.boeing.com/companyoffices/aboutus/boejapan.html.

$70 billion (in 2004 dollars) through June 2005. In addition, over the past decade, 80 percent of the airplanes ordered by Japanese customers have been Boeing products.[138]

Airbus has actively pursued partnerships with Japanese companies on new aircraft programs such as the A380, possibly in hopes of capturing a larger share of Japan's large jet transport market. Seven Japanese suppliers, including MHI, FHI, and the Japan Aircraft Manufacturing Company, signed up to manufacture parts for the A380 over a period of 20 years, for a total of $850 million in components including cargo doors and parts of the tail.[139]

The Japanese aerospace industrial base is not limited to supplying other manufacturers. Japanese companies also produce complete small jet and turboprop aircraft and helicopters, military aircraft and trainers, and space launch vehicles. About 48 percent of Japanese aircraft are sold to the Japanese Defense Agency.[140] Often these aircraft are manufactured under technical license or in coordination with non-Japanese (mostly U.S.) companies. Many indigenous military aircraft programs have had relatively small production runs, in large part due to a 1967 Japanese government ban on military product exports. This continuing ban and shrinking domestic defense budgets have led Japanese companies to seek out new opportunities to participate in civil aircraft programs.

As an example of new opportunities in civil aircraft production, Japanese firms have been interested in entering the regional jet market, with firms expressing interest in the idea since at least 1991.[141] In the mid-1990s, a partnership between Mitsubishi and Bombardier to produce a 100-seat regional jet was discussed[142] but never came to fruition. In 2003, Mitsubishi launched a study, partly funded by the government, to explore the feasibility of a Japanese regional jet. Initially, the study focused on the 30-50 seat market, but by 2005 it had become clear that there was greater demand in the 70-90 seat market. By 2007, the Japanese government indicated that it would offer financial assistance totaling ¥40 billion for the aircraft's development, about 1/3 of the estimated cost.[143] Mitsubishi began formally marketing the aircraft in October 2007 and by February 2008 had announced six partner suppliers.[144] The program was officially launched on March 28, 2008.[145]

Mitsubishi hopes that the expertise it has gained in composites while working on the Boeing 787 will help distinguish its planned regional jet from its competitors' offerings, which are already on

[138] "The Boeing Company and Japan." available at http://www.boeing.com/companyoffices/aboutus/boejapan.html
[139] "Airbus Picks Three More Suppliers from Japan for Its A380 Jet," *Wall Street Journal*, June 2002.
[140] "Aerospace Industry in Japan." SJAC. 2008.
[141] Paul Proctor. "Japanese Firms Force Advanced Aircraft Industry." *Aviation Week and Space Technology*. July 29, 1991.
[142] Eiichiro Sekigawa and Michael Mecham. "Mitsubishi Sees 100-seater in Global Express' Wing." *Aviation Week and Space Technology*, August 26, 1996.
[143] Knight Ridder Tribune Business News. "Japan's First Jetliner to Get Financial Lift." June 1, 2007.
[144] Joeseph C. Anselmo. "Mitsubishi Nears Regional Jet Launch Decision." *Aviation Week and Space Technology*, February 14, 2007. Available on the web at: http://www.aviationweek.com/aw/generic/story_channel.jsp?channel=comm&id=news/MRJ02148.xml&headline=Mitsubishi%20Nears%20Regional%20Jet%20Launch%20Decision.
[145] "MHI Officially Launches Mitsubishi Regional Jet Program." Available on the web at: http://www.mhi.co.jp/en/news/story/200803281230.html.

the market or are nearing flight-testing phase. Mitsubishi's jet would be the first regional jet "to adopt composite materials for its wings and vertical fins on [a] significant scale."[146]

[146] *Ibid.*

Country/Regional Studies: Europe

The European Union (EU) is the largest regional export market for the United States aerospace industry.[147] Although Japan is the largest market by individual country at 8.6 percent of total U.S. aerospace exports, combined exports of the U.S. aerospace industry to France, the United Kingdom, and Germany, which total 20.7 percent, illustrate the importance of the region.[148] In addition, European aerospace companies supply the full range of aerospace products and services, from large civil aircraft, to satellites, to subassemblies and components. As a result, European firms are both important partners as well as competitors for U.S .firms. As is the case with the U.S. aerospace industry, the global economic downturn has affected the EU aerospace industry. However, economic fundamentals are in place for continued long-term growth.

There is significant variety in the ownership structure of European major suppliers. For example, unlike in the United States, several major suppliers still have significant government ownership. EADS, for example, benefits from partial French, German and Spanish state ownership as well as other public shareholders.

As a union founded to enhance political, economic and social cooperation amongst member nations, the individual member states of the European Union are free to shape their own aerospace policies. Recognizing the advantage of a unified aerospace policy that would facilitate enhanced competition, particularly with the United States, the EU has taken steps to strengthen the coherence of its regional aerospace market. In the July 2002 "Strategic Aerospace Review for the 21st Century" (STAR 21) report, the European Advisory Group on Aerospace developed several recommendations. They included: (1) coordinated efforts to increase access to world aerospace markets, particularly through advocacy for changes to "Buy America" practices and convergence in export control policies; (2) mobilization of region-wide public and private research funds to launch a coordinated, long-term civil aerospace research strategy; (3) a shift from authority of individual member state specific aerospace policy makers to a more unified structure, including wider roles for the European Aviation Safety Agency and advocating for membership of the EU in the International Civil Aviation Organization (ICAO) alongside member states; and (4) consolidation of aerospace defense research and acquisition policies among member states. The EU and its member states are continuing to implement these recommendations today.

Country Profiles

The following is a brief summary of the five largest aerospace markets in the European Union.

[147] For purposes of this report, statistical comparisons of trade data were made using 2007 data, which is the most current available for all markets considered.

[148] "Top Twenty Aerospace Export Markets." Office of Aerospace and Automotive Industries, U.S. Department of Commerce available at http://www.ita.doc.gov/td/aerospace/inform/top20exp.xls .

France

The French aerospace industry is the largest in Europe, with 2007 exports of over $39.1 billion (in 2007 dollars).[149] The French aerospace industry employed approximately 132,000 people in 2007.[150] The long-term outlook for the French aerospace industry remains generally positive, characterized by continued revenue growth, record orders, and a stable industry workforce.[151] In the civil aerospace sector, the Airbus A380 and Dassault Falcon 7X entered into service in 2007 and the A350XWB, Falcon SMS, and Falcon 2000 LX programs were launched.[152] There was also a significant rise in telecommunications satellite orders. Despite recent strengthening of the U.S. dollar against the Euro, the generally weakening value of the dollar is seen as a major issue of concern.

Germany

The German aerospace industry is the second largest in Europe, with 2007 exports of $32.2 billion[153] and 2007 employment in aeronautics at 70,500. In general, the outlook for the German aerospace industry remains positive, with gains in the civil and military aviation sectors driving growth. Specifically, current Airbus A380 and Eurocopter helicopter production, coupled with future production of the Airbus A350XWB are driving strong civil aviation sales. Similar to France, in the military aviation sector, increased production of the Eurofighter and the Tiger and NH90 military helicopters are driving export sales growth. By extension, aerospace revenue gains are sustained by Germany's continued emphasis on research and development expenditures, which are greater on a percentage of sales basis than in other EU member countries.[154]

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[149] Eurostat data. This data is also available from the World Trade Atlas, published by Global Trade Information Services, Inc. (WTA), which is a secondary electronic source based upon the Eurostat data. See http://www.gtis.com/wta.htm.

[150] Groupment des Industries Francaises Aeronautiques et Spatiales (GIFAS). "2007 Results for the French Aerospace Industry." March 18, 2008. http://www.gifas.asso.fr/reaxia/files/fxqxfx/2008mars18_Communiquresse_EN.pdf

[151] Ibid.

[152] Ibid.

[153] Eurostat data. This data is also available from the World Trade Atlas, published by Global Trade Information Services, Inc. (WTA), which is a secondary electronic source based upon the Eurostat data. See http://www.gtis.com/wta.htm.

[154] German Aerospace Industries Association (BLDI) Press Report "German Aerospace Industry Remains in the Ascendant" April 6, 2005 available at http://www.bdli.de/index.php/component/option,com_docman/task,view_category/subcat,1/catid,35/limitstart,0/limit,12/Itemid,111/lang,en/ .

United Kingdom

The UK aerospace industry is the third largest in Europe, with 2007 exports of $28.2 billion (in 2007 dollars).[155] The UK aerospace sector growth is due primarily to the maintenance, repair and overhaul (MRO) market, which is driven by increasing demands for air travel.[156] The UK is home to several of the world's leading aerospace companies, including BAE Systems PLC and Rolls-Royce PLC. In addition, U.S. aerospace companies such as Boeing,[157] Honeywell,[158] Raytheon,[159] Rockwell Collins,[160] and Lockheed Martin[161] also maintain a presence in the UK. According to the Society of British Aerospace Companies (SBAC), UK aerospace companies directly employ over 124,000 people, and over 30,000 people in the United States.[162]

One of the primary challenges facing the UK aerospace industry is the impact of an appreciating British currency against the U.S. dollar. A large portion of the global aerospace market is U.S. dollar denominated. As a result, the rapid appreciation of the British pound sterling to historic highs against the dollar has a direct impact on the costs of research, development, and production as well as sales for UK aerospace manufacturers. Although the pound has since retreated from these historic highs, the dollar-to-pound exchange rate has compelled some UK aerospace producers to move production and other activities abroad to dollar-denominated locations. One of the earliest and most aggressive adopters of this outward mobility strategy was Rolls-Royce. Beginning in 1995, Rolls-Royce acquired the Allison Engine Company, based in Indianapolis, Indiana and renamed it the Rolls-Royce Corporation. This acquisition gave Rolls-Royce a significant U.S. presence, allowing the company to offer engines in virtually all market segments from helicopters to large civil aircraft. Subsequent acquisitions of oil and gas ventures, engine repair and overhaul facilities, and marine engine manufacturer Vickers established Rolls-Royce as a major presence in the U.S. aerospace industry.[163] As previously noted, Rolls-Royce is considering additional shifts in its industrial base away from the UK to lower-cost, dollar-denominated markets.[164] Further appreciation of the British pound will likely expand and accelerate the trend of outward mobilization at Rolls-Royce and across the UK aerospace industry as a whole.

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[155] H.M Customs and Excise data for Harmonized Tariff System (HTS) 88 "Aircraft, Spacecraft." This data is also available from the World Trade Atlas, published by Global Trade Information Services, Inc. (WTA), which is a secondary electronic source based upon the H.M. Customs and Excise data. See http://www.gtis.com/wta.htm .

[156] United Kingdom: An Overview of the Aerospace Market, U. S. Department of Commerce, April, 2006, available at http://www.buyusainfo.net/docs/x_7389140.pdf .

[157] Hoover's Company Records – Basic Company Record Boeing UK Ltd.

[158] http://www.honeywell.com/sites/uk/aerospace.htm .

[159] http://www.raytheon.co.uk .

[160] http://www.rockwellcollins.com/about/locations/rcuk/index.html.

[161] http://www.lockheedmartin.co.uk/aboutus/aboutus.html .

[162] SABC UK Aerospace Industry Survey 2007 available at http://www.sbac.co.uk/pages/24059849.asp

[163] http://www.rolls-royce.com/northamerica/history/default.htm

[164] "Rolls-Royce to shift production away from Britain" available at http:// findarticles.com/p/articles/mi_qn4158/is_20080208/ai_n21280488

Italy

The Italian aerospace industry is the fourth largest in Europe, with 2007 worldwide exports of $7.3 billion.[165] The Italian aerospace industry, which employed approximately 38,000 people as of 2008, is generally open to cooperation with the U.S. aerospace industry.[166] Major players in the Italian aerospace industry include Finmeccanica, which is the country's largest engineering and aerospace/defense group. Finmeccanica manufactures helicopters, military aircraft, defense systems, satellites, and is also an energy producer and builder of generation and transmission components, boilers, turbines, cogeneration plants, desalination plants, and nuclear power plants.[167] Telespazio, a Finmeccanica joint venture, is involved in satellite management and navigation, and broadband multimedia telecommunications.[168] Fiat Avio SpA is the country's major manufacturer of aircraft propulsion systems. Fiat Avio has partnerships with Pratt & Whitney, GE Aviation and Rolls-Royce for the production of aircraft engines.[169]

Spain

Spain's aerospace industry is the fifth largest in Europe, with 2007 exports of $4.1 billion[170] and 2007 employment of 34,100 workers.[171] The Spanish aerospace industry is dominated by three manufacturers. EADS CASA is Spain's largest aerospace company and is a world leader in light- and medium-sized military aircraft. EADS CASA is also a supplier of aerodynamic surface components for the Boeing 737, 757 and 777.[172] Gamesa Aeronautica designs, develops, and manufactures major subassembly structures for a number of large civil aircraft. [173] Indra Sistemas S.A. is Spain's leading producer of electronic defense equipment.[174] Industria de Turbo Propulsores S.A. (ITP) designs, produces and provides maintenance repair and overhaul services for a variety of aircraft engines and gas turbine compressors.[175] Again, similar to the other member countries of the EU, the outlook for Spain's aerospace industry remains positive in the long term, as continued sales growth by EADS-affiliated aerospace companies carries over to the industry in general.

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[165] Eurostat data. This data is also available from the World Trade Atlas, published by Global Trade Information Services, Inc. (WTA), which is a secondary electronic source based upon the Eurostat data. See http://www.gtis.com/wta.htm.

[166] http://www.aerospacemeetings.com/the-aerospace-industry-in-piemont-and-italy.php

[167] Hoover's Company Records – In Depth Company Record Finmeccanica SpA.

[168] http://www.telespazio.it/profile.htm l

[169] Outline of the Italian Aerospace Industry, U.S. Department of Commerce, available at http://www.buyusainfo.net/docs/x_9518011.pdf .

[170] Eurostat data. This data is also available from the World Trade Atlas, published by Global Trade Information Services, Inc. (WTA), which is a secondary electronic source based upon the Eurostat data. See http://www.gtis.com/wta.htm.

[171] http://www.atecma.org/atecma/inicio/estadisticas-nacionales/

[172] http://www.eads.net/web/lang/en/1024/content/OF00000000400004/4/41/529414.html .

[173] http://www.gamesa.es/gamesa/index.htm

[174] Hoover's Company Records – In Depth Company Record Indra Sistemas S.A.

[175] http://www.itp.es/ingles/acercade.htm.

Country Studies: Russia

The Russian aviation industry is in a state of dramatic transformation designed to position it as a formidable competitor to the aviation industries of the United States and EU countries. As recently as 2005, the Russian aviation industry could be characterized as a post-USSR era industry comprised of separate state and privately held manufacturers and design bureaus with limited cooperation in research and development, design, manufacture, sales and marketing. In 2006, however, the Government of Russia began a consolidation of the majority of the industry's aerospace companies under a central, state owned joint stock company, the United Aircraft Corporation (UAC). The outlook for the Russian aviation industry is for continued consolidation under the UAC enterprise, increased cooperation with U.S. and EU country aviation companies through parts and materials supply agreements, engineering and design services, and joint production through licensing agreements and joint ventures.

In the immediate post-USSR era, the Russian aviation industry found itself unable to compete with U.S. and European companies for market share. Both domestically and abroad, Russian aircraft makers were constrained with a product line that was non-competitive in comparison to aircraft produced by established competitors like Boeing and Airbus. By 2005, Russia's entire civil aviation industry was building on average a total of 10 aircraft per year. In comparison, in 2005 Boeing and Airbus booked over 1,000 orders each for new aircraft.[176] At the same time, on the domestic front, demand for civil aircraft was quite high and growing. According to the Russian Transport Ministry, by 2005, of 2,528 total civil aircraft currently in service, more than one-half had passed their legal operational limits and needed to be replaced. In addition, industry experts forecast that Russian airlines would need at least 620 long- and medium-haul aircraft in the next 20 years.

Faced with the reality of a rapidly aging civil aircraft fleet and no viable domestic industry to fulfill demand, Russia was faced with two choices: they could fill the country's aircraft needs with western sourced aircraft or attempt to ramp up Russian domestic production to meet their own needs, while also becoming a player in the international civil aircraft market. Rather than cede this vital sector to the West, President Putin decided on the latter option. In 2005, President Putin directed the formation of the Government Commission for Integration of Aircraft Building Enterprises in the Russian Federation. The Commission was charged with the responsibility of developing a plan to revitalize the Russian aviation industry and concluded that the best and most effective road to global competitiveness would be a consolidation of the country's mostly state-owned aviation companies. On November 2, 2006, the Commission announced its decision to establish an open joint stock company that would consolidate many of the state-owned aerospace companies under a single entity, the United Aircraft Corporation (UAC).

The UAC Board of Directors is chaired by Deputy Prime Minister Sergei Ivanov. Ivanov has functioned as a "troubleshooter" for President Putin on a number of high-profile tasks to include oversight and improvement of the country's aviation safety system. UAC's supervisory board selected Alexei Fedorov, former general director of jet manufacturer RSK MiG, as the

[176] http://www.businessweek.com/bwdaily/dnflash/jan2006/nf20060117_9445_db039.htm

company's President and General Director.[177] In this capacity, Fedorov is responsible for day-to-day operations of the consolidated entity. In addition to the two top spots, UAC's board includes representatives from the various consolidated companies, government and non-aviation industrial members, particularly from the financial sector.

UAC Director Fedorov has stated that he expects UAC to become the world's third largest aircraft manufacturer by 2015.[178] Accomplishment of this goal is based in large part on a variety of cooperation agreements between UAC member companies, its direct competitors and suppliers.[179] Specifically, UAC has signed agreements with Boeing and EADS for design, manufacturing and sales/marketing cooperation, Alenia Aeronautica of Italy for sales and marketing of UAC products, and Hindustan Aeronautics Limited of India for joint design and production of civil and military aircraft.

Similar to the consolidation of the aviation industry under UAC, Russia has also brought the country's helicopter industry under a single, majority state-owned entity. In November 2004, President Putin issued a decree directing the assets of Russia's helicopter industry to be consolidated under OPK Oboronprom's Helicopter Group. A diverse corporation with multi-sector investments in high technology and defense, OPK Oboronprom assumed the assets of the various member companies under its newly established Helicopter Group. OPK Oboronprom is majority owned by the government (51 percent) and its members include all major Russian helicopter manufacturers. OPK Oboronprom is under the leadership of Andrey Reus, former Deputy Minister of Industry and Energy.[180]

Beyond consolidation, Russian aviation companies have aggressively pursued agreements to supply materials, parts, and engineering services for Western commercial aircraft and engine manufacturers.[181] Boeing has invested more than $1.3 billion[182] into Russian joint ventures since the early 1990s and plans to bring that total to $2.5-$3 billion by 2010.[183] This investment has enabled Boeing to tap into the vastly underutilized expertise of Russian aerospace experts who have extensive experience. Boeing operates the Boeing Design Center in Moscow, employing Russian engineers to work in research, materials, design, information technology, and

[177] On October 1, 2007, Alexei Fedorov resigned from his post as general director and general designer of RSK MIG. He was replaced on an interim basis by Sergei Tsivilev, first deputy director general of the company. Tsivilev was investigated by Russia's Prosecutor General for fraud in conjunction with an alleged sale to Poland of counterfeit parts for MiG-29 aircraft but was not ultimately charged. http://www.themoscowtimes.com/stories/2007/10/02/061.html; http://www.kommersant.com/p731704/MiG_director_criminal_case/. Tsivilev was succeeded by Mikhail Pogosyan, who also retained his position as general director of JSC Sukhoi. http://www.migavia.ru/eng/news/?page=1&tid=4&id=40

[178] Moscow International Aviation and Space Salon 2007 Show Program interview with Alexei Fedorov, President of United Aircraft Corporation

[179] "Alcoa, United Aircraft Corporation Sign Technology Cooperation Agreement" available at http://www.alcoa.com/global/en/news/news_detail.asp?newsYear=2007&pageID=20070822005466en

[180] http://www.oboronprom.com/en/show.cgi?/corporation/about.htm

[181] http://www.boeing.com/commercial/777family/pf/pf_background.html

[182] http://www.boeing.com/news/releases/2002/q3/nr_020805a.html

[183] "Boeing to invest $2.5-$3 billion in Russian Aircraft Industry." Russian News and Information Agency. http://en.rian.ru/business/20050427/39749807.html April 27, 2005.

modification work on the 777, the 787, and other commercial aircraft models. Russia is a key supplier of raw materials—especially titanium—used in Western aerospace production.

The European aviation industry has also been active in Russia. In July 2001, Airbus's parent company, EADS, signed a cooperation agreement with the Russian Aerospace Agency and agreed to invest more than $2 billion in the Russian aerospace industry over a ten-year period.[184] The agreement calls for a broad range of cooperative projects, including Russian participation in the A320, A380, and other Airbus projects.

Russian manufacturers are also seeking partnerships and cooperative ventures with Western manufacturers to help them develop new aircraft. For example, Pratt & Whitney entered into a strategic partnership with Perm Motors Joint Stock Company, which is developing an internationally compliant upgrade to the widely used PS-90A engine in Russia.[185] In 2004, Boeing entered into a contract with Russian manufacturer Sukhoi to help develop and market the Superjet 100, which is designed to replace aging Russian aircraft and is intended to compete worldwide with regional jet aircraft from Bombardier and Embraer.[186] Although the capability of Russia's aviation industry in the areas of design and manufacturing is not in doubt, the country's ability to deliver the level of marketing and customer support needed to successfully export civil aircraft is more uncertain. To that end, Sukhoi Civil Aircraft and Alenia Aeronautica, a part of Italy's Finmeccanica group, have formed the Superjet International joint venture to conduct marketing and customer support in Western Europe, North America and South America. Snecma Moteurs of France is developing the engine in a 50/50 joint venture with NPO Saturn JSC, with French government assistance worth €250 million.[187] The Superjet began flight tests in spring 2008, and as of February, 2009 the two prototype aircraft had completed over 90 flights totaling 300 hours.[188] Commercial delivery of the first Superjet is scheduled for December, 2009.[189]

[184] "Negotiations between EADS and Russian Aerospace Agency Rosaviakosmos Finalised," EADS press archives, July 2, 2001, http://www.eads.net

[185] "Pratt & Whitney in Russian Gas Turbine Accord," Dow Jones Newswires, August 9, 2000.

[186] "Sukhoi picks up pace on RRJ," *Concise B2B Aerospace*, June 17, 2003.

[187] "Paris Breathes New Life into Jet Project", *The Moscow Times*, September 20, 2004.

[188] "Sukhoi Superjet 100: Two Aircraft Successfully Complete 300 Flight Hours" available at http://www.defense-aerospace.com/article-view/release/102274/two-sukhoi-superjets-log-300-flight-hours.html

[189] http://in.reuters.com/article/governmentFilingsNews/idINL489676420090304