Flight Plan 2008:

Analysis of the U.S. Aerospace Industry

INTERNATIONAL
TRADE
ADMINISTRATION

Office of Aerospace and Automotive Industries
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Dear Reader,

This is the third edition of the Department of Commerce's Aerospace Team's annual industry assessment. The publication's name was changed from *Apogee and Perigee* to *Flight Plan 2008* this year. This edition includes updated statistics and a more streamlined format. Designed to provide the reader with the status of the aerospace industry in the United States, topics include economic and competitive analysis of major aerospace firms and trading partners as well as information on issues impacting the overall health of the industry. The report provides insight into major aerospace industry topics such as unmanned aircraft systems, large commercial aircraft, regional jets, general aviation, commercial space, and workforce issues. *Flight Plan 2008* is not designed to cover every aspect of the industry's performance in detail. Rather, it is intended to provide an overview of salient issues which the reader can then research for additional information. This paper is based upon contributions and information from multiple government agencies and private sector entities.

Published by the Department of Commerce's Office of Aerospace and Automotive Industries, this report was written by members of the Aerospace Team. We welcome your comments, criticisms, and suggestions for improvement. I also suggest you view our website at: http://www.ita.doc.gov/td/aerospace/ for additional information on the U.S. aerospace industry.

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EXECUTIVE SUMMARY

The aerospace industry demonstrated strong growth in 2007, and economic indicators suggest that this growth should continue in the near term as the industry moves through its normal business cycle. The depreciation of the U.S. dollar has made U.S. aerospace products more affordable overseas. During 2007, increased industry consolidation and cooperation also made U.S. products more competitive across all aerospace sectors.

As mentioned above, the depreciation of the dollar vis-à-vis most foreign currencies has made sales of U.S. large civil aircraft (LCA) more attractive to airlines. Conversely, the high value of the Euro, as well as delayed product development and deliveries, has slowed Airbus sales. However, increasing worldwide air travel has also raised overall demand for LCAs, regional jets, and smaller business jets, providing Boeing and Airbus with strong orders. Similarly, post-September 11 recovery has pushed global demand for business jets and general aviation aircraft to new high levels. Despite this increasing demand, it is expected that industry consolidation will continue.

High product development costs, coupled with relatively small annual markets for aerospace products (by unit) are fueling the aerospace sector. In addition to the more traditional U.S.-European ventures, such as the GE Aviation and Pratt & Whitney venture the "Engine Alliance", new associations are emerging. One such example is the Italian-Russian venture Superjet International, formed by Alenia Aeronautica and Sukhoi Civil Aircraft. Superjet International will market and sell a new family of aircraft into Western markets and provide worldwide after-sales support. Similar programs have been announced in China and Japan. This type of international cooperation allows greater market access, as well as cost and risk sharing.

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 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.

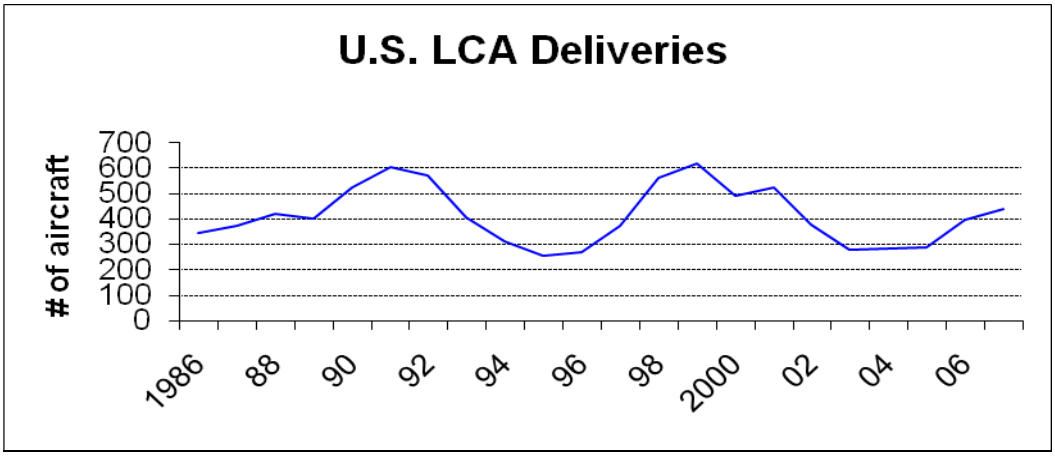
Aerospace sectors currently experiencing the strongest—and in some cases record—growth are large civil aircraft, helicopters, general aviation aircraft, regional and business jets, engines/powerplants, communications satellites, military unmanned aerial systems (UASs), and airport infrastructure and safety equipment. For these sectors, growth is expected to remain strong in the near term, although LCA orders may not match their record numbers in 2008. 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 telecom market demand increases. The maintenance, repair and overhaul (MRO) market has not recovered to pre-9/11 levels, and is not expected to recover for several years. The market for civil/commercial UASs remains stagnant in the absence of civil regulations for certification and operation in the national air space. 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 the only U.S. manufacturer of large civil aircraft (LCA). Large civil aircraft are those aircraft which have more than 100 seats or an equivalent cargo capacity. Boeing's LCA revenues typically account for more than half of the total non-government, civil output of the U.S. aerospace industry.

Market Trends

Domestic and global LCA production is cyclical, experiencing peaks about every ten years in the number of aircraft delivered with "valleys" approximately every other ten years.[1]



The terrorist attacks of September 11, 2001 economically devastated 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 said that the net number of new Boeing aircraft ordered in 2001 (number of new orders less the number of existing orders that were cancelled) was 314 airplanes. This was about half the figure from the previous year (net orders in 2000 of 598 aircraft). With demand stagnant in the immediate aftermath of September 11th, Boeing's sales continued to slump. The number of orders fell again in 2002, and bottomed out in 2003 with 249 net orders.

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 – to 285 – of aircraft delivered in 2004. The number of Boeing aircraft ordered in 2004 also increased from the previous year, marking an end to the market slide precipitated by September 11th. Market conditions continued to improve in 2005 and 2006, with the apparent demand for LCA in these two years stunning many analysts. Boeing announced net orders of 1,002 aircraft in 2005, an increase of over 360 percent from the 2004 order figure of 277 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

[1] 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.

figure for 2007 marks the highest number of aircraft orders Boeing has ever received in a single year.

While Boeing appears to be on the rebound in terms of number of aircraft ordered, it may be some years before the company regains previous sales levels when measured by dollar value. Boeing received its highest revenues from LCA sales in 1999 when it delivered a record 620 aircraft valued at about $38.5 billion. This is well below Boeing's 2007 LCA revenues, which totaled about $33.4 billion on deliveries of 441 aircraft.[2]

Access to foreign markets is crucial to Boeing. Over the next ten years, more than 70% of Boeing's large civil aircraft likely will be delivered to customers outside of the United States. Key foreign markets include China, Japan, and India.

Competition

As a practical matter, Europe's Airbus is Boeing's only competitor in the LCA sector. Other civil jet transport manufacturers with a significant global presence, such as Canada's Bombardier and Brazil's Embraer, do not produce aircraft comparable in size to the Boeing and Airbus aircraft. Heritage Ukrainian and Russian companies Antonov, Ilyushin and Tupolev do produce aircraft comparable in size, but are not competitive.

Created in 1970, Airbus was a consortium of four European government-supported companies. In 2001, those governments transformed Airbus into a single corporate entity, Airbus S.A.S. Today, Airbus is a wholly owned subsidiary of European Aeronautic Defense and Space Company (EADS). In 2006, EADS purchased from United Kingdom-based BAE Systems that company's 20 percent equity of Airbus. The French government owns 15 percent of EADS and a Russian consortium owns 6+ percent of the common stock.

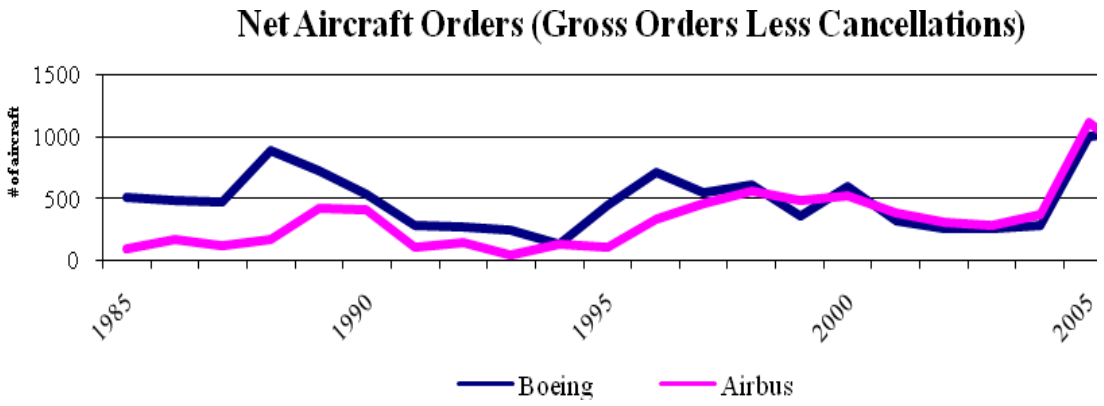
Throughout Airbus' history, the governments of France, Germany, the United Kingdom and Spain have provided the company substantial financial and other support. These governments have provided over $15 billion in "launch aid" to develop new models of Airbus aircraft. Airbus has benefited from government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

Boeing and McDonnell Douglas dominated the global LCA market until the 1990s when Airbus became a serious competitor, as it remains today. During the period 2001–2005, Airbus announced each year that it received more orders for civil aircraft than Boeing. Airbus makes the same claim concerning number of aircraft delivered for every year since 2003.

As calculated by various measurements, Airbus and Boeing had virtually equal shares of the LCA market in 2007. Airbus' share was:

- 50.7%, when measured by number of aircraft delivered (453 vs. Boeing's 441); and
- 48.7%, when measured by number of net aircraft orders (1,341 vs. Boeing's 1,413).

[2] Figures for 1999 and 2007are reported in current dollars, *i.e.*, not adjusted for inflation.



As demonstrated in the above chart, 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 starkly in their projection for the future market of large civil aircraft. In Airbus' view, the future of the LCA market lies with huge aircraft capable of long flights that will fill a growing demand for "hub-and-spoke" airline operations. Airbus says that larger aircraft will be increasingly required to mitigate 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. By comparison, the latest version of the largest civil aircraft now flown, the Boeing 747-400, 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 the lower fares that can be achieved with one or more intermediate stops. Consequently, Boeing argues that airline fleets will be composed of large numbers of aircraft with relatively small passenger capacities. The mix of particular aircraft models should be capable of meeting short-, mid- and long-range operations.

In keeping with its market projection, Boeing developed its latest jetliner, the 787 "Dreamliner", with fewer seats than the Airbus A380, and somewhat fewer than the last aircraft Boeing developed, the 777. Boeing anticipates the production of three versions of the 787: the 787-8, carrying 210-250 passengers; the 787-9, carrying 250-290 passengers; and the 787-3, carrying 290-330 passengers. In January 2008, Boeing announced a delay in the first Dreamliner delivery from late 2008 to early 2009 (due to production difficulties).

While the two LCA manufacturers have different views of the future market, neither Boeing nor Airbus has put all of its eggs in one basket. 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 stretched version of its existing 747, to be called the 747-8, that will add room for 34 more seats in a typical configuration of three passenger classes.

New U.S. Manufacturing Process

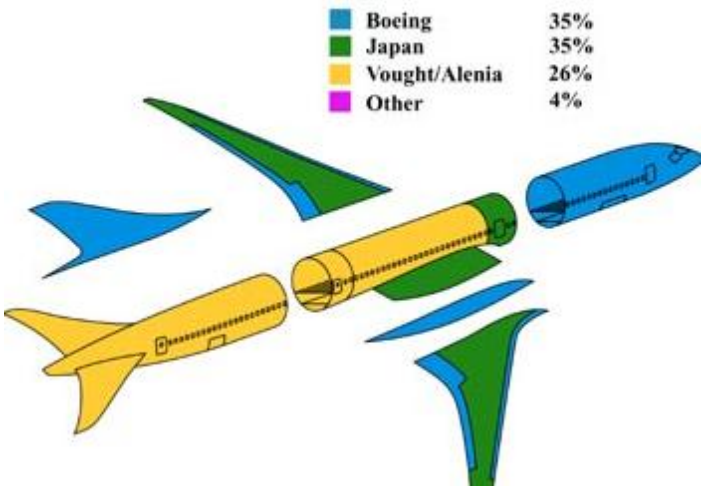
In a departure from its traditional way of manufacturing aircraft, Boeing will be using an assembly technique for the 787 aircraft that has been used by Airbus for decades. In this new, "systems integration" approach, instead of receiving parts from tens of thousands of suppliers, Boeing is working with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

- A partnership between Alenia (Italy) and Vought (Texas) will design and manufacture 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, will design and manufacture both wings, representing 35 percent of the 787 structures.

787 Structures Work Share[3]



Future Market

[3] Can be found at: http://www.aerospace-technology.com/projects/dreamliner/dreamliner8.html

Boeing's sales in the coming year are likely to be dominated by three models of aircraft: the single-aisle 737, the wide-body 777, and the new 787 with a body fabricated from carbon composite materials. Few observers expect the feverish pace of orders achieved in 2005-2007 to continue through 2008.

Key factors in 2008 that could affect the future of the U.S. large civil aircraft manufacturing industry include:

- **Airbus A380**: Will demand for this aircraft, now sluggish at best, improve? The total number of A380's on order at the end of 2007, 189 aircraft, falls significantly short of the "break-even" number Airbus needs to recoup the more than $13 billion it spent to develop the A380. Continued weak demand for the A380 could strain Airbus' ability to invest in future aircraft programs, without further European government assistance.

- **Boeing 787 "Dreamliner**": With Boeing 787 orders totaling 817 at the end of 2007, the Dreamliner is the fastest-selling civil aircraft in history. The program's success, however, is challenged by production difficulties, including some that appear to have resulted from Boeing's new "systems integration" approach, involving overseas suppliers of major subassemblies. Beyond the issue of late delivery penalty payments to airlines, 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)**: Dispute settlement panels are expected to issue decisions in 2008 concerning claims by the United States that European governments have made illegal subsidies to Airbus as well as counter litigation initiated by the European Union alleging illegal subsidies to Boeing. If U.S. claims are sustained by the panels, these decisions eventually could lead to significant changes in the way that Airbus is supported by European governments.

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. In recent years, however, deliveries have slowed, and some analysts believe that the natural market for regional jets is approximately 200 aircraft. Despite the downward trend, three other countries—China, Russia, and Japan—are currently developing RJs.

Company	Products	2006 Revenue from Aircraft	2005-2006 % Change in Revenue
Bombardier	Regional jets and turboprops; business jets	$8.2 billion	1.2%
Embraer	Regional jets, business jets	$8.3 billion	-8.8%

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.[4] 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, and in early 2007 had a backlog more than 6 times that of Bombardier. Overall, however, the regional jet market has not enjoyed the same growth that the large civil aircraft market experienced over the last several years. RJ deliveries fell between 2003 and 2006, though that trend reversed slightly in 2007.[5]

Both of the regional jet manufacturers are moving to focus on larger aircraft models. Though the regional jet market began with an emphasis on 50-seat jets, the largest market for today's regional jets is 70-seats and larger. 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 2007 and currently accounts for 59 percent of its 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 is also exploring an even larger product line—the C Series—which would go up to 130 seats. Though development on this product was put on the backburner in 2006, work on it has continued. At the

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

[5] Embraer regional jet deliveries are up from 95 aircraft in 2006 to 130 in 2007; Bombardier's, however, are down from 72 aircraft to 61 aircraft. Still, the trend is up 24 aircraft from 2006 despite an unequal performance by the manufacturers.

2008 Singapore Air Show, company officials noted that the project must be formally launched this year in order to meet the desired 2013 entry-into-service date.[6]

Chart 1: Regional Jet Announced Orders, 1997-2006[7]

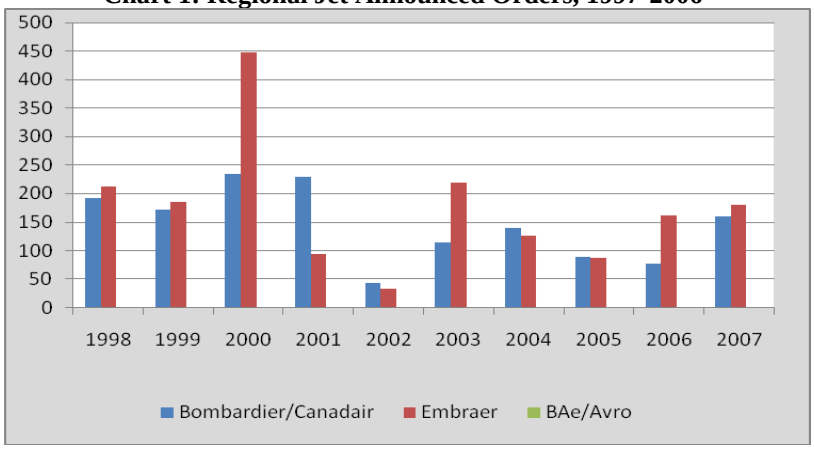
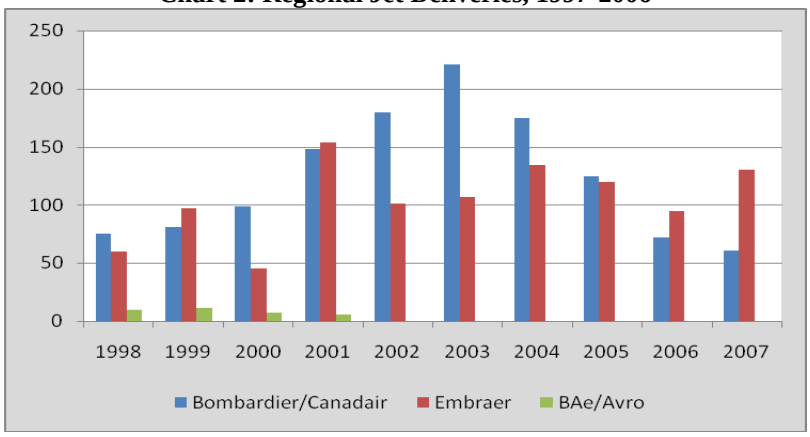


Chart 2: Regional Jet Deliveries, 1997-2006



Outlook

Though 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-aisles.

[6] Leithin, Francis. "Singapore 2008: Bombardier Hopes for C Series Launch this Year." February 19, 2008. Available on the web at: http://www.flightglobal.com/articles/2008/02/19/221646/singapore-2008-bombardier-hopes-for-cseries-launch-this-year.html

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

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 69 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. Both the Chinese and Russian aircraft are primarily intended to fill domestic demand and 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. The Japanese Mitsubishi Jet has not formally been launched, though a final decision is expected in April 2008.[8] Given the relatively small size of Japan's domestic aviation market, success of this aircraft program would be dependent on exports.

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 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. Though that level of production may be sufficient as these programs start off, eventually they will seek new markets. It is unclear whether or not those markets will materialize.

Notable Developments

The Chinese ARJ21 and the Russian Superjet both rolled-off the assembly line in the second half of 2007, and both should be delivered to customers within the next two years. The ARJ21 should begin flight testing in the first half of 2008 for delivery in September 2009. The Superjet was scheduled to have its first flight in 2007, but it was delayed until early 2008. The Superjet is still scheduled to enter into service by the end of 2008.

[8] 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.

Rotorcraft

Overview

The rotorcraft industry produces aircraft which are 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 can take off vertically and then fly horizontally as an airplane.

Rotorcraft are produced in most industrialized countries, either of indigenous design, 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, PZL Swidnik. Russian manufacturers of Mil and Kamov helicopters have been consolidated within OAO OPK Oboronprom (United Industrial Corporation). There are several Asian companies which produce helicopters under license, assemble aircraft produced elsewhere, or produce helicopters of indigenous design for the domestic market—primarily military versions. These include Hindustan Aeronautics (India), Indonesian Aerospace, Korean Aerospace, Kawasaki and Mitsubishi (Japan), and several Chinese entities (Chaig, CHRDI, GAIC, HAI and SSAC).

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

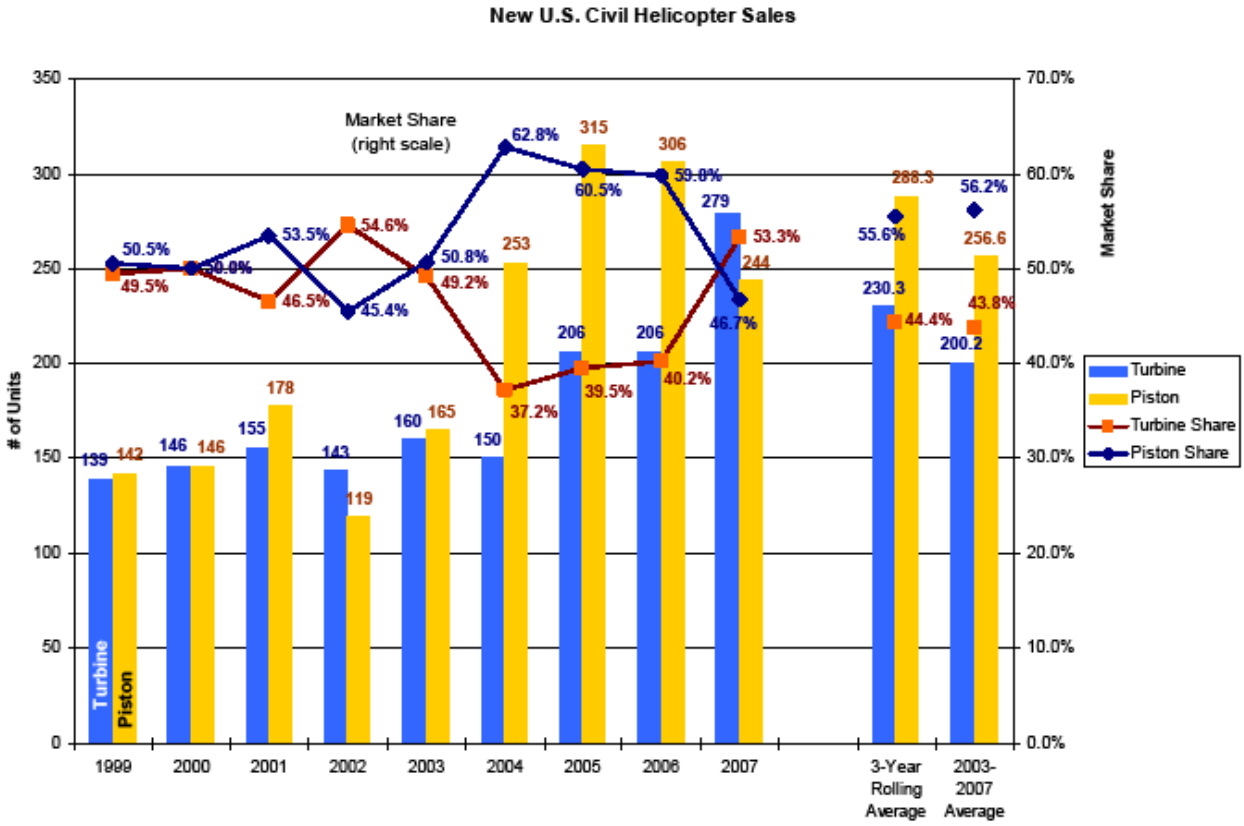
Foreign Competitors

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 and Kamov turbine-powered light, medium and heavy helicopters	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



Source: Helicopter Association International, *The Helicopter Market Newsletter*, *Turbine*, December 2007.

The year 2007 began with forecasts for steady growth in the civil helicopter market. With large backlogs, most helicopter manufacturers faced the challenge of delivering those aircraft on time without putting undue pressure on their production facilities and suppliers. Some producers of military helicopters (U.S. and foreign), especially had difficulties in making deliveries to their government customers. The tremendous growth in the shipments of piston helicopters is due to Robinson's success in producing and selling an inexpensive model for the general aviation market. It has proven popular for training, observation use, and police work.

While the subprime mortgage situation and the chance of a recession in the United States has adversely affected the ability of some customers to get their purchasing loans approved, the global rotorcraft industry is optimistic about future orders. This optimism is supported by the fact that a large number of helicopters currently in operation are nearly thirty years old. Major customers,

such as emergency medical service (EMS) providers and those that support offshore oil and gas exploration and production, are seeking new and replacement aircraft that meet the latest standards for safe design and onboard safety.

Additionally, the market is much broader than it was during the last market downturn in the 1970s, so that a decline in one sector of the market is not likely to trigger a steep decline in overall helicopter demand.

Moreover, *Forecast International* predicts that "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."[9] Industry analysts and manufacturers hope that, following the 2008 Beijing Olympics, the Chinese government will loosen restrictions in their airspace for the development of general aviation, including helicopter operations within its borders.

[9] *Forecast International*. https://www.forecastinternational.com/fistore/prod.cfm?ProductID=16445

Commercial Space

Overview

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 programs, where demand has remained stable during the commercial downturn that occurred during from 2001 to 2007.

U.S. and Foreign Manufacturers

Launch Company	Vehicles/Products	2007 Commercial Launches	2007 Total Launches
Boeing	Delta II, Delta IV, Sea Launch	3	10
Lockheed Martin	Atlas V	0	4
Arianespace	Ariane 5	6	6
International Launch Services	Proton	7	7
Orbital Sciences Corporation	Pegasus, Taurus (lightweight) Minotaur	0	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 U.S. Government 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 government 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 and Proton launches. Space Transport, Inc., 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 lightweight 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, Transformational Space, KT Engineering, and Bigelow Aerospace, are developing new launch vehicles and satellites that are

intended to lower launch costs and support NASA's Vision for Space Exploration. Most have only minimal financing, and have not moved beyond the initial program design stage. However, SpaceX is an American entrepreneurial firm that is privately developing the Falcon family of launch vehicles. SpaceX currently has contracts for up to twelve launches, seven of which are for commercial customers.[10]

Market Trends

In 2007, 68 total orbital launches took place globally, of which 23 were commercial launches.[11] Four of the commercial launches were performed by U.S. ventures. Boeing's Russian-built Sea Launch conducted one launch and Boeing's U.S.-built Delta II conducted the other three. Unfortunately, Sea Launch suffered a failure during this attempt, and the SES New Skies satellite on board was lost. Arianespace launched 12 satellites on 6 commercial launches.[12] Russia's Proton rocket launched four commercial satellites on four launch vehicles. 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 $1.55 billion in 2007, an increase of $125 million, or nearly 9 percent, over 2006.[13]

The 68 total global launches carried 117 spacecraft into orbit in 2007. Of those 117 spacecraft, 30 provide commercial broadcast and communications services, while the remaining spacecraft perform other scientific or government functions.[14]

In the commercial communications satellites sector, U.S. companies have captured approximately 70 percent of the commercial market over the past 5 years, with European companies striving to gain market share.[15] U.S. market share appears to be declining 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 allowing it to be launched from China at price lower than current Western market prices. While the United States maintains a small cost advantage (aided partly by the weakness of the 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 the 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.[16]

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[10] http://www.spacex.com/
[11] "2007 Year in Review", Federal Aviation Administration, Office of Commercial Space Transportation, January, 2008.
[12] Ibid.
[13] Ibid.
[14] Ibid.
[15] Satellite Industry Association.
[16] "2007 Year in Review," Federal Aviation Administration, Office of Commercial Space Transportation, January, 2008.

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. No U.S. company has sold one of these satellites to an international customer, even though the 2004 national policy on remote sensing encourages trade in this sector. Export control concerns and indecision and/or 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 the data commercially. The companies' success still hinges on purchases from their main customer, the U.S. Government. This government-customer focus will not change in the near term, but 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 has also seen steady growth over the past few years. Two U.S. companies—XM Radio and Sirius—dominate the satellite radio market. In February 2006, they announced plans to seek approval from the Federal Trade Commission to merge their operations. The Justice Department approved the merger on March 24, 2008.

China has had the ability to launch commercial satellites since the late 1980's, but has not conducted a commercial launch since 1999, mainly due to difficulties with export controls. More specifically, due to Tiananmen Square sanctions that remain in place, U.S. satellites being shipped to China for launch must receive a waiver from the President before shipment. When faced with such a difficult requirement, satellite customers have chosen other launch providers instead. The new European satellites containing no U.S. components will allow 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. Given the continued strong competition in the satellite market, China will only win these contracts with extremely low prices, negatively impacting U.S. manufacturers. China has also worked with Brazil and Europe to develop advanced satellite technology and is expected to begin offering low-cost, mid-size satellites on the international market within five years.

India has stated a strong interest in entering the commercial launch services market. In 2007, India performed one launch for the Indian Government, on its Polar Satellite Launch Vehicle (PSLV) rocket.[17] 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 intends to enter the commercial communications satellite market, and has already manufactured several communications and remote sensing satellites for the 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.[18]

[17] "2007 Year in Review," Federal Aviation Administration, Office of Commercial Space Transportation, January 2008.
[18] http://www.bis.doc.gov/InternationalPrograms/IndiaCooperation.htm

Japan conducted no commercial launches in 2006, but is hopes to become a commercial participant in the future. Unfortunately, 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 are also exploring building commercial "spaceports", for commercial launches and space tourism flights. The FAA is currently reviewing safety factors impacting such facilities. The 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 raising prices. Prices for intermediate to heavy class launches on several recent competitions have increased from approximately $50 million to $80 million in the last two 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.

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 the 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, if NASA decides to rely mainly upon the use of commercial suppliers to deliver cargo and supplies to the International Space Station, the market could get a significant annual boost. NASA's Commercial Orbital Transportation Services (COTS) program would coordinate the commercial delivery of crew and/or cargo to the International Space Station. This type of service is very important to NASA because the Space Shuttle is scheduled to be retired in 2010, leaving the Space Station to be re-supplied only by Russian rockets. NASA selected SpaceX in August 2006 and Orbital Sciences in February 2008 as the winners for Phase 1 of COTS. The winners will engage in Space Act agreements through 2010, but must meet performance milestones in 2008.

During the early to mid 1990's, the telecommunications boom encouraged a large number of entities around the globe to enter the market, but the late 1990's downturn created huge oversupplies in the launch and satellite sectors, which eliminated normal profit margins through

2005[19] and resulted in reduced launch prices.[20] Over the past two years, those prices have nearly returned to the mid-1990's 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 limited access to its vehicles (Proton, Zenit for Sea Launch and Land Launch, and Soyuz).

The oversupply and extremely low launch prices also pushed the 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 to the sector's high risk and low returns on investment. However, investments in telecommunications satellite systems in 2006 are pointing 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 opportunities for space tourism. With the successful flight of Space Ship One and the recent release of Space Ship Two from Virgin Galactic, as well as the ongoing competitions sponsored by the Federal Aviation Administration (FAA) and private organizations to develop new technologies, this sector has seen been reenergized. However, to turn these demonstration launches into successful suborbital and/or orbital space tourism operations will require huge investments, the development of new safety and operational guidelines, and the ability to use new technologies regularly and at a reasonable cost. With short space tourism flights currently predicted to cost approximately $200,000 per person per flight, space tourism remains only in the grasp of millionaires.[21] This market will remain small for at least 10 years, but advances in innovation will spur further research and development. Nonetheless, the FAA is already developing guidelines and regulations for the safe operation of such commercial flights.

The more stringent enforcement of U.S. export control policies in the late 1990's 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 decreased below 70 percent, 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 the U.S. export control policies has been to develop communications satellites that do not contain any U.S. components. A small number of these satellites have been sold, highlighting international concern about buying from the United States.

[19] U.S. Department of Commerce, Office of Aerospace and Automotive Industries.
[20] U.S. Department of Commerce, Office of Aerospace and Automotive Industries.
[21] http://www.virgingalactic.com/en/when.asp

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 won't 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 the remote sensing; space-based positioning, navigation and timing (also known as GPS); and space transportation industries. 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, especially while the commercial market remains flat.

Future Trends

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. The Commercial Orbital Transportation Systems (COTS) program may have a strong impact on the small, entrepreneurial launch sector, but that will be determined by the final size and scope of the program. Two winners, SpaceX and Orbital Sciences, are developing systems to demonstrate delivery and return of cargo to the International Space Station. If successful, NASA could use 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.

Arianespace is expected to remain the leader in the commercial launch services sector, due to competitive pricing and a reliable launch vehicle. In addition to Ariane 5 launches, Arianespace will soon offer launches of the Russian Soyuz rocket and the Vega rocket from its Spaceport in French Guiana.[22] The Soyuz is planned to have its inaugural launch from French Guiana in late 2008. That project is co-funded by the European Space Agency, the European Union, Arianespace and Russia.

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

General Aviation

Overview

U. S. general aviation manufacturers shipped 4,272 units in 2007, beating the previous year's total and marking the best year for general aviation since 1982.[23] Exports represented almost 35 percent of total U.S. production and over 38 percent of total billings. Worldwide, estimated billings were up 16.6 percent over 2006 to $21.9 billion. As predicted, business jet shipments topped 1,000 for the first time in history. Industry analysts expect growth in that sector to continue.

Though North America is expected to remain the top market for aircraft sales, over half of general aviation 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.

General Aviation Manufacturers

Adam Aircraft
Airbus
Alpha Aviation
American Champion
Aviat Aircraft
Boeing Business Jets
Bombardier
Cessna Aircraft Company
Columbia Aircraft (now part of Cessna)
Cirrus Design Corporation
Dassault Falcon Jet
Diamond Aircraft
Eclipse Aviation
Embraer
Gippsland Aeronautics
Gulfstream
Hawker Beechcraft (ex-Raytheon)
Liberty Aerospace
Maule Air Incorporated
Mooney Aircraft
Pacific Aerospace Corporation
Piaggio
Pilatus
Piper Aircraft, Inc.
Quest Aircraft Company
Sino Swearingen
Socata EADS
Symphony Aircraft
Tiger Aircraft

Company data from the General Aviation Manufacturers Association. GAMA estimates their data covers over 90 percent of the total market.

Trends

2007 brought continued solid growth in the general aviation market, with billings reaching an all-time high of $21.9 billion worldwide. By number of units, piston airplanes remained the largest segment of the market, accounting for 68 percent of airplanes shipped. However, by billings, piston aircraft are by far the smallest segment at $897 million, trailing both jets at $19.4 billion and turbo-props at $1.58 billion. In addition, shipments of piston aircraft actually declined slightly in 2007

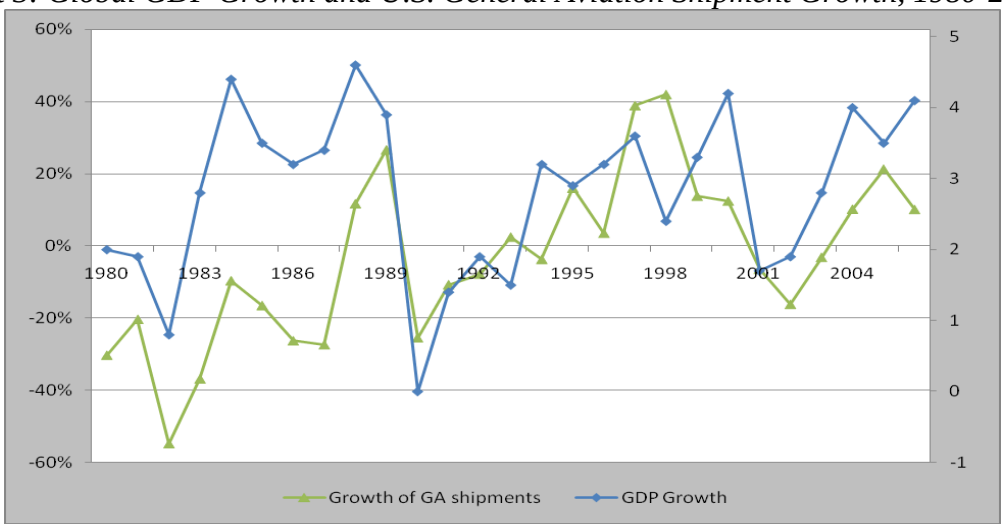
[23] Unless otherwise noted, all statistics and figures are taken from the General Aviation Manufacturers Association's General Aviation Statistical Databook, 2007.

(down nearly 3 percent), while shipments of both jets and turboprops grew (up 22.1 and 11.4 percent, respectively).

Approximately 77 percent of all general aviation aircraft shipped in 2007 was made in the United States, down one percent from last year. U.S. market share has been declining since 2001, and the average growth rate of U.S. shipments from 2001-2007 was 4.4 percent. By contrast, the average growth rate for the rest of the world during that time period was 18.3 percent.

As with large aircraft sales, economic growth is the major factor in the health of the general aviation industry. Given the costs involved, businesses tend to purchase a new plane or replace an old one when the economy is strong and profits are up. The chart below indicates that in recent years, changes in the general aviation market tend to lag economic growth by one year. General aviation 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 3: Global GDP Growth and U.S. General Aviation Shipment Growth, 1980-2006[24]



Outlook

Despite a sluggish U.S. economy, forecasters are not yet predicting a downturn in the general aviation market, at least not for business jets. Honeywell's Business Aviation Outlook called for slightly lower purchase expectations in North America, but greater expectations for purchases in other regions.[25] Rolls-Royce's September 2007 Outlook also predicts increased purchases of

[24] 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, Annual Average Rate of Growth-Percentage, and ALL years). Available on the web at: http://unstats.un.org/unsd/snaama/selectionbasicFast.asp.

[25] "Purchase expectations" refers to the percentage of the existing fleet that operators plan to replace or expand by, according to Honeywell survey respondents. Thus, the term "lower purchase expectations" refers to a smaller percentage relative to the previous year for a particular geographical region. Honeywell Financial Release, September 23, 2007.

business jets coming from abroad[26], and both estimate that by 2017, around 14,000 new jets will be delivered.

The FAA estimates that the business jet fleet will grow at an average of 6 percent per year through 2020, while growth in the piston and turboprop markets will be relatively stagnant at 0.3 percent and 0.6 percent per year, respectively.[27] Since the turboprop market actually grew at a rate similar to the business jet market from 2000-2006 (5.7 percent per year vs. 6.2 percent per year), presumably the expectation is that some old turboprop customers may turn to smaller jets.

Figure 2: Fixed-wing Turbine Business Aircraft Operators by Region, 2003[28]

Region	Number of Operators
North America	10,982
Europe	1,255
South America	979
Central America	485
Africa	379
Asia and Middle East	332
Oceania	143

Figure 3: Fixed-wing Turbine Business Aircraft Fleet by Region, 2003[29]

Region	Number of Planes
North America	16,650
Europe	2,378
South America	1,255
Rest of World	2,560

Though expectations remain high for the Asian market, much of the near term growth is being driven by a significant number of orders from the Middle East. The emergence of a strong business aviation community in the rest of Asia has been hampered by regulation, taxes and tariffs, and an aversion to what are perceived to be ostentatious luxury items. Given the role general aviation could play in increasing access to more remote locations in Asia, as well as the continued strong economic performance of Asian markets, manufacturers are hopeful that sales in this region will accelerate (see next section).

Purchase expectations are also strong in Latin America and Europe, aided in part by the weak dollar. Aircraft vendors have noted increased interest in business jets from clients in Eastern Europe and Russia. Eclipse Aviation expects that its less expensive very light jet (VLJ) will be particularly attractive in this market and is currently considering sites for an assembly facility in Russia. ETIRC Aviation, a subsidiary of the European Technology and Investment Research Center (ETIRC), which provides sales and support services for Eclipse aircraft in Eastern Europe,

[26] Rolls-Royce Outlook. September 2007. Available on the web at: http://www.rolls-royce.com/civil_aerospace/overview/market/outlook/downloads/outlook06-09-07.pdf
[27] FAA Forecast 2007-2020. March 16, 2007. Available on the web at: http://www.faa.gov/data%5Fstatistics/aviation/aerospace%5Fforecasts/2007%2D2020/
[28] National Business Aviation Association. NBAA Factbook 2004, p. 21.
[29] National Business Aviation Association. NBAA Factbook 2004, p. 21.

Russia, and the Commonwealth of Independent States, booked a large sale of Eclipse jets in May of 2007[30] to launch an air taxi service in Turkey.

Notable developments

The new markets are playing an increasingly important role for general aviation manufacturers, not only in terms of increased sales but also for manufacturing. Like Eclipse, several general aviation manufacturers have already built or are considering new facilities abroad. In 2005, Diamond Aircraft announced a joint venture with a local government to produce piston aircraft in China; the facility received certification from the European Aviation Safety Agency (EASA) in February 2008. In late 2007, Cessna announced that it would produce its new light sport aircraft in China, with engines and avionics shipped from the United States. The finished planes will be shipped back to the United States in pieces for reassembly at designated facilities. Indian entrepreneur Vijay Mallya acquired a 50 percent stake in Oregon-based Epic Air, an experimental aircraft manufacturer which has been developing very light jets. After announcing the deal in September 2007, some press reports indicated that Mallya was considering setting up an additional manufacturing facility in India. A motivating factor for most of these endeavors is to build market share by producing aircraft in the target market.

The very light jet (VLJ) market continues to garner significant attention, with industry forecasts predicting between 3,000 and 7,000 thousand aircraft to be delivered over the next few decades. However, as noted in a recent GAO report[31], the estimates for VLJs vary wildly due to different assumptions and limited information. In particular, there are varying definitions as to what constitutes a VLJ—some forecasts actually place the two current VLJs available for sale (from Cessna and Eclipse) in separate categories. Depending on how the market segments come to align in practice, manufacturers such as Diamond, Cirrus, Piper, Epic, and Embraer may eventually find themselves competing for the same customers. Some industry analysts are already concerned about the number of companies investing in VLJs, and in February 2008, the industry had its first casualty—Adam Aircraft, which had already launched a turboprop version of its aircraft, shuttered its Colorado facility after having already closed the facility in Utah. Critical to the success of the remaining companies is the viability of the new air taxi business model, which is being marketed as a way business travelers can avoid the inefficiencies of airline travel.

Policy debates on both sides of the Atlantic are having significant effects on the general aviation community. In the United States, the debate over FAA funding has pitted general aviation against the airlines as both sides question the equitableness of various funding mechanisms. Though the debate seemed to have been decided to the general aviation community's liking in 2007, it will likely be reinvigorated in 2009 due to elements of the Administration's budget proposal. In Europe, the debate over greenhouse gas emissions has included general aviation for the first time. Early drafts of the European Commission's proposal covering aviation in the EU's emissions trading regime excluded all but the largest business jets, later versions encompassed all aircraft over 5,700 kg (12,566 lbs) which includes most business jets. Business jets seem to have been caught up in the general backlash against aviation in Europe, which is experiencing expansion resulting from deregulation similar to what the United States experienced over 15 years ago. GAMA estimates that general aviation is responsible for 0.2 percent of total global greenhouse gas emissions.

[30] 120 firm orders with an option of 60 more.
[31] Government Accountability Office. Very Light Jets. GO-07-1001. August 2007. Available on the web at: http://www.gao.gov/new.items/d071001.pdf

Engines/Powerplants

Overview

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[32] 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	2007 Revenue (million)	2007 Income (millions)	2006-2007 % Change in Income
General Electric (Parent of GE Aviation)	Turbofan, turboprop, and turboshaft engines for a variety of civil and military aircraft; aeroderivative industrial and marine gas turbines	$172,738	$22,208	6.62
United Technologies Corp. (Parent of Pratt & Whitney)	Turbofan and turboprop engines for a variety of civil and military aircraft; rocket engines; aeroderivative industrial and marine gas turbines	$57,549	$4,224	13.18
Rolls-Royce PLC	Turbofan, turboprop, and turboshaft engines for a variety of civil and military aircraft; aeroderivative industrial and marine gas turbines	£ 4,038 ($7,945)*	£ 564 ($1,110)*	8.67

*At an exchange rate of £1 = $1.97

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

[32] In FY 2006, Rolls Royce civil and defense aerospace segments comprised a combined 75 per cent of the company's total revenues. See Rolls Royce PLC 2006 Financial Report Review of Operations.

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 Pratt & Whitney, 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 Pratt & Whitney, was formed to produce an engine for the Airbus A380.

A 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 in Russian aircraft manufacturer Sukhoi's SuperJet 100. PowerJet hopes to find additional regional jet customers for this engine as well as to develop additional variants.[33]

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.

[33] "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

Since no Russian engine manufacturers produce engines for use on Boeing or Airbus aircraft, the impact of Russian jet engines on the LCA jet engine market is negligible. As discussed above, however, Russian manufacturers are looking to participation in joint ventures in order to gain access to the global aircraft engine market.[34]

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.[35]

Market Trends

By definition, market trends in the aircraft engine market are linked to aircraft sales. Boeing and Airbus, the two LCA manufacturers, typically have two engine options for each model offering, except the Boeing 737. The same situation exists for most regional jet aircraft. Therefore, an end user-customer could, and often does, purchase a U.S.-manufactured Boeing 747 aircraft and equip it with UK-manufactured Rolls-Royce engines. Similarly, customers choose to equip Airbus aircraft such as the A330 and A320 with Pratt & Whitney and CFM 56 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 unchanged in 2007. In the delivery segment, GE Aviation, Rolls-Royce and CFM[36] currently lead 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 high unit sales of the CFM 56 engine. As the CFM 56 is the sole engine choice for the entire Boeing 737 series and is also used in a number of Airbus aircraft, deliveries of the engine should remain high for the foreseeable future.

On the other hand, 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 and 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.

Pratt & Whitney's position as the second-largest aircraft engine manufacturer in the United States is increasingly based on its revenue from military sales and 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 CFM 56 engine offered by its competitor CFM, and EcoPower, a closed-loop, environmentally friendly engine wash service that results in improved engine fuel economy and performance. Pratt & Whitney's most promising new product is its geared turbofan (GTF). The GTF offers significant fuel consumption savings over similar size engines, and the company is working with NASA to

[34] 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 .

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

[36] 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.

demonstrate the engine's ability to use alternative, non-petroleum based aviation fuels.[37] The company has experienced 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, Pratt & Whitney 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 could be somewhat modest as Pratt & Whitney is a partner in both the Engine Alliance and IAE. From these cooperative efforts, Pratt & Whitney still stands to benefit from the introduction of new aircraft and engines. In addition, Pratt & Whitney has already secured two launch customers for its GTF engine and is looking to find additional customers.[38] 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, Pratt & Whitney will use its own joint venture channel to market its GTF engine through its membership in IAE, as German manufacturer (and fellow IAE member) MTU is working closely with the company on product testing.[39]

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

[37] "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

[38] "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

[39]" 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____

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.

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.

Aside from ascendancy of competitors outside the United States and EU, the most significant development with potentially long-term impact is monetary in nature. The weakness of the U.S. dollar and corresponding rise of the Euro has compelled Rolls-Royce to shift its industrial base away from the United Kingdom to lower-cost, dollar-denominated markets. Rolls-Royce CEO Sir John Rose recently 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."

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.[40]

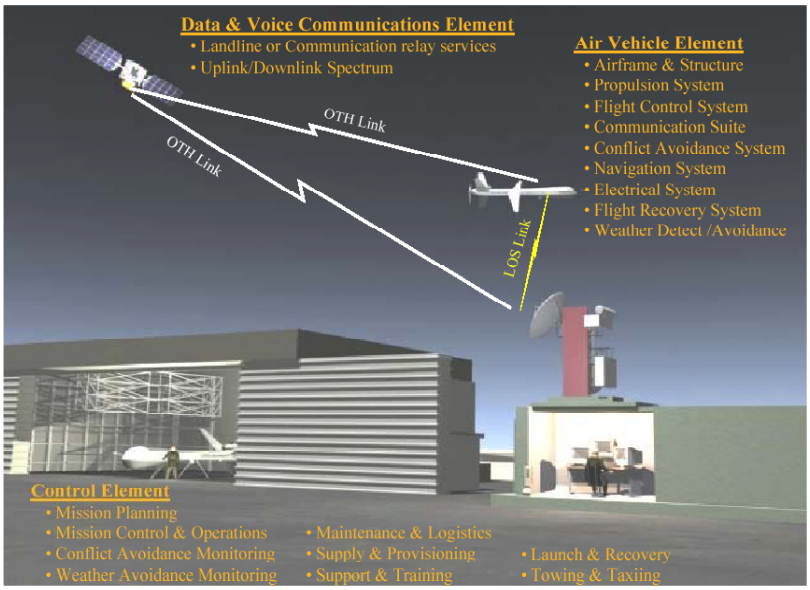
[40] "China to develop large commercial aircraft by 2020" available at http://www.iht.com/articles/2007/03/12/business/jet.php

Unmanned Aircraft Systems (UAS)

Overview

Unmanned Aircraft Systems (UASs) are air vehicles and associated equipment that do not carry a human operator, but instead fly autonomously, or are remotely piloted. UASs 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.

Figure 1. Conceptual UAS System[41]



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 UASs 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[42]:

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

Market Trends in 2007

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

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 UASs globally. As of February 2007, DOD had more than 3,900 unmanned aircraft in its inventory compared to fewer than 50 in 2000. The majority of these aircraft are currently being used in support of ongoing operations in Iraq and Afghanistan.[43] Particularly, smaller, shorter range UASs have seen dramatic usage increases. Today's operational military UASs 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" in December 2007.[44] 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.

The DOD Quadrennial Defense Review released in February, 2006, calls for increased reliance on UASs by nearly doubling the DOD UAS capacity, and tasking a rationalization of UAS development and use among the armed services. The QDR calls for 45 percent 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.

[43] "Unmanned Aircraft Systems: Advance Coordination and Increased Visibility Needed to Optimize Capabilities," Government Accountability Office, July 2007, GAO-07-386, p. 2.
[44] http://www.acq.osd.mil/usd/Unmanned%20Systems%20Roadmap.2007-2032.pdf

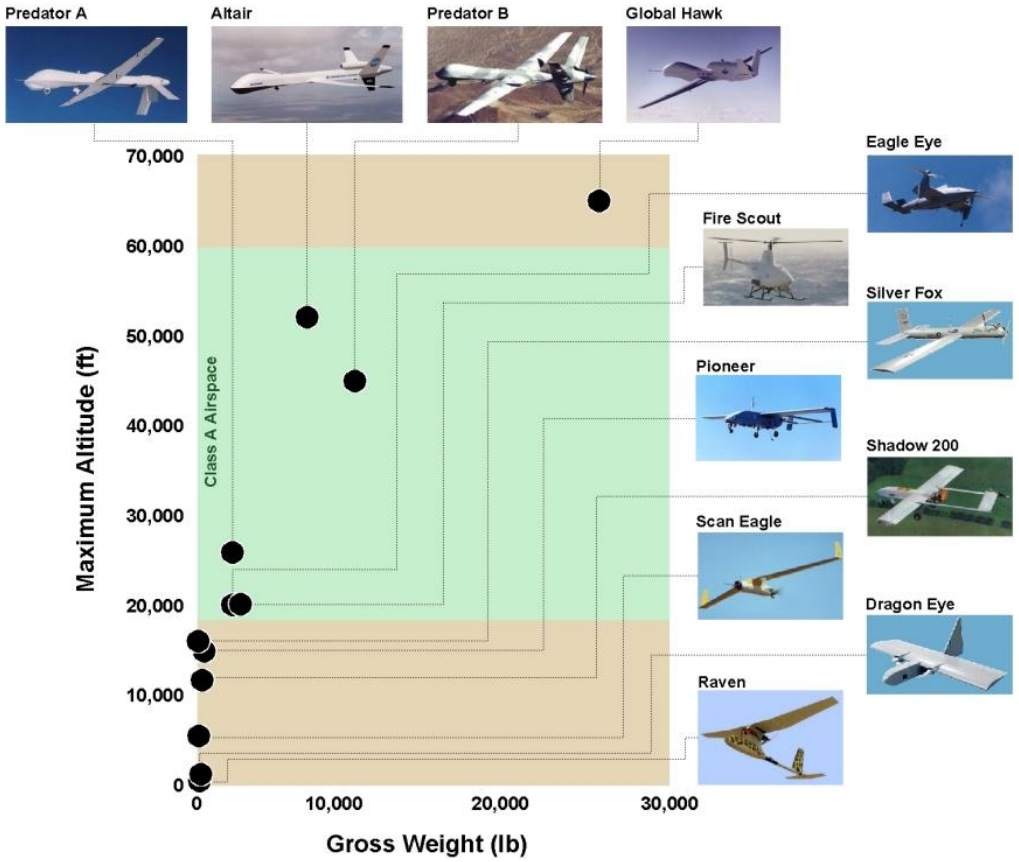


Figure 2. Current U.S. Operational UASs[45]

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 UASs 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 over the next seven years, providing the world's second largest market for UAVs and unmanned combat vehicles.[46] 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

[45] "The Impact of Unmanned Aerial Vehicles on the Next Generation Air Transportation System: Preliminary Assessment", Unmanned Aerial Vehicle National Task Force, October 22, 2004
[46] Unmanned Aerial Vehicle Market Brief, U.S. Commercial Service-Germany, March 21, 2005; http://www.buyusainfo.net/docs/x_2891343.pdf

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 UASs into civil airspace are key factors limiting growth in the non-military UAS sector. As a result, most civil operations of UASs in 2007 were related to test or demonstration flights.

The Federal Aviation Administration (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.[47] 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 UASs into the NAS. The Unmanned Aircraft Program Office (AIR-160), responsible for coordinating all FAA certification and operational policy activities related to UASs, is expected to publish a UAS roadmap to clarify the path toward normal certification and operation of UASs in the NAS.[48] Publication of the roadmap has been delayed until sometime in 2008.

Current access to national air space in the United States is predominately granted through special Certificates of Authorization (COAs) issued by the FAA for public UASs. 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 100 COAs were issued in 2006; 140 COAs were expected to be issued in 2007.[49] UASs 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.

- The Department of Commerce's National Oceanic and Atmospheric Administration has conducted test flights for weather and environmental data gathering and fisheries management, and used a UAS to gather weather data by flying through Hurricane Noel in November 2007.

- NASA initiated flight tests in early 2007 with an Ikhana (modified Predator B).[50] One high profile test occurred in October 2007 when NASA flew Ikhana over the wildfires in Southern California, providing data via the National Interagency Fire Center to incident commanders in the field to aid them in allocating their fire-fighting resources and

[47] *Federal Register*: February 13, 2007 (Volume 72, Number 29), Rules and Regulations, Pages 6689-6690; available at http://www.gpoaccess.gov/fr/retrieve.html .
[48] For more information, visit http://www.faa.gov/uas
[49] Remarks by Tony Ferrante, Director for Air Traffic Safety Oversight Service, Federal Aviation Administration, at AUVSI Unmanned Air Systems Program Review, February 9, 2007.
[50] http://www.nasa.gov/centers/dryden/news/NewsReleases/2007/07-12.html

demonstrating UAS capabilities for firefighting missions.[51] In December 2007, NASA expanded its UAS testing capabilities by taking delivery of two Global Hawk Advanced Concept Demonstration Vehicle UASs previously used by the DOD for use in science missions starting in 2009.[52]

- Department of Homeland Security took delivery in 2007 of their third UAS for border patrol monitoring, and expect to take delivery of a fourth system in early 2008.[53] During 2006 and 2007, Customs and Border Patrol Predator B UASs flew more than 1,500 flight hours in support of border security missions and contributed to the seizure of more than 15,000 pounds of marijuana and the apprehension of more than 4,000 illegal aliens.[54]

- In 2007, the Houston, Texas and Miami-Dade, Florida police departments conducted demonstration flights of UAS capabilities for law enforcement purposes.

Another authority for operating aircraft in the NAS is via an airworthiness certificate issued by the FAA.[55] After issuing two experimental certificates in calendar years 2005 and 2006, the FAA issued 17 experimental certificates in 2007 to seven systems. The FAA anticipates issuing approximately four experimental certificates per year for the near future.

Table 1. Experimental Certifications Granted in 2007 for Non-military UAS

System	Company	Date	Description
Shadow 200B	AAI	Feb. 2007	1 experimental certificate for flight test operations
Cobra	Raytheon Missile Systems	Feb. 2007	3 experimental certificates (1 year) for flight test operations
Sky Warrior ERMP	General Atomics	May 2007	1 experimental certificate for flight test operations
GE-50	Aurora Flight Sciences	May 2007	limited experimental certificates for two test flights
Skybus 30K	Telford Aviation	May 2007	1 experimental certificate for flight test operations
CyberBug	Cyber Defense	June 2007	1 experimental certificate for flight test operations
GE-50	Aurora Flight Sciences	July 2007	limited experimental certificates for one test flight
Cobra	Raytheon Missile Systems	October 2007	3 experimental certificates for flight test operations (including one recertification)
gMAV	Honeywell International	December 2007	1 experimental certificate for flight test operations
GE-50	Aurora Flight Sciences	December 2007	limited experimental certificates

[51] http://www.nasa.gov/vision/earth/lookingatearth/socal_wildfires_oct07.html
[52] http://www.nasa.gov/centers/dryden/news/NewsReleases/2007/07-73P.html
[53] http://www.dhs.gov/xnews/speeches/sp_1202219631845.shtm
[54] http://www.dhs.gov/journal/leadership/2007_12_01_archive.html
[55] Public users operating UASs under a COA typically are responsible for certifying that their aircraft are airworthy via an approved means, such as a Department of Defense airworthiness statement.

			for two test flights

Competitors

The U.S. UAS industry is undergoing a major transition. Unlike a decade ago, all major U.S. aerospace prime contractors are now involved in UAS programs and expected to remain working on UASs 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 UASs 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 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 have outperformed the overall S&P 500 over the last five years. Most privately held U.S. UAS manufacturers are not widely diversified out of this market segment, although they may produce a variety of UASs. 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 UASs, 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 competition.

Accordingly, the following listing of companies is intended only to provide a representative snapshot of the UAS industry in early 2008. The following U.S. companies manufacture UASs 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**	**2006 Revenue (thousands)**	**2006 Income (thousands)**	**2005-2006 % 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*	$494	($20,099)	(114%)
General Atomics	Predator*, Altair, Sky Warrior*	N/A		
Honeywell	gMAV*	$31,367	$3,061	23.2%
Insitu	Scan Eagle, GeoRanger	N/A		
Lockheed Martin	Desert Hawk	$39,620	$3,953	32.3%
Northrop Grumman	Global Hawk, Fire Scout	$30,148	$2,623	6.8%
Raytheon	Cobra*	$20,291	$1,961	25.3%
Textron	Bell Eagle Eye*, AAI Shadow*	$11,490	$1,413	37.3%
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 UASs 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.[56]

2008 and Beyond

In 2008, 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 warfighting 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. Although growth is expected in 2008 across all sizes and classes, small UASs likely will see the greatest increase in use in 2008 as more systems are deployed in active combat at the unit level.

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

- NOAA is planning to establish 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
- Additional demonstration tests by local law enforcement authorities will be undertaken.

[56] "UAV Systems: The Global Perspective 2005", UVS International

The FAA will formally initiate development of special regulations to govern operation of small, low-flying UASs within visual line-of-sight but 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[57], 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 Integrated Product Team (JIPT) for UAS. However, little appreciable increase in UAS operations will occur in the United States in 2008, based on the reduced number of experimental airworthiness certifications estimated by the FAA to be granted in 2008.

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 UASs 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. One market assessment conducted by a series of UAS manufacturers concluded that the civil market for UASs may be between $3 billion - $10 billion by 2015.

[57] http://www.rtca.org/comm/Committee.cfm?id=45

Maintenance, Repair, and Overhaul

Overview

In terms of value, the global maintenance, repair, and overhaul (MRO) industry has not recovered to pre- 9/11 levels, as pressure from struggling airlines forced MRO firms to become more cost efficient. According to industry experts, the unit cost of MRO has been declining and is expected to decline through 2015.[58] Thus, although airline fleets are actually increasing globally, their market value is not expected to recover for several years. North America remains the largest consumer of MRO services, but labor cost advantages are causing some airlines to outsource to offshore MRO providers. The foreign market share for MRO will likely increase as fleets expand overseas, particularly in Asia.

Major MRO Providers in North America[59]

OEMs	**Independents**	**Airlines**
EADS	AAR Aircraft Services	Air Canada Technical Services
GE	Avborne	American M&E
Goodrich	Cascade	Delta Tech
Hamilton Sundstrand	Chromalloy	
Honeywell	Empire Aero	
Middle River	Evergreen	
Nordam	Pemco	
Pratt & Whitney	MTU	
Rockwell Collins	ST Aerospace	
Rolls Royce	Timco	

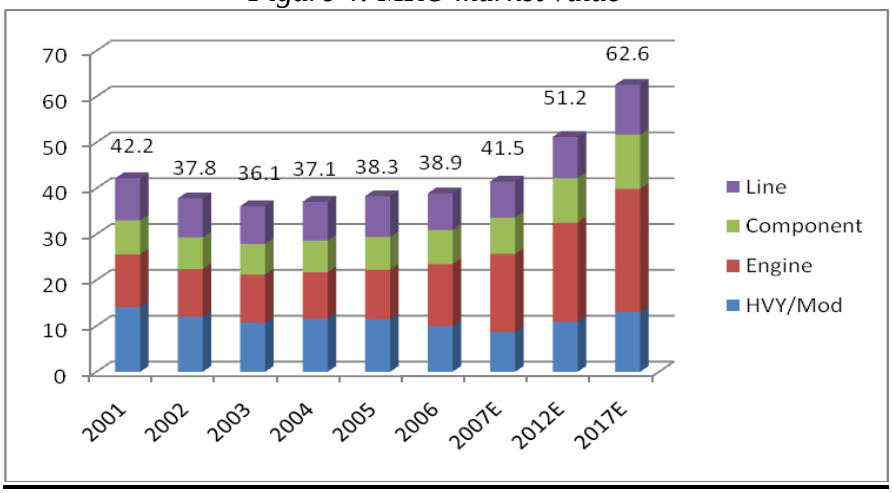
Trends

MRO firms fall into three main categories: the Original Equipment Manufacturers (OEMs), the airlines, and the 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 staff to take care of non-covered maintenance needs. Today, 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 TeamSAI and BACK Aviation Solutions, approximately 50 percent of MRO activity was

[58] TeamSAI produces a widely-used industry forecasting tool. Until 2006, that tool was produced with BACK Aviation Solutions. In 2007, the tool was produced with Ascend. David Marcontell. TeamSAI. "Engine MRO Industry Growth." Presentation at the Aero-Engine Cost Management Conference, Hollywood, FL. February 6, 2006.
[59] Jonathan M. Berger, SH&E International Air Transport Consultancy. "MRO Facilities for the Americas Region." Presentation at the 5th Annual Aircraft Maintenance Outsourcing Conference for the Americas, Las Vegas, NV. November 9, 2005. Available on the web at: http://www.sh-e.com/presentations/Berger_MRO_Speech_11-05.pdf

outsourced in 2000, a figure that they expect will increase to 65 percent by 2010.[60] Seventy-three percent of North American heavy airframe maintenance expenditures stay in North America, with 14 percent completed in Asia and 5 percent in Europe.[61] In contrast to heavy airframe maintenance, North America is a net importer of MRO services for both engines and airframes.[62] Outsourced airframe maintenance is more likely to be for, but is not limited to, wide-body aircraft.

Figure 4: MRO market value[63]



The global market value of MRO services has been slowly growing since 2004 but it has still not recovered to pre-9/11 levels, and is not expected to for several years. Changes in fleet composition, labor costs, and customer demand have led to a general decrease in the cost of maintenance services and the time it takes 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, has helped lower the overall cost of maintenance.[64]

In addition, industry pressure to increase efficiency in the MRO process has led firms to make organizational changes that have reduced the time for and cost of repairs. Finally, the international market, and particularly pressures to reduce labor costs to remain competitive have contributed to a shrinking market for MRO services in the United States.

The only exception to these trends is in the engine MRO segment, where new engine technologies are actually increasing the cost of maintaining the engine. Also, unlike airframe maintenance, most of the cost of engine overhaul comes from parts rather than labor, and thus is not as affected by the

[60]Marcontell. TeamSAI. "Future of MRO for the Americas." Presentation at the Renaissance Hotel in Las Vegas, NV. November, 2005.
[61]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/
[62]Kevin Michaels. AeroStrategy. "MRO Market Outlook—Forecast and Key Trends." Presentation at MRO Asia, September 2006.
[63] Frank Jackman. "MRO Market is Up and Down." *Overhaul and Maintenance.* April 2007. Available on the web at: http://www.aviationweek.com/media/pdf/2007forecast.pdf.
[64]Marcontell, TeamSAI. "Engine MRO Industry Growth." Presentation at the Aero-Engine Cost Management Conference, Hollywood, FL. February 6, 2006.

labor cost reductions the industry has been able to achieve.[65] Industry analysts predict that engine MRO will be the highest growth segment of the market over the next several years.

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 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.[66] 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 planes by 2025[67] and China to acquire about 2,600 new planes in that timeframe.[68]

On the supply side, MRO capacity in Asia is likely to grow, as companies set up new facilities to cater 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 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.[69] Firms from Singapore, which has long been a 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[70] and Asia is a net exporter of airframe maintenance services.[71]

Notable Developments

Backlash against outsourcing has been increasing in recent months, as labor unions working for in-house airline MRO facilities allege increased risks to safety from outsourced MRO. Maintenance, particularly component maintenance, has always been completed by independent repair stations, but an increasing number of airlines are now outsourcing heavy maintenance. Though the unions include all independent repair stations in their critique, they specifically criticize foreign facilities, citing inexperience and language barriers as contributing to the risk. The labor unions and the 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.

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[65] Jackman. "MRO Market Up Modestly As Efficiencies Take Hold." *Overhaul and Maintenance.* April 12, 2006. Available on the web at: http://www.aviationweek.com/media/pdf/AprForecast.pdf.
[66] Jackman. April 2007.
[67] 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 .
[68] The Boeing Company. "2005 Current Market Outlook." p. 28. Available on the web at: http://www.boeing.com/commercial/cmo/index.shtml .
[69] 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.
[70] Marcontell. November 2007.
[71] Michaels. September 2006.

Airport Infrastructure/Aviation Security

Overview

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 $31 billion in 2004 to $36 billion in 2005.[72] 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	Parsons Transportation	Battelle	SRA International/Galaxy
Corp.	Group	SRS Technologies, Inc.	Security
Daktronics, Inc.	ESRI	TransCore	SecureScan
ARINC	URS Corporation	Raytheon/McNeil	ARINC (Verified Identity
Arconas	Airports Seating Alliance	Security	Pass/Clear)
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,	Vanderlande Industries	American Science and	L-3 Communications,
LLC	Bradford Airport Logistics	Engineering, Inc.	Security and Detection
All Weather Inc.	NBP Corporation		Systems, Inc.

Analysis and 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)[73], the U.S. Government is working, on a multi-agency basis, to develop policy and technology roadmaps that will support a doubling or 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."[74] Some

[72] Airports Council International. "Airports invest to meet surging traffic demand." Press Release. January 24, 2006.
[73] 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).
[74] Kevin Brass. "Dubai turns focus to airports." *International Herald Tribune*. March 29, 2006.

analysts expect China alone to build up to 50 new airports in the next decade.[75] Furthermore, existing airports continue to renovate and expand in order to handle future increases in passengers and cargo traffic as well as larger jets (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 Federal Aviation Administration, 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 (as in 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.[76] This business is projected to grow at a rate of 9 percent a year over the next 10 years.[77]

The need for new and/or expanded airport capacity is further underlined by the current and potential job growth that has been spurred by the surge in passenger traffic and cargo volumes over the past two years.[78] According to Airports Council International and the Air Transport Action Group, 4.5 million persons were employed on airport sites worldwide in 2005.[79] Amsterdam's Schiphol Airport alone employs approximately 58,000 people on its grounds each day.[80] 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".[81] 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.[82]

Figure 1 provides a breakdown, by region, of airport employment in 2005.

Figure 1: 2005 Airport Employment[83]

[75] *Ibid.*
[76] *Ibid.*
[77] *Ibid.*
[78] Airports Council International. "Airports Stimulate Employment and Economic Growth." Press Release. April 11, 2006.
[79] *Ibid.*
[80] John D. Kasarda. "The Rise of the Aerotropolis." *The Next American City*. Issue 10. Spring 2006.
[81] 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 web at http://www.uli.org/AM/Template.cfm?Section=Home&CONTENTID=21387&TEMPLATE=/CM/ContentDisplay.cfm
[82] Kevin Brass. "Dubai turns focus to airports." *International Herald Tribune*. March 29, 2006.
[83] Airports Council International. "Understanding Airport Business." Press Release. July 6, 2006.

Region	Employed directly by airport operators	Total employees on airport sites
Africa/Middle East	50,000	250,000
Asia/Pacific	100,000	950,000
Europe	135,000	1,100,000
Latin America/Caribbean	25,000	200,000
North America	42,000	2,000,000
Total	**352,000**	**4,500,000**

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.[84]

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 (the Gore Commission).[85] 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.[86]

The Bush Administration has 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 Administration drafted a National Strategy for Aviation Security (NSAS).[87] 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 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.

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

[85] 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

[86] 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

[87] 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

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.[88] 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 course, 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.

Future Market

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 National Strategy for Aviation Security 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 throughout much of the world airports have been government-owned enterprises, this paradigm is shifting towards commercially operated businesses (as is the case in the United States).[89] As such, the current and planned new airports and expansion projects will provide numerous opportunities for providers of airport infrastructure products. Granted, government-owned airports will continue to favor local or regional providers. That being said, the paradigm shift towards commercial operation as well as current government-to-government negotiations regarding procurement indicate that opportunities will arise and 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 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 (rather than jerry-rigged, as is the case in many airports today).

[88] 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
[89] Kevin Brass. "Dubai turns focus to airports." *International Herald Tribune*. March 29, 2006.

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.

Cross-Cutting Issues

Workforce

In 2002, the Commission on the Future of the U.S. Aerospace Industry reported that the U.S. aerospace workforce is in jeopardy. It pointed to a significant reduction in the number of U.S. workers, a lack of young workers who are attracted to the aerospace industry, a loss of U.S. jobs through offsets agreements, and the need for more mathematics and science education in the United States. These concerns continue today.

Although various sources report conflicting figures on the number of workers employed in the U.S. aerospace manufacturing industry, a trend is clear: the number of workers fell by approximately half between 1990 and 2004, but then began a slow rebound.[90] Among the reasons for the decline are increases in manufacturing productivity, the elimination of jobs associated with mergers and acquisitions, cutbacks in defense procurement following the end of the Cold War, and increased offshore sourcing of components. Since bottoming-out in early 2004, U.S. aerospace employment has slowly rebounded. The number of workers for December 2007 was 495,100, up 13 percent from the December 2003 figure (436,800).[91] While their numbers have declined over the last 15 years, American aerospace workers are well paid. In the most recent month for which data is available, December 2007, the average hourly wage rate for aerospace production workers was $28.39, approximately 62 percent higher than the wage rate for U.S. manufacturing production workers in general (which was $17.54).[92] Additionally, the Commission on the Future of the U.S. Aerospace Industry reported that 26-27 percent of aerospace workers will be eligible to retire by 2008, and the industry is having difficulty attracting and retaining younger workers to replace those leaving.

Anecdotal evidence appears to show that offsets in civil aircraft trade are increasing, either because they are formally required, or a company feels pressure to provide them. An "offset" is compensation required of producers as a condition for selling to a government-owned or controlled entity, and may involve subcontracting, co-production, or technology transfer that could have adverse effects on the U.S. economy**.**

To address these concerns, the President's American Competitiveness Initiative (ACI) recognized the importance of intellectual capital as an ingredient to economic well-being. This initiative is aimed at boosting federally funded R&D and at strengthening U.S. education of mathematics and science. Further, in December 2006, President Bush signed Public Law 109-420, establishing an "Interagency Aerospace Revitalization Task Force" headed by the U.S. Department of Labor. The law stipulates that the task force will "develop a strategy for the Federal Government for aerospace workforce development" and report annually to Congress on its findings and recommendations.

Environment

[90] http://data.bls.gov/cgi-bin/srgate
[91] Ibid.
[92] http://data.bls.gov/cgi-bin/dsrv

Many foreign countries are taking action to limit the environmental impact of aviation. Some of this work is coordinated through the International Civil Aviation Organization (ICAO), where 187 member countries work together to establish consensus-based standards and recommended practices. G-8 member countries have proposed inclusion of aviation in a post-Kyoto Protocol work program to address greenhouse gas (GHG) emissions policies. However, some countries are considering unilateral measures to limit GHG emissions from aviation that may not be aligned with international consensus. For example, the European Commission proposes to include foreign airlines in a European emissions trading system (ETS) in the absence of mutual consent from foreign governments, in violation of ICAO principles and resulting in significant 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. U.S. manufacturers are supportive of new environmental regulations that are technologically feasible and economically reasonable, and are considered in a balanced manner. Dramatic changes in environmental regulations may impose a significant financial burden on struggling airlines or force the early retirement of some aircraft or equipment.

In addition to noise and emissions-related activities, government agencies, academia, manufacturers and operators have established the Commercial Aviation Alternative Fuels Initiative (CAAFI) to develop a roadmap for the development of non-petroleum based aviation fuels to limit emissions and enhance energy security. 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.[93] 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 is expected to experience significant demand for aircraft over the next several decades, taking delivery of around 380 new aircraft.[94] Domestic passenger traffic is expected to grow at 12.5 percent per year as the growing Indian middle class starts to spend 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 in 2005, with Indian carriers ordering 327 new aircraft. The expected growth in the Indian market has generated considerable competition amongst foreign firms.

Overall, India imports a majority of 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

[93] "2007 Year in Review", Federal Aviation Administration, Office of Commercial Space Transportation, January, 2008.
[94] Fleet estimate from Boeing. U.S. Commercial Service Market Research http://www.buyusainfo.net/docs/x_4342293.pdf .

2001, was the first indigenous fighter produced in India in nearly 40 years.[95] 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 ($76.1 million at current exchange rates).

In response to complaints over a lack of transparency in the defense acquisition process, the 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.[96] A second program, announced in 2006, would invest $12.5 billion in regional airports through 2009.[97] Most recently, the U.S-India Aviation Cooperation Program (ACP), a public-private partnership between the U.S. Trade and Development Agency (USTDA), the U.S. Federal Aviation Administration (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.

[95] 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
[96] U.S. Commercial Service Market Research. http://www.buyusainfo.net/docs/x_866852.pdf
[97] "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 nearing 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 3,000 new aircraft by 2026.[98] 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 1999, China established 10 new state-owned enterprises (SOEs), two of which were aerospace related. All of China's large aerospace-related institutes were operationally merged with enterprises in their area of specialty. The two industry leaders for aircraft are China Aviation Industry Corporation I (AVIC I), which focuses on large- and medium-sized aircraft, leasing and general aviation aircraft, and China Aviation Industry Corporation II (AVIC II), which produces small aircraft, feeder aircraft, and helicopters. AVIC I and AVIC II and their subsidiaries have about 560,000 employees.[99]

China has extensive plans for its indigenous civil aircraft manufacturing sector. AVIC I is currently developing China's first indigenous regional jet, the ARJ21. AVIC I hopes to sell 500 regional jets in 20 years and will seek FAA certification to facilitate exports of the aircraft. AVIC I also plans to launch a stretched version of the ARJ21, which would take the aircraft from its maximum of 90 seats to a new maximum of 105. The first ARJ21 rolled off of the assembly line in December 2007, and flight testing should begin in March 2008. The first delivery is scheduled for September 2009. Orders for the ARJ21 stand at 171.[100]

With the regional jet project well under way, China has since turned to the large civil aircraft category. In March 2006, China released its 11th 5-Year plan, which included the goal of developing an indigenous large passenger aircraft. The goal is to produce the plane for military and civil purposes by 2015, with entry into commercial service in 2020.[101] The Chinese government is expected to make an announcement about the company that will be responsible for manufacturing this aircraft in late Spring 2008.

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 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

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[98] Boeing Current Market Outlook 2007. Available on the web at: http://www.boeing.com/commercial/cmo/pdf/Boeing_Current_Market_Outlook_2007.pdf.

[99] Peder Andersen. "China's Growing Market for Large Civil Aircraft." U.S. International Trade Commission, Office of Industries Working Paper. February 2008. Available on the web at: http://www.usitc.gov/ind_econ_ana/research_ana/research_work_papers/documents/ChinaLCA2-14-2008final.pdf.

[100] K.K. Chadha. AINonline. February 19, 2008. Available on the web at: http://www.ainonline.com/news/single-news-page/article/china-lays-plans-for-arj21-900/?no_cache=1.

[101] Andersen. p. 12.

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), avionics (Rockwell Collins), flight control systems (Honeywell, Parker Aerospace), and the landing gear (Lieberherr Aerospace).[102]

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.[103] 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.[104] 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[105] never came to fruition. Despite this history, in October 2006 Airbus signed a "Framework Agreement" with a Chinese consortium to assemble A320 aircraft in Tianjin, China, with production designed to serve the Chinese market. Production is anticipated to begin in 2009.

For coproduction of regional jets, Chinese companies have found a willing international partner in Embraer. AVIC II 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.[106] The enterprise delivered its first plane in 2004; slow orders, however, placed some doubt on the long-term viability of the project.[107] These concerns were somewhat alleviated in August 2006 when HNA, the fourth largest airline company in China, placed an order for 50 ERJ 145s to be produced at the Harbin plant.

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 aviation industry, with air traffic increasing at a rate of 8.0 percent per year.[108] AVIC I predicts that passenger traffic is expected to grow 14.5 percent annually between 2005 and 2010.[109] Given that there are only about 1,100 registered aircraft operating in China (compared to roughly 219,000 in the United States[110]), industry analysts

[102] Andersen. p.11.
[103] *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.
[104] Andersen. p. 8.
[105] Diane Brady and Charles Goldsmith. "Airbus is Set to Help China Build Jetliner." *The Wall Street Journal.* November 20, 1996.
[106] "Embraer Joint Venture Will Build RJs in China." *Aviation Financial News.* December 9, 2002.
[107] Nicholas Ionides. "ERJ-145 deal earns reprieve for Chinese assembly line." *Flight International.* Jan 24-30, 2006.
[108] Boeing Current Market Outlook 2007.
[109] Presentation by CAAC Deputy Director General Sha Hongjiang, at the U.S.-China Aviation Summit, Washington, D.C., September 18, 2006.
[110] Speech by CAAC Vice Minister Li Jun, China–U.S. Aviation Symposium, Beijing, April 2004.

predict that Chinese airlines will need to add over 3000[111] large- and medium-sized aircraft to their fleets over the next two decades.

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 is changing as Chinese airlines become more independent.

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.[112] 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 U.S. Federal Aviation Administration 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.

[111] Consolidated estimate from Boeing, Airbus, CAAC, and industry analysts.
[112] 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. But 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.[113]As a result, Japanese airlines import their aircraft, mostly from the United States.[114] Japan has been the largest market for U.S. aerospace exports since 2003, accounting for $26.3 billion in exports from 2003-2006.[115]

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 29,765 aerospace workers.[116] 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.[117]

The expansion into new civil aerospace markets has been aided significantly through financial support from the Japanese government, such as through the International Aircraft Development Fund (IADF) made up of the four heavies and the Ministry of Economy, Trade, and Industry (METI).[118] 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.[119]

More than 91 Japanese companies, including the four heavies, are program partners, subcontractors, or suppliers to Boeing across its commercial-airplane product lines.[120] 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 ordered 796 Boeing airplanes worth approximately $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.[121]

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[113] Kevin Done. "Mitsubishi to Market New Regional Jets." *The Financial Times.* October 9, 2007.
[114] Japanese customers have ordered 845 aircraft from Boeing compared to about 105 from Airbus. Data from Boeing and Airbus websites.
[115] International Trade Administration analysis of Census data. Available on the web at: http://www.ita.doc.gov/td/aerospace/inform/Trade.htm.
[116] "Aerospace Industry in Japan." The Society of Japanese Aerospace Companies (SJAC). 2007.
[117] The Society of Japanese Aerospace Companies (SJAC), 2003.
[118] 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.
[119] The Society of Japanese Aerospace Companies (SJAC), 1998.
[120] "The Boeing Company and Japan," Updated June 2005. Available on the web at: http://www.boeing.com/companyoffices/aboutus/boejapan.html.
[121] "The Boeing Company and Japan."

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.[122]

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 61 percent of Japanese aircraft are sold to the Japanese Defense Agency.[123] 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.

For example, Japanese firms have been interested in entering the regional jet market, with firms expressing interest in the idea since at least 1991.[124] In the mid-1990s, a partnership between Mitsubishi and Bombardier to produce 100-seat regional jets was discussed,[125] but never came to fruition. In 2003, Mitsubishi launched a study, half-funded by the government, to explore the feasibility of a Japanese RJ. 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.[126] Mitsubishi began formally marketing the aircraft in October 2007 and by February had announced 6 partner suppliers.[127] A formal launch of the program is expected within several weeks.

Mitsubishi hopes that the expertise it has gained in composites while working on the Boeing 787 will help distinguish its regional jet from its competitors' offerings, which are already on the market or are nearing flight-testing phase. Mitsubishi's jet would be the first composite regional jet.

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[122] "Airbus Picks Three More Suppliers from Japan for Its A380 Jet," *Wall Street Journal*, June 2002.
[123] "Aerospace Industry in Japan." SJAC. 2005.
[124] Paul Proctor. "Japanese Firms Force Advanced Aircraft Industry." *Aviation Week and Space Technology*. July 29, 1991.
[125] Eiichiro Sekigawa and Michael Mecham. "Mitsubishi Sees 100-seater in Global Express' Wing." *Aviation Week and Space Technology*, August 26, 1996.
[126] Knight Ridder Tribune Business News. "Japan's First Jetliner to Get Financial Lift." June 1, 2007.
[127] 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.

Country/Regional Studies: Europe

The European Union (EU) is the largest regional export market for the United States aerospace industry. Although Japan was the largest single country export market for the U.S. aerospace industry in 2007, combined exports of the U.S. aerospace industry to France, the United Kingdom, and Germany, the EU's three largest aerospace markets, illustrate the importance of the region for both the U.S. and EU aerospace markets.[128] 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 and competitors for U.S .firms.

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 and Spanish state ownership, nearly 5 percent ownership by a Russian state-owned bank as well as other public shareholders. EADS emerged in 2000 from the link-up of the German–French Aerospatiale Matra and Spain's CASA. Additionally, Thales-Alenia is 27.2 percent owned by the French state.

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 regional 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.

[128] "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 $46.7 billion (in 2007 dollars).[129] The French aerospace industry employed approximately 132,000 people in 2007.[130] The outlook for the French aerospace industry remains generally positive, characterized by continued revenue growth, record orders, and a stable industry workforce.[131] In the civil aerospace sector, the Airbus A380 and Dassault Falcon 7X entered into service in 2007 and the A350, Falcon SMS, and Falcon 2000 LX programs were launched.[132] There was also a significant rise in telecommunications satellite orders. However, the decreasing value of the dollar is seen as a major issue of concern despite the continued growth of export orders.

Germany

The German aerospace industry is the second largest in Europe, with 2006 exports of $27.7 billion[133] and 2007 employment in aeronautics at 70,500. Germany accounts for approximately one-fifth of the total revenue generated by the European aerospace industry.[134] 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, production of the Airbus A400M tactical airlifter, 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.[135]

United Kingdom

The UK aerospace industry is the third largest in Europe, with 2007 exports of $27.7 billion (in 2007 dollars).[136] The UK aerospace sector continues to grow by approximately 8 percent annually from 2003 to 2007, due primarily to growth in the maintenance, repair and overhaul (MRO) market,

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[129] 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.

[130] 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

[131] Ibid.

[132] Ibid.

[133] 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 .

[134] The German Aerospace Industry Maintains Its Ascent: U S. Department of Commerce, September 2005, available at http://www.buyusainfo.net/docs/x_4638399.pdf.

[135] 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/ .

[136] 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 .

which is driven by increasing demands for air travel.[137] 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,[138] Honeywell,[139] Raytheon,[140] Rockwell Collins,[141] and Lockheed Martin[142] 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.[143]

Probably the primary challenge 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. In fact, 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.[144] As previously noted, Rolls-Royce is considering additional shifts in its industrial base away from the UK to lower-cost, dollar-denominated markets.[145] 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.

Italy

The Italian aerospace industry is the fourth largest in Europe, with 2006 worldwide exports of $4.4 billion.[146] The Italian aerospace industry, which employed approximately 38,000 people in 2005, is generally open to cooperation with the U.S. aerospace industry.[147] Major players in the Italian aerospace industry include Finmeccanica, 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.[148] Telespazio, a Finmeccanica joint venture, is involved in satellite management and navigation, and broadband multimedia

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[137] 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 .
[138] Hoover's Company Records – Basic Company Record Boeing UK Ltd.
[139] http://www.honeywell.com/sites/uk/aerospace.htm .
[140] http://www.raytheon.co.uk .
[141] http://www.rockwellcollins.com/about/locations/rcuk/index.html .
[142] http://www.lockheedmartin.co.uk/aboutus/aboutus.html .
[143] SABC UK Aerospace Industry Survey 2007 available at http://www.sbac.co.uk/pages/24059849.asp
[144] http://www.rolls-royce.com/northamerica/history/default.htm
[145] "Rolls-Royce to shift production away from Britain" available at http://findarticles.com/p/articles/mi_qn4158/is_20080208/ai_n21280488
[146] 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 .
[147] http://www.european-defence.co.uk/examples/natoeu_defence_report.pdf
[148] Hoover's Company Records – In Depth Company Record Finmeccanica SpA.

telecommunications.[149] 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.[150]

Spain

Spain's aerospace industry is the fifth largest in Europe, with 2006 exports of $3.0 billion[151] and 2007 employment of 25,700 workers. The Spanish aerospace industry, which has declined from 28,099 workers in 2005, is dominated by three manufacturers.[152] EADS CASA is Spain's largest aerospace company and is a world leader in light- and medium-sized military aircraft. EADS CASA is also responsible for final assembly of the Airbus A400M and is a supplier of aerodynamic surface components for the Boeing 737, 757 and 777.[153] Gamesa Aeronautica designs, develops, and manufactures major subassembly structures for a number of large civil aircraft. [154] Indra Sistemas S.A. is Spain's leading producer of electronic defense equipment.[155] 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.[156] Again, similar to the other member countries of the EU, the outlook for Spain's aerospace industry remains positive, as continued sales growth by EADS affiliated aerospace companies carries over to the industry in general.

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

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

[151] 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 .

[152] http://www.atecma.org .

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

[154] http://www.gamesa.es/gamesa/index.htm l.

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

[156] 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.[157] 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 First 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 company's President and General Director.[158] In this capacity, Fedorov is responsible for day to day operations

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

[158] 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

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.[159] Accomplishment of this goal is based in large part on a variety of cooperation agreements between UAC member companies, its direct competitors and suppliers.[160] 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.

Beyond consolidation, Russian aviation companies have aggressively pursued agreements to supply materials, parts, and engineering services for Western commercial aircraft and engine manufacturers.[161] Boeing has invested more than $1.3 billion[162] into Russian joint ventures since the early 1990s and plans to bring that total to $2.5-$3 billion by 2010.[163] 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 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.[164] The

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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/

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

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

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

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

[163] "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.

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

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.[165] 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.[166] 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.[167] The Superjet should begin flight testing in spring 2008 and enter service in late 2008 or early 2009.[168]

[165] "Pratt & Whitney in Russian Gas Turbine Accord," Dow Jones Newswires, August 9, 2000.
[166] "Sukhoi picks up pace on RRJ," *Concise B2B Aerospace*, June 17, 2003.
[167] "Paris Breathes New Life into Jet Project", *The Moscow Times*, September 20, 2004.
[168] "Sukhoi's Superjet might fly this month" AIN online, available at http://www.ainonline.com/news/single-news-page/article/sukhois-superjet-might-fly-this-month/?no_cache=1&cHash=fa08adf806