

Boeing's Global Supply Chain for 787 Dreamliner: A Sustainable Competitive Advantage or Lack of Oversight?

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Abstract

In the early 2000s, US based Boeing; the world's largest aerospace company lost its title of "the world's largest supplier of commercial aircraft" to Airbus. The key for Airbus success was its long term plan to come up with new models of different aircraft segments. Whereas for Boeing, since the introduction of B-777 in 1994, ten years passed without the introduction of any new line of aircrafts in its product line. Also, the aggressive marketing strategy for its A-320 family of aircrafts by Airbus in the form of undercutting Boeing's 737 aircraft price to make entry into the discount carrier market was giving it the number advantage over Boeing in the smaller aircraft segment. Another possible factor for Boeing losing the top position could be the help from British, French, German and Spanish government to Airbus in the form of development loans and different types of other subsidies.

To gain back control in the aviation market Boeing decided to bring a game changer product, the Boeing 787 aircraft which consists of 50 percent composite materials make up and 20 percent more fuel efficient than any other mid-sized aircraft. For making such a revolutionary product one requires lot of investment and technological up-gradation, which is always a risky affair in financial terms. To bring its new product quickly into market, and to reduce its financial risk Boeing decided to built a global supply chain for its Boeing 787 Dreamliner aircrafts. Companies from countries such as Canada, Italy, Australia, Japan, United Kingdom, France, Germany, etc., are part of Boeings 787 global supply chain.

But in recent years, the B-787 Dreamliner has taken a hit because of the battery fire in two planes making the regulators around the world to ground all the fifty operating Dreamliners for some time. Boeing's engineers are blaming the multi tier global supply chain for the faults in the aircraft, where the top tiers of 50 suppliers were made responsible for managing their sub-contractors. As per a Boeing 787's electrical engineer the cheap poor quality plastic power panels supplied by subcontractors was the cause of the battery failure. Earlier also the Dreamliner had faced multiple supply chain problems which delayed the planes debut for more than three years and also resulted in project cost escalation by Billions of dollars.

This case will discuss Boeing's rationale behind the unconventional supply chain for B-787, and the challenges currently it is facing in managing its global supply chain.

Background Study

In the early 2000s, US based Boeing, the world's largest aerospace company lost its title of "the world's largest supplier of commercial aircraft" to Airbus (Refer Exhibit 2) and needed a game changer product in its commercial aircraft portfolio to gain back control. A key to Airbus success in pushing Boeing to 2nd position was its long term plan to come up with new models at different aircraft segments. In case of Boeing, since the introduction of B-777 in 1994, ten years passed without the introduction of any new line of aircrafts in its product line, and the R&D was simply focused on modifications in existing models.

In the year 2002, Airbus started its work on preparing giant aircraft hangers next to Blagnac airport near Airbus's headquarters at the outskirts of Toulouse for the world's biggest airliner, the A-380. It was the first manifestations of a \$10.7 billion programme to develop a rival to the iconic B-747, the 416-seater jumbo that has enjoyed a monopoly in big airliners, in both passenger and freighter categories for over 30 years. By August 2003 Airbus was having 129 firm orders and 70 options to purchase for A380. By August 2003, the value of the firm orders for A-380 was around \$35 billion.

Also, in the initial years of 2000, the aggressive marketing strategy for A-320 type of aircrafts by Airbus has helped it to gain market shares in the low-fare-airlines segment where Boeing's 737s had a monopoly for a long time. Another reason of Boeing losing the top position could be the help from British, French, German and Spanish government to Airbus in the form of development loans and different types of other subsidies.

As per analysts from aviation industry the only way in which Boeing should have saved itself from loosing further market share to Airbus was by selling its plane cheaper than the competitors. To reduce its production cost and to improve its supply chain Boeing decided to go global, partnering with companies from countries such as Canada, Italy, Australia, Japan, United Kingdom, France, Germany, etc for its latest aircraft model B-787.

Boeing 787 Dreamliner problems

The following is the list of problems faced by Dreamliner:

2012

July -- A General Electric Co. engine on a 787 in North Charleston, South Carolina, breaks during a preflight test. The National Transportation Safety Board rules it a "contained" failure, meaning the broken pieces did not

exit through the engine wall. GE orders inspections of the engines. The Federal Aviation Administration stops short of grounding planes for inspections.

Dec. 4 -- A United Airlines 787 with 184 people aboard is forced to make an emergency landing in New Orleans after experiencing electrical problems.

Dec. 5 -- U.S. regulators say there is a manufacturing fault in 787 fuel lines and advises operators to make extra inspections to guard against engine failures.

Dec. 13 -- Qatar Airways grounds one of its three 787s after finding the same electrical problem that affected the Dec. 4 United flight.

Dec. 17 -- United confirms finding an electrical problem in a second plane in its 787 fleet.

2013

Jan. 7 -- A parked 787 operated by Japan Airlines catches fire at Boston Logan International Airport after a battery in an auxiliary power system explodes.

Jan. 8 -- A second 787 operated by Japan Airlines leaks fuel at Logan, forcing it to cancel its takeoff and return to the gate. The plane departs later.

Following a safety inspection, United finds a wiring problem in the same electrical system that caused the Jan. 7 fire in Boston, the Wall Street Journal reports.

Jan. 9 -- Japan's All Nippon Airways Co. cancels a 787 flight scheduled for a domestic trip within Japan due to brake problems.

Jan. 11 -- A cockpit window on an ANA 787 cracks during a Japanese domestic flight. The plane lands safely with no injuries. A separate ANA 787 springs an oil leak from its left engine, which is discovered after the plane lands safely.

The U.S. Department of Transportation took a critical decision of making 787 Dreamliner to undergo a comprehensive review of its critical systems.

Jan. 13 -- The Japan Airlines 787 that leaked fuel in Boston on Jan. 8 experiences another, separate fuel leak while undergoing checks in Tokyo.

Jan. 15 -- A 787 operated by ANA makes an emergency landing at Takamatsu in western Japan after smoke appears in the plane's cockpit.

Overview of Boeing

Start and Growth

In 1903, two events launched the history of modern aviation. The Wright brothers made their first flight at Kitty Hawk, N.C., and 22-year-old William Boeing left Yale engineering college for the West Coast. After making his fortune trading forest lands around Grays Harbor, Wash., Boeing moved to Seattle, Wash., in 1908 and, two years later, went to Los Angeles, Calif., for the first American air meet. Boeing tried to get a ride in one of the airplanes, but he did not have any chance to fly from the dozen aviators participating in the event. Boeing came back to Seattle disappointed, but determined to learn more about this new science of aviation.

For the next five years, Boeing's air travel was mostly theoretical, explored during conversations at Seattle's University Club with George Conrad Westervelt, a Navy engineer who had taken several aeronautics courses from the Massachusetts Institute of Technology. The two checked out biplane construction and were passengers on an early Curtiss Aeroplane and Motor Co.-designed biplane that required the pilot and passenger to sit on the wing.

On July 15, 1916, Boeing incorporated his airplane manufacturing business as Pacific Aero Products Co.; a year later, he changed the name to the Boeing Airplane Co. By the end of 1917, World War I was under way, and for the first time, American airplanes were going into battle. Boeing knew the Navy needed training airplanes, and they had already designed the Model C seaplane. The seaplanes flew well at the Navy base at Pensacola, Fla. and the Navy ordered 50 Model Cs. This was the company's first production order. By May of 1918, 337 people were on the Boeing payroll.

From 1922 through 1925, Edgar Gott, William Boeing's first cousin, was president of the company. While Gott was president, the Navy awarded Boeing a contract to build a primary trainer. The Navy bought 71 NB trainers, and Boeing subsequently sold five more to Peru. By 1928, with 800 employees, Boeing was one of the largest aircraft manufacturers in the country.

The company has expanded over the years, and merged with McDonnell Douglas in 1997. With corporate offices in Chicago, Boeing currently employs more than 170,000 people across the United States and in 70 countries. Boeing is organized into two business units: Boeing Commercial Airplanes and Boeing Defense, Space & Security.

Boeing Commercial Airplanes

Boeing has been the premier manufacturer of commercial jetliners for more than 40 years. Today, the main commercial products are the 737, 747, 767 and 777 families of airplanes and the Boeing Business Jet (Refer Exhibit 1). New product development efforts are focused on the Boeing 787 Dreamliner, and the 747-8. The company has nearly 12,000 commercial jetliners in service worldwide, which is roughly 75 percent of the world fleet.

Boeing Financials

From December 2011 to December 2012, The Boeing Company has seen little change in their bottom line (from \$4.0B USD to \$3.9B USD) despite revenues that grew from \$68.7B USD to \$81.7B USD (Refer Exhibit 7). A key factor for sustaining its position is the increase in the percentage of sales devoted to the cost of goods sold from 81.28% to 84.02%. In the first Quarter of 2013 the company earning per share (EPS) rose by 24% to \$1.73 on strong operating profits. Because of higher delivery of B-737 and B-777, Boeing generated revenue of \$18.9 billion in the quarter. Though the company managed high delivery of B-737 and B-777, there has been a big fall in the numbers of B-787 delivery. Cash and marketable securities of \$11.8 billion is providing strong liquidity to the company.

Boeing 787: A key competitive strategy for sustainable development

Boeing in 2004 launched the 787 aircraft family, an all-new, super-efficient airplane. Top international aerospace companies, led by Boeing at its Everett, Wash., facility near Seattle and in North Charleston, S.C. builds the airplane. The 787-8 Dreamliner can carry 210 - 250 passengers on routes of 14,200 to 15,200 km, while the longer 787-9 Dreamliner will carry 250 - 290 passengers on routes of 14,800 to 15,750 km.

Boeing designed 787 Dreamliner with the objective to generate revenues by creating value for customers. Boeing aimed to improve the travel experience for the passengers. As compared to the aluminum used in airplane manufacturing for other aircrafts, the composite materials used in the 787 (carbon fiber, aluminum and titanium) allows for increased humidity and pressure in the passenger cabin, offering substantial improvement to the flying experience. The lightweight composite materials enable the B-787 to fly nonstop between any two cities without layovers. Boeing 787 provides airlines with matchless fuel efficiency, resulting in excellent environmental

performance. The airplane uses 20 percent less fuel than similarly sized other airplanes. The 787 can travel at Mach 0.85, a similar speed as today's fastest twin-aisle airplanes. Airlines also take in more cargo revenue capacity, 20 to 45 percent advantage over similarly sized airplanes.

The key to the exceptional performance of the B-787 is its collection of new technologies and its groundbreaking design. The primary structure of the B-787 is made up of 50% composite materials, including the fuselage and wing. At the center of the B-787 design is a modern systems architecture that is simpler, more functional and more efficient. The onboard health-monitoring systems enable the airplane to self-monitor and report systems maintenance necessities to ground-based computer systems. Advances in engine technology are the principal contributor to overall fuel efficiency improvements on the 787 aircraft. The new engines from General Electric and Rolls-Royce represent a two-generation jump in technology. The design and manufacture process of the 787 has added further efficiency improvements. For example, manufacturing the 787 fuselage as one-piece sections has eliminated 1,500 aluminum sheets and 40,000 - 50,000 fasteners per section.

Immediately with the launch of 787 Dreamliner program in April 2004 Boeing received a record order from All-Nippon Airways (Refer Exhibit 4). 58 customers from across the world have placed orders for more than 900 airplanes valued at more than \$185 billion, making it the most successful twin-aisle launch in Boeing's history. More than 50 of the world's most capable top-tier supplier partners are working with Boeing to bring innovation and expertise to the 787 program (Refer Exhibit 3). The suppliers have been involved since the early design phase of the program and all are connected virtually at 135 sites around the world (Refer Exhibit 3).

The B-787 program opened its final assembly plant in Everett in May 2007 and in North Charleston in July 2011. First flight of the 787-8 Dreamliner occurred on December 15, 2009, followed by certification in August 2011. First delivery of the 787-8 to ANA took place on Sept. 25, 2011 (Refer Exhibit 6).

B-787s Green Technology: A Strategic Edge over Competitors

More than 75% of Boeing's commercial airplane R&D efforts contribute to advancing environmentally progressive innovations. Boeing's mission was to provide airlines with unmatched fuel efficiency. This would result in astonishing environmental performance. No other

company has come even close. The 787 actually uses 20 percent less fuel than other similarly-sized airplanes. For the 787 Dreamliner, Boeing is planning to come with a new exhaust nozzle made of ceramic matrix composite material, designed to make engines quieter, lighter and more efficient.

Also, Boeing took the leadership role in forming the Aircraft Fleet Recycling Association, which has grown to more than 40 members committed to the goal of recycling up to 90 percent of a retired airplane by 2016. Boeing is leading industry efforts to continue researching and developing improved recycling technologies and processes. Boeing also collaborated with the University of Nottingham, England, to develop carbon fiber recycling processes and technology to process recycled fiber into new applications and products.

B-787 Global Supply Chain

Boeing decided to go for global supply chain for its 787 aircraft family to gain competitive advantage over its European competitor Airbus Industries. B-787s suppliers are distributed over 12 countries (Refer Exhibit 3). Japanese companies such as Toray, Teijin, Seiki, Fuji, Kawasaki and Mitsubishi are producing 35% of the aircraft. Italy's Alenia Aeronautica is manufacturing around 10% of the plane. 70-80% of the entire aircraft is built by other companies (suppliers). Also, some parts of the Dreamliner are built by Boeing at its facilities outside the US, in Canada and Australia.

With the huge financial risk of over \$5 billion in the 787 Dreamliner project, to mitigate risk Boeing needed partners from across the globe. The global nature of both technology and aircraft market meant finding exceptional developers and suppliers from different countries across the world. It also meant finding international companies willing to step up to the risk associated with a highly expansive new product. These partners not only spread the risk but also bring loyalty to the table. Countries that have a stake in the B-787 project are more likely to buy from Boeing than compared to the European competitor Airbus. The best example of it is the orders being received from Japanese airlines. Japanese Airline Company All Nippon Airways (ANA) order for 66 Dreamliner is the second largest order for the aircraft in the Boeings order book. In total Boeing received 111 B-787 orders from Japan (Refer Exhibit 5). Similarly orders for 53 B-787 were received from UK. Total 249 orders out of the total 930 B-787 orders are from the partner/supplier countries which accounts to 27% of total B-787 orders (Refer Exhibit 5).

Global Supply Chain Issues at Boeing

The 787's supply chain was envisioned to keep manufacturing and assembly costs low, while spreading the financial risks of development to Boeing's suppliers. Also another key factor behind going global was to reduce the "cycle time" of aircraft manufacturing to 3 days, thus coming out of the assembly line faster than any other aircraft. Though going global for manufacturing helped Boeing in controlling the financial risk but it has also exposed Boeing to the off-shoring risk.

Delay in Production at Supplier's Site

The delivery of the first 787 got delayed by more than 6 months because of the problems of Boeing's global chain of suppliers in completing their work. Some of the other challenges that Boeing faced were worldwide shortage of fasteners that hold together the plane's fuselage, wing and tail sections, and out-of-sequence production work.

Electric Systems Flaw

In recent times the B-787 project has taken a tail spin because of the battery fire on a Dreamliner in Boston and the smoldering of another battery on a flight in Japan a week later, making the regulators around the world to ground all the fifty operating Dreamliners for some time. Boeing's engineers are blaming the multi-tier global supply chain for the faults in the aircraft, where the top tiers of 50 suppliers were made responsible for managing their sub-contractors. As per a Boeing 787's electrical engineer the cheap poor quality plastic power panels supplied by subcontractors was the cause of the battery failure.

It was a mammoth challenge for Boeing to make the 50 Dreamliners grounded for 3 months operational. Boeing moved a small army of technicians to 13 international locations, transporting 15 tons of tools per repair kit, and installing newly designed equipment in the field, taking five days per airplane working around the clock in two 12-hour shifts. According to Louis J. Mancini, Senior vice president, Boeing, the process of fixing the grounded aircrafts was complicated and required a series of steps such as changes to the battery, changes to the charger, changes to the vent tube, the enclosure, etc. After extensive redesign of the lithium-ion battery being used in the Dreamliner and slight modifications in the aircraft the grounded Dreamliners were recertified for flight.

New Challenges from Airbus

While Boeing is struggling with the Battery snag

in its 787 Dreamliners, its biggest rival Airbus displayed its latest aircraft A350-900 in the Paris Air Show during the month of June this year. Made with lightweight carbon composites, the A350 targets Boeing's 777 and the 787 Dreamliner. Over 70% of the A350's weight-efficient airframe is made from advanced materials that combine composites (53 per cent), titanium and advanced aluminum alloys. The innovative carbon fibre reinforced plastic fuselage results in lower fuel burn as well as easier maintenance. With this new fuselage, along with the latest systems and engines Airbus is claiming for a 25 % lower fuel burn, 25 % lower operating costs, and 25 % lower CO₂ emissions. The A350-900 also offers more range and additional seats for greater revenue potential. Airbus is pinning its hopes on the fuel-efficient A350 to compete in the long-haul sector where it still lags behind Boeing. The only disadvantage that A350 have over B787 is the cost of the European built plane which costs about \$254-\$332 million each, compared with \$206-\$243 million for a Dreamliner. With Airbus already getting orders for 444 A350-900s, and a steep fall in the delivery of B-787s in the first quarter of 2013, Boeing need to come back strongly with new strategies to fix its Global supply chain problems, so as to maintain its first mover advantage in the fuel-efficient range of aircrafts.

End Notes

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xxvi Multi-tier global supply chain: For the 787 Dreamliner, Boeing contracted with a top tier of about 50 suppliers, handing them complete control of the design of their piece of the plane. Those major partners had to make the upfront investment, share the risk and own their design. Each was responsible for managing its own subcontractors.

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Annexures



Source: Boeing website <http://www.boeing.com/boeing/commercial/products.page?>, accessed on July 30, 2013

Exhibit 1 : Boeing Commercial Models Currently in Production

Orders

| Year | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 |
|--------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Airbus | 493 | 833 | 1419 | 574 | 271 | 777 | 1341 | 790 | 1055 | 370 | 284 | 300 | 375 |
| Boeing | 435 | 1203 | 805 | 530 | 142 | 662 | 1413 | 1044 | 1002 | 272 | 239 | 251 | 314 |

| Year | 2000 | 1999 | 1998 | 1997 | 1996 | 1995 | 1994 | 1993 | 1992 | 1991 | 1990 | 1989 |
|--------|------|------|------|------|------|------|------|------|------|------|------|------|
| Airbus | 520 | 476 | 556 | 460 | 326 | 106 | 125 | 38 | 136 | 101 | 404 | 421 |
| Boeing | 588 | 355 | 606 | 543 | 708 | 441 | 125 | 236 | 266 | 273 | 533 | 716 |

Sources: Airbus net orders until May 31, 2013 <http://www.airbus.com/company/market/orders-deliveries/>
Boeing net orders until Jun 04, 2013 <http://active.boeing.com/commercial/orders/index.cfm>

Deliveries

| Year | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 |
|--------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Airbus | 247 | 588 | 534 | 510 | 498 | 483 | 453 | 434 | 378 | 320 | 305 | 303 | 325 |
| Boeing | 245 | 601 | 477 | 462 | 481 | 375 | 441 | 398 | 290 | 285 | 281 | 381 | 527 |

| Year | 2000 | 1999 | 1998 | 1997 | 1996 | 1995 | 1994 | 1993 | 1992 | 1991 | 1990 | 1989 |
|--------|------|------|------|------|------|------|------|------|------|------|------|------|
| Airbus | 311 | 294 | 229 | 182 | 126 | 124 | 123 | 138 | 157 | 163 | 95 | 105 |
| Boeing | 491 | 620 | 563 | 375 | 271 | 256 | 312 | 409 | 572 | 606 | 527 | 402 |

Sources: Airbus net orders until May 31, 2013 <http://www.airbus.com/company/market/orders-deliveries/>
Boeing deliveries until May 31, 2013 <http://active.boeing.com/commercial/orders/index.cfm?content=displaystandardreport.cfm&optReportType=CurYrDelv>

Exhibit 2 : Boeing Vs Airbus- Orders and Delivery

The 787 Team consists of:

| Company/Business Unit | Main Location | 787 Work Statement |
|--|-------------------------------|---|
| Boeing Commercial Airplanes (announced Nov and Dec 2003) | Washington | Airplane development, integration, final assembly, program leadership |
| Alenia Aeronautica (announced Nov. 2003) | Italy | Horizontal stabilizer, center fuselage |
| Boeing Charleston (announced as Vought Aircraft Industries Nov. 2003) | South Carolina | Aft fuselage |
| Boeing Fabrication (announced Nov 2003) | Washington, Canada, Australia | Vertical tail assembly, movable trailing edges, wing-to-body fairing, interiors |
| Spirit Aerosystems Inc. (announced as Boeing-Wichita Nov 2003; Apr 2004) | Kansas, Oklahoma | Fixed and movable leading edges, flight deck, part of forward fuselage, engine pylons |
| Fuji Heavy Industries (announced Nov 2003) | Japan | Center wing box, integration of the center wing box with the main landing gear wheel well |
| Kawasaki Heavy Industries (announced Nov 2003) | Japan | Main landing gear wheel well, main wing fixed trailing edge, part of forward fuselage |
| Mitsubishi Heavy Industries (announced Nov 2003) | Japan | Wing box |

Case

| Company/Business Unit | Main Location | 787 Work Statement |
|--|----------------|---|
| Hamilton Sundstrand (announced Feb 2004, Mar 2004, Jul 2004, Sep 2004) | Connecticut | Auxiliary power unit, environmental control system, remote power distribution units, electrical power generating and start system, primary power distribution, nitrogen generation, ram air turbine emergency power system, electric motor hydraulic pump subsystem |
| Rockwell Collins (announced Feb 2004, Jun 2004) | Iowa | Displays, communications/ surveillance systems, pilot control system |
| Honeywell (announced Feb 2004, Jul 2004, Dec 2004) | Arizona | Navigation, maintenance/crew information systems, flight control electronics, exterior lighting |
| GE Aviation (formerly Smiths Aerospace) (announced Feb. 2004, Jun. 2004) | United Kingdom | Common core system, landing gear actuation and control system, high lift actuation system |
| Goodrich (announced Mar 2004; Apr 2004, Jun 2004, Nov 2004, Dec 2004) | North Carolina | Fuel quantity indicating system, nacelles, proximity sensing system, electric brakes, exterior lighting, cargo handling system |
| Messier-Dowty (announced Mar 2004) | France | Landing gear structure |
| Dassault Systèmes (announced Feb 2004) | France | Global collaboration tools/software |
| Boeing Interiors Responsibility Center (announced Mar 2004) | Washington | Interior |
| Eaton Aerospace (formerly FR-HiTemp) (announced Mar 2004) | United Kingdom | Pumps and Valves |
| Rolls-Royce (announced April 2004) | United Kingdom | Engines |
| General Electric (announced Apr 2004) | Ohio | Engines |
| Boeing Propulsion Systems Division (announced Apr 2004) | Washington | Propulsion systems engineering and procurement services |
| Moog Inc. (announced May 2004) | New York | Flight control actuators |
| Kidde Technologies (announced May 2004) | North Carolina | Fire protection system |
| Toray Industries (announced May 2004) | Washington | Prepreg composites |
| Thales (announced Jul 2004, Aug 2004, Sep 2005) | France | Electrical power conversion, integrated standby flight display, in-flight entertainment system |
| Labinal (announced Jul 2004) | France | Wiring |
| Parker Hannifin (announced Sep 2004) | Ohio | Hydraulic subsystem |
| Messier-Bugatti (announced Nov 2004) | France | Electric brakes |
| Latecoere (announced Nov 2004) | France | Passenger doors |
| Monogram Systems (announced Nov 2004) | California | Water and waste system |
| Air Cruisers (announced Nov 2004) | New Jersey | Escape slides |
| Delmia Corp. (announced Nov 2004) | Michigan | Software |
| Intercim (announced Nov 2004) | Minnesota | Software |
| Panasonic (announced Dec 2004, Nov 2005) | Japan | Cabin services system, in-flight entertainment system |
| Bridgestone (announced Dec 2004) | Japan | Tires |
| Ultra Electronics Holdings (announced Dec 2004) | United Kingdom | Wing ice protection system |
| GKN Aerospace (announced Dec 2004) | United Kingdom | Composite mat for the wing ice protection system |
| Korry Electronics (announced Jan 2005) | Washington | Flight-deck control panels |
| Ipeco (announced Apr 2005) | United Kingdom | Flight-deck seats |
| Diehl Luftfahrt Elektronik (announced Apr 2005) | Germany | Main cabin lighting |
| Jamco (announced Apr 2005, May 2005) | Japan | Lavatories, flight deck interiors, flight deck door and bulkhead assembly, galleys |
| C&D Zodiac (announced Apr 2005) | Washington | Sidewalls, window reveals, cargo linings, door linings and door surrounds |

Case

| Company/Business Unit | Main Location | 787 Work Statement |
|---|---------------|--|
| Securaplane (announced Apr 2005) | Arizona | Wireless emergency lighting system |
| Donaldson Company, Inc. (announced May 2005) | Minnesota | Air purification system |
| Astronautics Corp. of America (announced May 2005) | Wisconsin | Electronic Flight Bag (EFB) |
| CTT Systems (announced Aug 2005) | Sweden | Zonal Drying system |
| PFW (announced Oct 2005) | Germany | Metallic tubing and ducting |
| Saab Aerostructures (announced Oct 2005) | Sweden | Large cargo doors, bulk cargo doors and access doors |
| Korean Airlines - Aerospace Division (announced Oct 2005) | Korea | Raked wing tips for the 787-8 |
| PPG Aerospace (announced Dec. 15, 2005) | Alabama | Electrochromic windows |
| Vought Aircraft Industries (announced July 2009) | Texas | Longerons, stringers, shear ties, and frame assemblies |

Source: Boeing website http://www.boeing.com/boeing/commercial/787family/dev_team.page

Exhibit 3 : Boeing 787 Dreamliner Partners

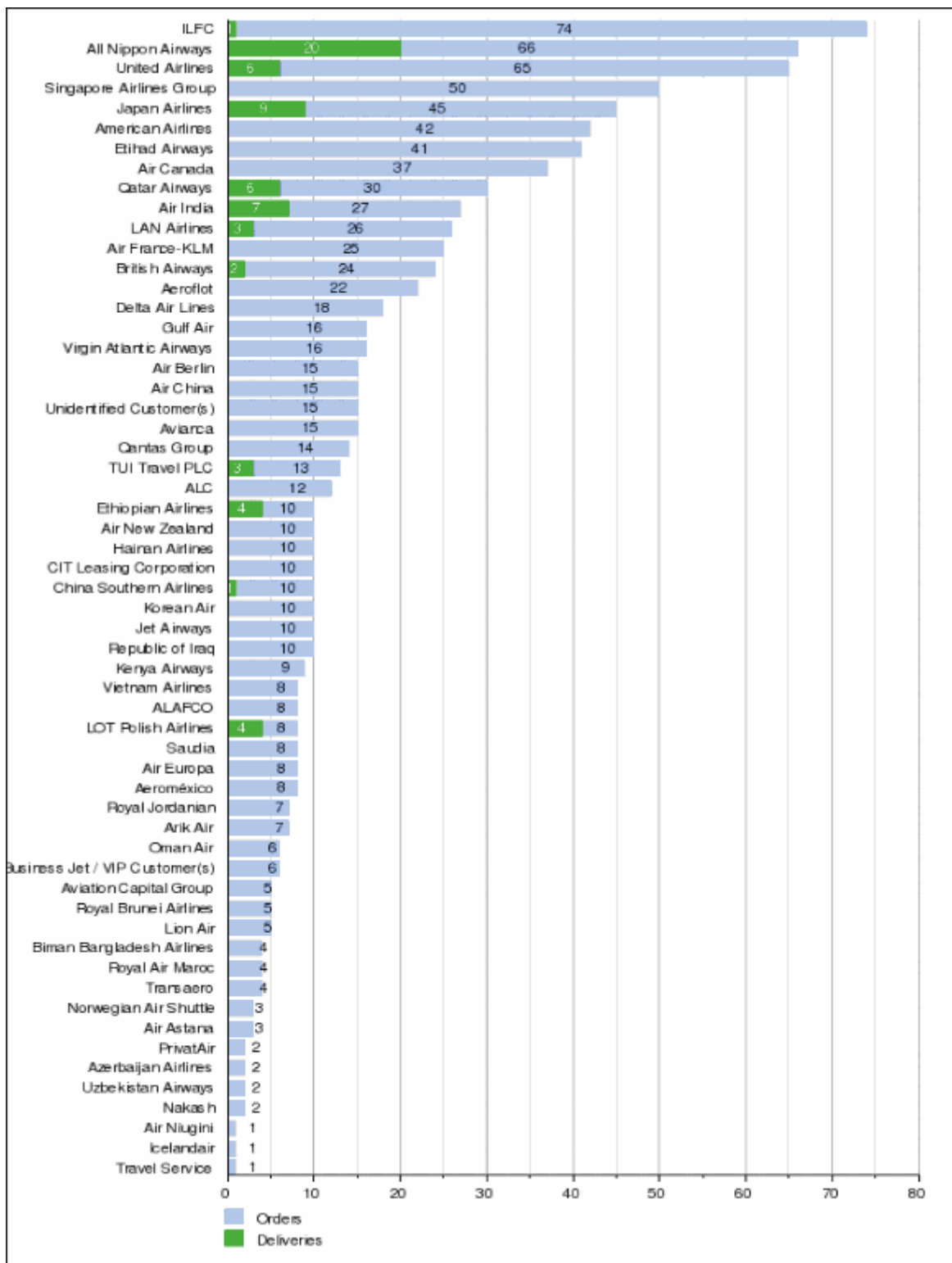


Exhibit 4 : B-787 Orders and Delivery as on June 30, 2013

Japan

| Aircraft Models | 727 | 737 | 747 | 767 | 777 | 787 | DC-8 | DC-9 | DC-10 | MD-11 | MD-80 | Md-90 | Total |
|-----------------|-----|-----|-----|-----|-----|-----|------|------|-------|-------|-------|-------|-------|
| Orders | 50 | 161 | 186 | 164 | 100 | 111 | 41 | 22 | 22 | 15 | 34 | 16 | 922 |
| Deliveries | 50 | 152 | 174 | 164 | 100 | 29 | 41 | 22 | 22 | 15 | 34 | 16 | 819 |
| Unfilled | - | 9 | 12 | - | - | 82 | - | - | - | - | - | 1 | 103 |

France

| Aircraft Models | 707 | 727 | 737 | 747 | 767 | 777 | 787 | DC-8 | DC-10 | MD-80 | Total |
|-----------------|-----|-----|-----|-----|-----|-----|-----|------|-------|-------|-------|
| Orders | 42 | 31 | 40 | 62 | 6 | 59 | 25 | 11 | 6 | 15 | 297 |
| Deliveries | 42 | 31 | 40 | 62 | 6 | 55 | - | 11 | 6 | 15 | 268 |
| Unfilled | - | - | - | - | - | 4 | 25 | - | - | - | 29 |

Germany

| Aircraft Models | 707 | 717 | 727 | 737 | 747 | 757 | 767 | 777 | 787 | DC-9 | DC-10 | MD-11 | Md-80 | Total |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-------|-------|-------|-------|
| Orders | 35 | 5 | 64 | 349 | 83 | 42 | 16 | 13 | 15 | 2 | 14 | 18 | 20 | 676 |
| Deliveries | 35 | 5 | 64 | 326 | 72 | 42 | 16 | 8 | - | 2 | 14 | 18 | 20 | 622 |
| Unfilled | - | - | - | 23 | 11 | - | - | 5 | 15 | - | - | - | - | 54 |

U.K.

| Aircraft Models | 707 | 737 | 747 | 757 | 767 | 777 | 787 | DC-9 | DC-10 | MD-80 | Total |
|-----------------|-----|-----|-----|-----|-----|-----|-----|------|-------|-------|-------|
| Orders | 40 | 282 | 103 | 95 | 49 | 51 | 53 | 4 | 8 | 2 | 687 |
| Deliveries | 40 | 274 | 103 | 95 | 49 | 51 | 5 | 4 | 8 | 2 | 631 |
| Unfilled | - | 8 | - | - | - | - | 48 | - | - | - | 56 |

China

| Aircraft Models | 707 | 737 | 747 | 757 | 767 | 777 | 787 | MD-11 | MD-80 | MD-90 | Total |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|
| Orders | 10 | 665 | 97 | 59 | 22 | 116 | 35 | 6 | 35 | 22 | 1067 |
| Deliveries | 10 | 525 | 88 | 59 | 22 | 80 | 1 | 6 | 35 | 22 | 848 |
| Unfilled | - | 140 | 9 | - | - | 36 | 34 | - | - | - | 219 |

South Korea

| Aircraft Models | 707 | 737 | 747 | 767 | 777 | 787 | DC-9 | DC-10 | MD-10 | MD-80 | Total |
|-----------------|-----|-----|-----|-----|-----|-----|------|-------|-------|-------|-------|
| Orders | 1 | 48 | 87 | 12 | 52 | 10 | 1 | 3 | 5 | 14 | 233 |
| Deliveries | 1 | 43 | 78 | 12 | 45 | - | 1 | 3 | 5 | 14 | 202 |
| Unfilled | - | 5 | 9 | - | 7 | 10 | - | - | - | - | 31 |

Source: <http://active.boeing.com/commercial/orders/index.cfm?content=customerselection.cfm&pageid=m15524>The Boeing Company. June 30, 2013. Retrieved July 14, 2013

Exhibit 5 : Countrywide Orders and Delivery as on June 30, 2013: B-787 Partner Countries

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Total |
|----------|------|------|------|------|------|------|------|------|------|------|-------|
| Order | 56 | 235 | 157 | 369 | 93 | -59 | -4 | 13 | -12 | 82 | 930 |
| Delivery | - | - | - | - | - | - | - | 3 | 46 | 17 | 66 |

Source: Boeing 787: Orders and Deliveries (updated monthly)". The Boeing Company. June 30, 2013. Retrieved July 11, 2013

Exhibit 6 : 787Dreamliner Orders and Delivery- Year on Year

| Currency in Millions of US Dollars | As of Dec 31, 2009 | Dec 31 2010 Restated | Dec 31 2011 Restated | Dec 31 2012 |
|--|--------------------|----------------------|----------------------|-------------|
| Revenues | 68,281.0 | 64,306.0 | 68,735.0 | 81,698.0 |
| TOTAL REVENUES | 68,281.0 | 64,306.0 | 68,735.0 | 81,698.0 |
| Cost of Goods Sold | 56,365.0 | 51,683.0 | 55,739.0 | 68,556.0 |
| GROSS PROFIT | 11,741.0 | 12,463.0 | 12,868.0 | 13,054.0 |
| Selling General & Admin Expenses, Total | 3,364.0 | 3,644.0 | 3,408.0 | 3,717.0 |
| R&D Expenses | 6,506.0 | 4,121.0 | 3,918.0 | 3,298.0 |
| OTHER OPERATING EXPENSES, TOTAL | 9,870.0 | 7,765.0 | 7,326.0 | 7,015.0 |
| OPERATING INCOME | 1,871.0 | 4,698.0 | 5,542.0 | 6,039.0 |
| Interest Expense | -339.0 | -516.0 | -498.0 | -463.0 |
| Interest And Investment Income | 249.0 | 267.0 | 278.0 | 268.0 |
| Other Non-Operating Expenses, Total | -26.0 | 226.0 | 166.0 | 146.0 |
| Other Non-Operating Income (Expenses) | -26.0 | 226.0 | 150.0 | 140.0 |
| Gain (Loss) On Sale Of Investments | -- | -174.0 | -119.0 | -84.0 |
| Gain (Loss) On Sale Of Assets | -24.0 | 6.0 | 24.0 | 4.0 |
| EBT, INCLUDING UNUSUAL ITEMS | 1,731.0 | 4,507.0 | 5,393.0 | 5,910.0 |
| Income Tax Expense | 396.0 | 1,196.0 | 1,382.0 | 2,007.0 |
| Earnings From Continuing Operations | 1,335.0 | 3,311.0 | 4,011.0 | 3,903.0 |
| EARNINGS FROM DISCONTINUED OPERATIONS | -23.0 | -4.0 | 7.0 | -3.0 |
| NET INCOME | 1,312.0 | 3,307.0 | 4,018.0 | 3,900.0 |
| NET INCOME TO COMMON INCLUDING EXTRA ITEMS | 1,312.0 | 3,298.0 | 4,009.0 | 3,892.0 |
| NET INCOME TO COMMON EXCLUDING EXTRA ITEMS | 1,335.0 | 3,302.0 | 4,002.0 | 3,895.0 |

Source: Bloomberg Businessweek website, <http://investing.businessweek.com/research/stocks/financials/financials.asp?ticker=BA>, accessed on July 31, 2013

Exhibit 7 : Operating Results

Author Profile



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