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How Airbus Surpassed Boeing: A Tale of Two Competitors

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DEDICATION

This thesis is dedicated to my mother and father, Rita and Kenneth Muckala whose guidance kept me on the path and to my brother and sister who have always had faith in me, inspiring me to reach new heights and seek new challenges.
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ABSTRACT

Two of the most recognizable competitors in this new era of Euro-American competition are Airbus and Boeing. These two competitors are the world’s leading aircraft manufacturers and their competition is shaping the face of the commercial aviation industry. The competition between these two companies is for the “World’s Leading Commercial Airline Manufacturer.” This title is currently held by Airbus who has lead yearly production and taken more orders over the past three years.

Boeing has fallen behind in being the technological leader due to a falling budget, poor industrial model, and ethical practices. As a result of losing ground to Airbus over the past few years, Boeing has been continuously restructuring itself in an effort to compete in this new era of competition. By comparing these two companies the author’s objective was to determine a clear path forward for Boeing.

To make this determination the author examined both companies while making a detailed analysis of certain areas. Three focus areas were chosen based on initial analysis and the magnitude of their effects. These focus
areas included subsidies, technology integration, and vision of the future.

Airbus’ early successes can be attributed to an unfair subsidy advantage that is now at the center of this competition. The next aspect at the center of this competition is their philosophies on automation and the implementation of technology. Boeing and Airbus have different philosophies on the implementation of automation. While both philosophies are sound, there are advantages and disadvantages to each.

Finally, each company in an attempt to gain an edge in the competition has staked its future on what each believes to be the future direction of commercial aviation. Airbus has gone with the philosophy of the jumbo jet with the A380, whereas Boeing has opted for targeting the medium range market with the 787.

The analysis of these two companies shows their difference in philosophies with regard to embracing new technologies in aircraft design and manufacturing. This thesis examines how Airbus has risen as the “World Leading Commercial Aircraft Manufacturer” and Boeing’s need to self-optimize.
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1 Introduction

It was the fall of the Soviet Union in the early 1990s that began the shaping of the world’s modern market. In the present day world of economic competition there have risen two distinct sides, the United States and the European Union.

It is without a doubt these two competitors will shape the future of the world on all levels. One of these levels is aviation. In line with the two global competitors there exist two major competing companies in the realm of commercial aviation, Boeing and Airbus.

In recent years Boeing has stumbled on both the military and commercial side of aviation thus needing to be revamped. (Sweeten, 1999) Boeing has ceded its decades-long dominance in the commercial aviation industry to Airbus. Boeing, who lacked true competition for many years, fell to the fact that if not in competition with anyone then you must beat your last performance.

In 2005, Airbus made more deliveries than Boeing for the third straight year and took more orders for aircraft for the fifth consecutive year asserting its position as the “World Leading Aircraft Manufacturer,” a title Boeing had held for many decades. (Griffiths, 2006) Adding to
Boeing’s struggles was an ethics scandal at the top of the Boeing leadership. The question is: Can and will Boeing recover? Airbus has surpassed Boeing because of its desire to beat Boeing, an aggressive approach to technology integration and an unfair subsidy advantage.

This thesis discusses the history of both Airbus and Boeing, how Airbus succeeded at its goal of unseating Boeing as the “World’s Leading Aircraft Manufacturer” and the future implications that these competitors will bring in the airline industry.
2 History of Airbus

Airbus Industries began as a consortium of European aviation firms to compete with American companies such as Boeing and McDonnell Douglas. In the 1960s European aircraft manufacturers competed with each other as much as with the American giants. In the mid-1960s tentative negotiations commenced regarding a European collaborative approach.

Nationalism within each country, and barriers to trade imposed by neighboring countries, caused each of the European firms to be confined largely to its own domestic market. As a result, these firms were prevented from achieving adequate economies of scale. Also, no single European government's budget was large enough to provide its firms with the huge amounts of support through military research and development and other indirect subsidies enjoyed by U.S. firms. The European firms thus were unable to overcome the increasingly formidable barriers to entry.

The European governments were justifiably concerned that competition from America's commercial aircraft manufacturers would eventually cause Europe's weak and divided industry to cease to exist, and that outcome was
unacceptable to them. By the late 1960s, Europe's political leaders began to focus on the only option they believed was available to them - pooling their resources and engaging in a cooperative effort to establish a European presence in the global jetliner industry. The European governments were highly motivated, and after much political wrangling they managed to put aside political differences and issues of national pride.

In September 1967 the British, French and German governments signed a Memorandum of Understanding (MoU) to start developing the 300 seat Airbus A300. This was the second major joint aircraft program in Europe, following the Concorde, for which no ongoing consortium was devised. An earlier announcement had been made in July 1967 but had been complicated by the British Aircraft Corporation (BAC). The British government refused to back its proposed competitor, a development of the BAC 1-11 and instead supported the Airbus aircraft.

In the months following this agreement both the French and British governments expressed doubts about the aircraft. Another problem was the requirement for a new engine (to be developed by Rolls-Royce, the RB207). In December 1968 the French and British partner companies, Sud
Aviation and Hawker Siddeley, proposed a revised configuration, the 250 seat Airbus A250. Renamed the A300B the aircraft would not require new engines, reducing development costs.

In 1969 the British government shocked its partners by withdrawing from the project. Given the participation by Hawker Siddeley up to that point, France and Germany were reluctant to take over the wing design and thus the British company was allowed to continue as a major subcontractor. In 1978 Britain rejoined the consortium when British Aerospace (the merged Hawker Siddeley and BAC) purchased a 20% share of the company. (Hayward, 1987)

The Airbus A300 was the first aircraft model launched by Airbus. Airbus Industries was formally set up in 1970 following an agreement between Sud-Aviation (France) and Deutsche Airbus—itsself a German aerospace consortium consisting of Bölkow, Dornier, Flugzeug-Union Süd, HFB, Messerschmitt, TG Siebelwerke, and VFW. The grouping was joined by CASA of Spain in 1971. Each company would deliver its sections as fully equipped, ready to fly items, a precursor to “Lean” manufacturing. “Lean” manufacturing is a management philosophy focused on reducing waste by eliminating overproduction, waiting time, defective
products, and processing thus increasing quality and efficiency while reducing cost. The name "Airbus" was taken from a non-proprietary term used by the airline industry in the 1960s to refer to a commercial aircraft of a certain size and range, for this term was acceptable to the French linguistically.

In 1972 the A300 made its maiden flight and the first production model, the A300B2 entered service in 1974. Initially the success of the consortium was poor but by 1979 there were 81 aircraft in service. It was the launch of the A320 in 1981 that guaranteed Airbus as a major player in the aircraft market – the aircraft had over 400 orders before it first flew, compared to 15 for the A300 in 1972. (Brander, 1983)

The A320 was the first all-new design in its category in 30 years. The aircraft provided better operating efficiency, better performance and greater passenger comfort. It was the first commercial aircraft to feature “fly-by-wire” flight controls and side sticks. It set the standard for all subsequent Airbus cockpits. With the A320, Airbus started its philosophy of a two-man crew, pilot and co-pilot with no engineer.
The use of “fly-by-wire” gave Airbus the ability to follow another philosophy of creating families of aircraft sharing the same cockpit layout and the same flight handling characteristics. This philosophy has helped reduce the amount of training required by airline pilots and has proved an advantage as Airbus began development of its long range aircraft. Airbus entered the long range markets with the A330 and A340 to challenge U.S. makers in the intercontinental travel and medium range markets. These platforms, having similar cockpits and handling qualities to their predecessors, have been popular among carriers. Of note, Airbus sees the existing A330 as the answer to the market for which Boeing is developing the 787.

Until recently, Airbus was still a fairly loose alliance but that changed shortly after major defense mergers in 2000. DaimlerChrysler Aerospace (successor to Deutsche Airbus), Aérospatiale (successor to Sud-Aviation) and CASA merged to form EADS. In 2001 BAE Systems (formerly British Aerospace) and EADS formed the Airbus Integrated Company to coincide with the development of the new Airbus A380 which will seat 555 passengers and be the world's
largest commercial passenger jet when it enters service in 2007, again taking another title from Boeing.
3 History of Boeing

The company was incorporated in Seattle, Washington by William E. Boeing on July 15, 1916, as “Pacific Aero Products Co.” following the June 15, 1916 maiden flight of one of the two “B&W” seaplanes built with the assistance of George Conrad Westervelt, a U.S. Navy engineer. On May 9, 1917, the company became the “Boeing Airplane Company.” William E. Boeing had studied at Yale University and worked initially in the timber industry, where he became a rich man and acquired knowledge about wooden structures. This knowledge would prove invaluable in his subsequent design and assembly of airplanes.

In 1927, Boeing created an airline, named Boeing Air Transport (BAT). A year later, BAT, as well as Pacific Air Transport and Boeing Airplane Company merged into a single corporation. The company changed its name to United Aircraft And Transport Corporation in 1929 and acquired Pratt & Whitney, Hamilton Standard Propeller Company, and Chance Vought. United Aircraft then purchased National Air Transport in 1930. The Air Mail Act of 1934 prohibited airlines and manufacturers from being under the same corporate umbrella, so the company split into three smaller companies – Boeing Airplane Company, United Airlines, and
United Aircraft Corporation, the precursor to United Technologies. As a result, William Boeing sold off his shares.

Shortly thereafter, an agreement with Pan American World Airways (Pan Am) was reached to develop and build a commercial flying-boat able to carry passengers on transoceanic routes. The first flight of the Boeing 314 Clipper was in June 1938. It was the largest civil aircraft of its time, with a capacity of 90 passengers on day flights, and of 40 passengers on night flights. One year later, the first regular passenger service from the U.S. to the United Kingdom was inaugurated. Subsequently, other routes were opened so that soon Pan Am flew with the Boeing 314 to destinations all over the world.

In 1938, Boeing completed work on the Model 307 Stratoliner. This was the world’s first pressurized-cabin transport aircraft, and it was capable of cruising at an altitude of 20,000 feet which gave it the capability of cruising above most weather disturbances. (Krugman 1986)

During World War II, Boeing built a huge number of bombers. In the beginning of March 1944, production had been scaled up in such a manner, that over 350 aircraft were built each month. During these years of war, the
leading aircraft companies of the U.S. had to cooperate. The Boeing-designed B-17 bomber was assembled also by Lockheed Aircraft Corp. and Douglas Aircraft Co., while the Boeing B-29 was assembled also by Bell Aircraft Co. and by Glenn L. Martin Company.

After the war, most orders of bombers were canceled and 70,000 people lost their jobs at Boeing. The company aimed to recover quickly by selling its Stratocruiser, a luxurious four-engine commercial airliner developed from the B-29. However, sales of this model were not as expected and Boeing had to seek other opportunities to overcome the situation. The company successfully sold military aircraft adapted for troop transportation and for aerial refueling. (Leary, 1995)

In the mid-1950s technology had advanced significantly, which gave Boeing the possibility to develop and manufacture totally new products. In 1958, Boeing began delivery of its 707, the United States' first commercial jet airliner, in response to the British De Havilland Comet, French Sud Aviation Caravelle and Soviet Tupolev Tu-104 'Camel'; which were the world’s first generation of commercial jet aircraft. With the successful sale of the 707, a four-engine, 156-passenger airliner, the U.S. became
a world leader in the commercial jet market. A few years later, Boeing added a second version of this aircraft, the 720 which was slightly faster and had a shorter range. This was followed by the introduction of the 727, another commercial jet airliner of similar size, which had three engines and was designed for medium-range routes. The 727 was immediately well accepted as a comfortable and reliable aircraft by passengers, crews, and airlines. Although production was discontinued in 1984, at the turn of the millennium nearly 1,300 727s were still in service at airlines around the world.

In 1967, Boeing introduced another short- and medium-range airliner, the twin-engine 737. It has since become the best-selling commercial jet aircraft in aviation history. The 737 is still being produced, and continuous improvements are still being made. Several versions have been developed, mainly to increase seating capacity and range.

The roll-out ceremonies for the first 747-100, Boeing's next big step, took place in 1968 at the massive new factory in Everett, WA about an hour's drive from Boeing's Seattle home. The aircraft made its first flight a year later. The 747 had an intercontinental range and a larger
seating capacity than Boeing's previous aircraft. In January 1970 the first 747, a four-engine long-range airliner, flew its first commercial flight. This famous aircraft completely changed the way of flying, with its 450-passenger seating capacity and its upper deck.

Until recently, Boeing had been the only aircraft manufacturer to offer such an airliner and has delivered near to 1,400 units. Now, Airbus will offer the A380, which when delivered will be the largest operational airliner. To keep up; as with most of Boeing’s aircraft, the 747 has undergone continuous improvements to keep it technologically up-to-date. Larger versions have also been developed by stretching the upper deck.

Looking back at the 1970s, there was a heavy recession in the airlines industry so Boeing did not receive one single order for more than one year. Boeing’s bet for the future, the new 747 was delayed in production and engendered much higher costs than had been forecast. Another problem was in 1971 the U.S. Congress decided to stop the financial support for the development of the supersonic 2707, Boeing’s answer to the British-French Concorde, forcing the company to discontinue the project. The company had to reduce the number of employees from over
80,000 to almost half, in the Seattle area. However, the 707 and 747 formed the backbone of many major airline fleets through the end of the 1970s and the early 1980s.

In 1983, the economic situation began to improve. Boeing assembled its 1,000th 737 passenger airliner. During the following years, commercial aircraft and their military versions became the basic equipment of airlines and air forces. As passenger air traffic increased, competition was harder, mainly from a European newcomer in commercial airliner manufacturing, Airbus. Boeing had to offer new aircraft, and developed the single-aisle 757, the larger, twin-aisle 767, and upgraded versions of the 737 to compete with its growing competitor.

In April 1994, Boeing introduced its most modern commercial jet aircraft, the twin-engine 777, in between the 767 and the 747, with a seating capacity of between 300 and 400 passengers in a standard three class layout. The longest range twin-engine aircraft in the world, the 777 was the first Boeing airliner to feature a "fly-by-wire" system and was conceived in response to the inroads being made by Airbus into Boeing’s traditional market. This aircraft, commonly known as the “Triple Seven,” reached an important milestone by being the first airliner to be
designed entirely by using CAD techniques. Also in the mid-1990s, the company developed the revamped version of the 737, known as the “Next-Generation 737,” or 737NG. It has since become the fastest-selling version of the 737 in history, and on April 20, 2006 sales passed those of the 'Classic 737,' with a follow-up order for 79 aircraft from Southwest Airlines. The “Next-Generation 737” line includes the 737-600, the 737-700, the 737-800, and the 737-900. (Matlack 2004)

In 1996, Boeing acquired Rockwell’s aerospace and defense units. The Rockwell products became a subsidiary of Boeing, named Boeing North American, Inc. One year later, Boeing merged with McDonnell Douglas. Following the merger between Boeing and McDonnell Douglas, the McDonnell Douglas MD-95 was renamed the 717-200, and the production of the MD-11 was later stopped. Boeing introduced a new corporate identity with completion of the merger, incorporating the Boeing logotype and a stylized version of the McDonnell Douglas symbol, which was derived from the Douglas Aircraft logo from the 1950s. (Rogers, 1996)

In recent years Boeing has faced an increasingly competitive Airbus, which offers some commonality between models (reducing maintenance and training costs) and the
latest fly-by-wire technology. From the 1970s Airbus has increased its family of aircraft to the point where they can now offer an aircraft in almost every class Boeing does. Indeed, Airbus is now competing in markets that Boeing once had a monopoly over, e.g., the A320 has been selected by several low-cost operators. The aircraft used by these airlines has traditionally been the 737. The 747 has suffered by competing with Boeing’s 777-300 series.

Currently, Boeing is planning to introduce a new aircraft; the 787 “Dreamliner”, and four new aircraft variants; the ultra-long-range 777-200LR, the 737-900ER, 737-700ER and the 747-8. The 787 was originally known by the developmental designator 7E7. The Boeing 777-200LR has the longest range of any commercial aircraft, and is the first airliner to able to fly halfway across the planet with a commercially viable payload, and holds the world record for the longest flight by a commercial airliner at 21,601km. (Donnelly, 2003)

After several decades of numerous successes, Boeing lost ground to Europe’s Airbus and subsequently lost its position as market leader in 2003. Multiple Boeing projects were pursued and then cancelled including the Boeing Sonic. The Boeing Sonic Cruiser was launched in 2001 along with a
new advertising campaign to promote its new motto, “Forever New Frontiers”, and rehabilitate its image. Boeing is now focused on the newly-launched 787 as a platform of total fleet rejuvenation, which has benefited from strong sales success at the expense of Airbus' competing offerings.

As an aside, on October 10, 2001, against fierce competition for the contract to the Joint Strike Fighter, Boeing lost to rival Lockheed Martin in the multi-billion dollar contract. Boeing’s aircraft was the X-32, which lost out to Lockheed’s F-35 entrant. The X-32 may have been hampered by the requirement for a redesign after several flaws were found in the original concept.
4 Defining the Issue of Subsidies

Since the average effective life of a commercial aircraft is twenty-five years, within the next fifteen years virtually every airplane in the world's commercial aircraft fleet will have been manufactured by either Boeing or Airbus.

Boeing has long been the leader in the world aviation industry. Having survived the turbulent formative years of the industry, Boeing's first success in the commercial market, the 707, was the result of the use of military technology gained from Boeing’s military aircraft development. This was a common theme seen throughout Boeing’s history and rise to glory.

Airbus has followed a very different path to prominence. In many ways it is a highly improbable enterprise, having started from scratch as the result of a cooperative effort among notoriously nationalistic and independent European governments. When Airbus was created in 1970, there was much skepticism as to whether Airbus could succeed (Thornton, 1995). However, massive government subsidies to Airbus enabled it to become a major competitor, and it is now posing a strong challenge to Boeing's dominance.
Airbus slowly but steadily expanded its market share during the first two decades of its existence, reaching its self-determined "survival threshold" of 30 percent of new orders in the early 1990s. Its successes during this period came largely at the expense of a rapidly fading Lockheed and a more tenacious but slowly slipping McDonnell Douglas. Lockheed suspended jetliner production in 1981, and, at the time of its merger with Boeing, McDonnell Douglas held only a 4 percent share of new aircraft orders. The loss of market share by these manufacturers was almost exactly matched by gains for Airbus, while Boeing consistently maintained its accustomed market share of 60 percent or more. With the other competitors out of the picture, the battle for market share is being waged directly between Boeing and Airbus. Airbus's continued growth in market share in recent years has come directly at Boeing's expense. Boeing's share of new orders in 1998 has slipped to 54 percent, going towards the increasing percentage of Airbus.

The remarkable success of Airbus is a testimony to the theory of strategic trade policy and use of modern technology as it becomes available. According to this theory, comparative advantage can be created through
subsidies and other forms of protection from competition granted to favored industries, or "national champions," that likely would not prosper in a competitive market. This notion of managed trade is in stark contrast to the free-market orientation that is generally pursued by U.S. firms and endorsed by U.S. policymakers.

During the 1920s and 1930s, there were many aircraft producers throughout Europe and the United States, but all were small, most were poorly financed, and none were dominant. Market demand was limited, and individual aircraft were generally produced one by one rather than as part of an assembly-line process. This situation changed dramatically during World War II, as aircraft were mass-produced in large numbers for the military; and the pace of technological advance accelerated. In the years immediately after the war ended, U.S. and European manufacturers attempted to capitalize on these developments by applying what they had learned to the production of commercial aircraft. European firms were especially aggressive in applying jet-engine technology to commercial aircraft, and in the 1950s they produced the world's first commercial jetliners.
American manufacturers were slower to adopt the new jet-engine technology, but they learned from European mistakes, and their more measured approach proved quite successful. The fact that the United States was the dominant military and economic power of the free world both facilitated and necessitated the accelerating rate of growth in the U.S. industry in the 1950s and 1960s. The need for larger and faster military aircraft with extended range resulted in huge expenditures by the U.S. military for research and development. Naturally; the private companies that produced these military aircraft enjoyed significant spillover benefits for the production of commercial aircraft. The government provided additional indirect support through funding for the National Aeronautics and Space Administration (NASA) and support of higher education, which produced large numbers of well-educated engineers, metallurgists, and other technically trained college graduates; and regulation of the domestic airline industry, which provided a stable market for commercial jetliners. In addition, rising income and output levels in the United States, along with the large geographic size of the country, created a growing demand
for efficient air transport, further fostering the development of more and better aircraft.

While demand was growing steadily, the production side of the industry was undergoing important structural changes. The industry gradually evolved into one characterized by large economies of scale, steep learning curves, enormous expenditures for research and development, high costs overall. A high level of dependence on technology staying power became essential, since it might require ten years or more and billions of dollars to take a new jetliner from conception to test flight. Once testing is complete and production of a particular model is under way, per-unit costs can be brought down to manageable levels as the huge development costs are spread more widely, and production efficiency increases because of learning-curve effects. The increasing sophistication of aircrafts has made the break-even point drift upward and to the right. The current rule of thumb in the industry is that at least 600 units are required to attain the break-even level of production for a particular model.

As the cost structure in the commercial jetliner industry became more problematic, and as the demand for jetliners became increasingly cyclical, the number of firms
producing such aircraft gradually declined, mostly as a result of merger and consolidation. By the 1970s, only three U.S. firms remained, and those three dominated the worldwide market. But three was still too many, as stated previously, which resulted in Boeings rise to dominance.

The changing nature of the commercial aircraft industry during the postwar years resulted in mergers and consolidations among European producers as well. In spite of these consolidations, the European firms could not individually establish an effective presence in the industry. The success of Airbus, with its business model of heavy government subsidization without recoupment of costs, posed a particular threat to U.S. airplane manufacturers. Moreover, it created a general threat to a U.S. economy, then in the midst of mild recession.

Airbus, founded in 1969 by state-run aerospace companies in France, Germany, and the United Kingdom was heavily funded by these governments. Among its advantages was a harmonious aviation industry established by the United Kingdom and France while creating Concorde. Though its initial market share was small, Airbus quickly grew with the help of heavy development subsidization. In addition, with center-left governments in power in European
countries throughout the 1970s, possible nationalistic implications for Airbus' success could be seen. While Boeing was a privately established and financed company, albeit one with significant involvement with United States defense contracts, Europe's aerospace corporations were government creations, and from the beginning of the jet age were entirely government financed and supported. When Airbus was created in the late 1960s, the Concorde was still under production by European governments despite staggering costs. Boeing, meanwhile, was nearly bankrupted by its development of the original jumbo, the 747. Boeing was forced to lay off thousands of workers and to provide private sector airlines with favorable purchase terms in order to both secure much needed deposits and establish the order base to spur further development and production. Eventually, the U.S. government did provide minimal assistance, mostly in the form of encouraging negotiations between Boeing and major airline customers; it provided essentially nothing in the way of direct financial support for the 747. In contrast to U.S. manufacturers, Europe's civil aircraft development was almost entirely government funded.
The Boeing 747 has been the premier jet for long-haul international travel since its introduction in the late 1960s. Updated models of the 747 are still in production, and it remains a backbone of Boeing’s line. While Airbus has introduced several jets designed to compete with smaller Boeing products, until recently it has not attempted to directly compete with the 747—the world’s largest, most expensive and most profitable commercial aircraft.

It was at the Paris Air Show in 1991, riding high after driving Boeing’s market share below fifty percent, Airbus announced that it would begin preliminary development of a passenger airplane with a capacity of up to 700—the largest in history. Despite this announcement, after the signing of the 1992 Bilateral Agreement, Airbus announced that it would abandon its solo effort and entered into discussions with Boeing for joint development of the super-jumbo. With potential development costs estimated at up to $15 billion, a joint project was believed to be the only way Airbus could develop a new airplane and stay within the boundaries of the subsidy agreement. Boeing and Airbus agreed to a one-year feasibility study of the project, which took place in 1993. (Jenny, 1993)
Though the initial cooperation went beyond the feasibility study, the companies eventually decided not to proceed with the joint project. Even during periods of putative cooperation, the two companies pursued different tracks, perhaps in preparation for the eventual need to proceed on their own. The cooperation ended in 1995, with each side claiming that the market would not bear the introduction of such a large airplane. Airbus then proceeded to develop just such an airplane independently.

Airbus continued to proceed with its plans and development, albeit in a low profile manner, despite the breakdown of cooperation with Boeing, and negative reports by aviation analysts. From 1997 to 2000, the company continued to talk to potential partners and customers about the need for a super-jumbo, and became convinced that its future depended on having its own top of the line super-jumbo. It appears that Airbus' decision to develop the super-jumbo was not strictly a business decision, but was also motivated, at least in part, by strategic considerations. Airbus announced tentative plans to proceed with the A380 in mid-2000, contingent upon receiving forty to fifty orders from airline customers. The orders were received, and in December 2000 Airbus officially announced
the launch of the 500 to 900 seat A380, to be delivered sometime around 2006.

The reaction of Boeing and the U.S. government was swift and predictable. Both parties claimed that, despite the conversion of Airbus from a French holding company to a joint stock company in mid-2000, the program was unfairly and perhaps illegally subsidized by European governments, and that Airbus' actions could start a trade war. Boeing claimed that it had not proceeded with its plans for a super-jumbo because of the potentially prohibitive cost, and that for Airbus to develop such an airplane with the backing of European governments would be a violation of world trade conventions. Airbus responded that everything it was doing was within the letter of the agreements signed by the European Union and United States, and that it would proceed as planned.
5 The Trade Agreement

From the first days of its existence, Airbus was the beneficiary of direct subsidies in the form of government loans for aircraft development. These loans, amounting to between 70 and 90 percent of an aircraft's development cost, carried below-market interest rates. Rather than repaying the loans according to a prescribed timetable, as typically would occur in a competitive market, the Airbus firms repaid the loans from revenue received as new aircraft were delivered. Moreover, debt forgiveness was commonplace, a practice that would not likely occur in a competitive market.

Throughout the 1970s and 1980s, U.S. trade officials and aircraft manufacturers protested that these subsidies violated international trade agreements and gave Airbus unfair competitive advantages. The United States asserted that the subsidies allowed Airbus to price its jetliners at 10 percent or more below cost (Fortiman 1989). Perhaps the more important point is that Airbus would probably never even have gotten off the ground without this substantial government support. In short, U.S. officials maintained that Europe's treatment of Airbus was tantamount to an
industrial policy of subsidizing Airbus to ensure its competitiveness. In the process a European comparative advantage in the jetliner industry was artificially created.

The European governments were unyielding in the face of these protests, since they were strongly motivated to ensure the development of a viable commercial aircraft industry. They thought that this industry would complement the growth of the entire European aerospace industry and would thus be expected to yield social and economic benefits that exceed the cost of the subsidies. Commercial aircraft would occupy a pivotal position in international trade, be an important creator of wealth and employment, and contribute greatly to both national prestige and national defense. Research and development in commercial-aircraft manufacturing would also produce technological spillovers for other key industries. In addition, the United States would be prevented from holding a worldwide monopoly in production of commercial aircraft.

Subsidies were needed to provide Airbus with some breathing space until it could stand on its own, but both Airbus and the governments realized that large direct subsidies could not continue indefinitely. The critical
goal for Airbus was to capture at least 30 percent of new orders. Airbus officials thought that after that milestone had been reached, the enterprise could continue on a more self-sustaining basis and depend less heavily on direct government support. In the interim, government subsidies allowed Airbus the luxury of not having to base its decisions to launch new models solely on expected profits or losses (Cravens 1992).

Airbus defended its subsidies by arguing that U.S. commercial aircraft producers also benefited from government assistance, though this assistance was more indirect. Organizations such as NASA, which is funded by taxpayer dollars, support aeronautics and propulsion research that is shared with U.S. aircraft manufacturers. In addition, research sponsored by the U.S. military yields important technological spillovers for the U.S. commercial aircraft industry; most notably in aircraft engines and aircraft design.

The battle over the appropriateness of subsidies raged for the first twenty-two years of Airbus's existence. The first major attempt to put the issue to rest was contained in a commercial aviation section written into the Tokyo round of the General Agreement on Tariffs and Trade (GATT).
treaty in 1979. The negotiations leading up to this agreement provided the United States with the first opportunity formally and unequivocally to put an end to the subsidy issue by negotiating for a provision in the treaty to ban direct government subsidies. Although U.S. negotiators proposed straightforward language that would have achieved this end, they did not press the point when other signatories objected. Instead, they agreed on compromise language that imposed what the U.S. negotiators thought were significant limitations on government subsidies for civilian aircraft production. Subsidies, however, were not expressly forbidden, and interpretations of the phraseology in the treaty would be the cause of much controversy during the 1980s (McGuire 1997).

The European governments saw the treaty as a victory and continued on their course. The limitations on subsidies referred to in the treaty applied to subsidies that would have the effect of harming the competitive position of industries in other signatories' countries. Since U.S. firms dominated the commercial aircraft market, the European position was that subsidies to Airbus could not possibly cause material harm to the competitive position of
U.S. manufacturers and were therefore allowed by the treaty.

By the early 1980s, when the Airbus A300 was winning about half the business for wide-bodied jets and U.S. exports were suffering because of the strengthening dollar, U.S. trade officials renewed their attack on European subsidies. Negotiators from the Reagan administration accused Airbus of violating trade agreements. The heated discussions were laced with charges and countercharges, but little progress was made. This situation suited European negotiators quite well, since they were essentially buying time. From the U.S. perspective, the problem was exacerbated by the fact that U.S. manufacturers did not support the filing of a formal complaint. Europe was a major market for them, and they did not want to be harmed by European retaliation.

In 1992, officials in both the United States and the European Union (EU) finally agreed on a bilateral reduction in subsidies and signed what has come to be known as the "Airbus accord." The principal element of the accord was a cap on how large a subsidy the U.S. and European aerospace industries could receive for product development. Such launch aid was limited to 33 percent of the total
development cost of an aircraft, and the loan would have to be repaid with interest within seventeen years. In addition, the indirect subsidies (spillover benefits from military contracts) would be limited to 4 percent of a firm's commercial aircraft revenue.

Since the accord formally legitimized the use of subsidies, the agreement can be viewed in many ways as a victory for Airbus. The failure of the U.S. aircraft industry and the U.S. government to take formal action on the subsidies issue during the 1970s and 1980s, on the basis of violation of then-existing trade agreements, had given Airbus the time it needed to establish itself as a force in the marketplace. By 1992, Airbus had achieved its goal of capturing 30 percent of new orders. The A320 was profitable, and the newly launched A330 and A340 models were showing great promise. The accord thus came at a time when Airbus was becoming less dependent on subsidies and could operate comfortably under the 33 percent cap.

There seems to be little doubt that Airbus would not be in a position of such prominence today without the huge direct subsidies that the consortium has received. Moreover, U.S. policymakers and aircraft manufacturers believed that these subsidies violated trade agreements and
gave Airbus an unfair advantage. Why, then, did the United States not press the issue more forcefully? There may have been several reasons. One is that it may not have realized how instrumental the subsidies were going to be in making Airbus a viable competitor long-term. Instead, U.S. negotiators focused on issues such as government financing of export sales, which was a short-term consideration. Second, some sectors of the U.S. aircraft industry, such as engine manufacturers and airline companies, had a vested interest in seeing Airbus succeed, and thus did not support taking action against Airbus. Third, U.S. airframe manufacturers feared a loss of business in Europe if they pressed too vigorously on the subsidies issue. Fourth, at critical times during the 1980s the U.S. negotiators lacked clear focus and direction, since there was no unified and well-defined position in their negotiating stance.

For a time, it was not clear whether the Commerce Department or the Office of the U.S. Trade Representative should take the lead in the negotiations. Finally, the very success of U.S. manufacturers served to weaken the U.S. negotiating position. Since U.S. manufacturers dominated the industry, it would have been difficult to convince negotiators from other countries that U.S. manufacturers
should receive more protection from competition. Furthermore, other countries such as Japan and Brazil may have wanted to leave the door open for government support of their own aircraft industries in the future, so it is unlikely that they would have supported the U.S. position.
6 Competing Technologies

Boeing maintains a long practice of technological distinction and modernization, by building new versions of its line up of commercial airplanes; improving, producing, supporting and modifying aircraft for the U.S. military; by building launch vehicles capable of hoisting tons into orbit; to improving communications for people around the world through a sophisticated system of satellites.

Boeing has been building commercial airliners since 1927 with the first Boeing commercial jet airliner, the 707, introduced in 1955. Accolades to Boeing as the success is remarkable when one realizes that the Boeing "Design/Build" process has not changed very much during the past three decades.

The importance of the above statement lies in the fact that despite the system being antiquated, cumbersome and inefficient creating production delays, increased costs and spawning a huge bureaucracy simply to handle the paperwork, the company managed to achieve its goal. However, Boeing must clearly be motivated to bring this World War II era process into the 21st Century if it is to compete with Airbus.
Airbus Industries has quickly provided much competition to Boeing. The important factor is that Airbus is provided government subsidies allowing it to operate in the red. This advantage is not available to Boeing, thereby enabling Airbus to afford to develop new technologies without having to worry about passing on the costs to the customers. This means that Airbus price their aircraft competitively to lure away airlines from Boeing. This is the major point of the thesis that demonstrates how the management of Airbus worked towards achieving a state of the art jet, without incurring huge costs.

It should be noted that cost cutting effects of the changing airline industry resulting from deregulation in 1978 are still being felt in the commercial aircraft industry. The competition among airlines for passengers has resulted in a greater emphasis on cost cutting leading to mergers and bankruptcies. In addition, airlines modified their routing systems since they were not limited to certain routes, as was the case before deregulation, changing their buying patterns for aircraft accordingly.

Initially after deregulation, airlines were less concerned with having the most technologically advanced airplane and more concerned about the affordability of that
airplane. Cost and efficiency were important. However, with the integration of automation, affordability and efficiency was able to go hand in hand with the implementation of technology. Over the past several decades, safer and more reliable designs have been responsible for much of the progress made in reducing the accident rate and increasing efficiency. Improvements in engines, systems, and structures have all contributed to this achievement. At the forefront of this rolling change was Airbus with its government subsidies to help implement new designs. As automation in the cockpit increased, there have been many resulting ideas on how to implement this technology. As with most increases in capabilities such as automation, there are advantages and disadvantages. Advantages of automation have been increased capacity and productivity, relief from routine operations, precise handling of routine operations, and economical utilization of machines. The two largest manufacturers of transport aircraft, Boeing and Airbus, have two different philosophies on the implementation of automation.

In looking at Boeing’s philosophy, the idea of “automation as a tool” comes to mind. When dealing with automation, Boeing has four areas that it considers:
Customer input; Appropriate degree of automation; Crew interaction capability; and Communication, navigation, and surveillance improvements. Boeing’s cockpits are designed to provide automation to assist the aircrew and not to replace their responsibility for the safe and efficient operation of the aircraft. According to Boeing and certain studies, aircrew errors typically occur when aircrew do not perceive or interpret a problem and fail to act appropriately in order to prevent the situation from escalating. Hence Boeing’s philosophy is to incorporate intuitive, easy-to-use systems, in an attempt to decrease the hazards. These systems support instrument displays with visual and tactile motion cues to aid the crew in the use of automation and more importantly to minimize potential confusion about what functions are automated. In addition, visual and tactile motion cues are provided by feedback to the controls in order to reinforce situational awareness and help keep the aircrew fully aware of changes occurring to the airplane’s status and flight path during all phases of automated and manual flight. This philosophy has led to an over reliance on the system even though the system was designed only to be a tool.
Airbus, on the other hand, has a philosophy that mirrors the idea of “automation as a control.” Airbus uses its design of automation as a means of increasing efficiency and economy of the aircraft as well as safety throughout the flight envelope of the aircraft, thereby decreasing the risk. According to Airbus, “within the normal flight envelope, automation must not work against operator inputs, except when absolutely necessary for safety. This means that it is possible for automation to have the final input in the control of the aircraft. The aircrew can be limited by automation. The challenge with this progression is the aircrew’s ability to fully comprehend what is going on. If the aircrew cannot understand the automation or what the automation is doing then they cannot effectively plan ahead or control the aircraft during certain tasks. In looking at these task demands, one must also consider unexpected demands on the aircrew, which has led to many incidents and mishaps. Unlike Boeing, Airbus does not use tactile motion cues. Tactile motion cues provide visual and mechanical feedback to the aircrew. The belief is that aircrew should monitor instruments as opposed to monitoring the movement of controls thereby keeping the pilot mentally engaged.
Automation must not reduce the overall reliability of the aircraft, which includes the aircrew. Airbus’ philosophy has resulted in excessive mental workload resulting in aircrew system operating errors.

One of the most significant differences between Boeing and Airbus is their philosophies on automation. Automation has allowed for more efficient crew resource management. The findings of the President's Task Force on Crew Complement in the early 1980s allowed airplanes to be certified for two-person operation, and this crewing was adopted as the standard for all new types. In many cases, especially for Airbus, a common type rating covered many models. Along with development was the introduction of the first "glass cockpit" aircraft in civil service. Their primary flight and aircraft systems displays were on cathode-ray tubes (CRTs), which motivated the glass cockpit description, although all types use some electromechanical instruments as well. They have also made extensive use of digital microprocessors (the 767 and 757 had over 100).

During the 1980s, considerable operational experience was gained with these third-generation aircraft. As manufacturers gained confidence in the new automation
technology, it was incorporated and its uses were extended in new designs.

This era saw the development and introduction of the Airbus A320 (1989) (the first of the all-glass cockpit airplanes), the Boeing 747-400, a greatly advanced two-person crew version of the venerable 747 in service since 1970, the McDonnell-Douglas MD-11, a two-person crew DC-10 variant that entered service in 1991, and the Fokker F-100, an enlarged and highly automated outgrowth of the earlier F-28 regional jet.

The early adoption of automation philosophy by Airbus has given it a highly competitive advantage against Boeing and the competition in automation technology between the two competitors has generally been won by Airbus in the last few years. The majority of aircrew are subscribers to the Airbus design philosophy that basically attempts to prevent an aircraft from getting into a hazardous situation where the Boeing design philosophy provides control authority to perhaps get you out of a hazardous situation. There are several cases that show that computerized control over the flight regime can still result in an accident if the crew misinterprets the automation or cannot keep up with what the automation is doing. A case in point is the
1994 crash of a China Airlines Airbus A310 in Nagoya. A counter-point is that Airbus type automation might have saved the American Airlines Boeing 757 in Columbia by automatically retracting the speedbrakes, which were left deployed, during their terrain escape maneuver. In both of the above examples the aircraft functioned as they were designed, it was the flight crews that misinterpreted the condition of their aircraft. To paraphrase a popular advertising slogan used in the aviation business "the best safety device in any aircraft is a well trained pilot".
7 The Road Ahead

The future changes to the Boeing Commercial Aircraft Company must encompass all fields if they are to compete with Airbus. From the philosophy of the company to the technical details, every aspect of the design/build process will need to be modified if Boeing is to compete. Boeing has been smarter ever since Airbus snatched the lead in the civil jet market by delivering more aircraft for the first time. Airbus is still in front this year, with 224 deliveries to the end of September, compared to Boeing's 218. The Americans' beef is that Airbus still gets soft loans from the governments of Germany, France, Britain and Spain.

Boeing's chief executive, Harry Stonecipher, has been itching to have a go at Airbus. He was brought out of retirement to run the company after it lost its two top executives in a row after improper dealings with the Pentagon over defense contracts. Previously, as number two at Boeing, he was always pushing for a more aggressive line against Airbus subsidies.

According to Boeing, Airbus can only make such rapid moves in the marketplace because it can count on launch
aid. Mr. Stonecipher points out that the European company has been able to roll out five new products in the past decade, while Boeing, with an eye to shareholders and its bottom line, has managed one.

It is true that the big attraction of state-provided launch aid is that if a product flops, the money does not have to be repaid; so the risk is borne partly by European taxpayers. But Airbus now has to continue paying penalties long after the loan and interest have been repaid.

The Duopoly Market

Boeing embarked on an ambitious four-year restructuring program in the mid-1990s and had hoped that, by adopting “Lean” production techniques and otherwise reengineering its production processes, it would be able to produce airplanes more rapidly and at 25 percent less cost. However, because demand for new aircraft was soaring, and Boeing was reluctant to see its market share slip, it attempted to gear up production rates to record levels at a time when its assembly lines and other processes were still being transformed. The company was unprepared and ill equipped to handle the additional work, and numerous production problems ensued. Antiquated computer systems,
parts shortages, inexperienced workers, work being done out of proper sequence, and other inefficiencies led to severe production bottlenecks.

The merger with McDonnell Douglas in the late 1990s only compounded these problems. The meshing of corporate cultures did not go as smoothly as hoped, and power struggles in the upper ranks of management detracted from the drive to streamline the firm's operations. Indecisiveness with regard to how best to use the new resources coming into the firm eroded employee morale. Moreover, Boeing's assemblers have complained that production goals have increasingly come from the top down, without proper concern as to whether those goals could be achieved. The problems were so great that in the fall of 1997 Boeing even had to shut down its assembly lines for several weeks in an attempt to sort out the chaos.

Boeing's problems have been exacerbated by the fact that for the past several years Boeing and Airbus have engaged in vicious price competition, with both firms offering discounts of 20 percent or more in order to capture or preserve market share. It is ironic that, in the midst of one of the greatest boom periods ever for commercial aircraft sales, profitability has been elusive
for both firms. Boeing's announcement in 1998 that it was raising prices 5 percent on most of its models, followed by Airbus's announcement of a 3 percent price increase, may be a sign that this ruinous price competition, which has been a boon for the airlines, may be abating.

Boeing cut back the production rates of its wide-bodied, long-range 747 and 777 models in 1999, because of both weakness in the Asian market and Boeing's forecast that demand for wide-bodied models will be declining during the next decade. Boeing has focused instead on expanded production of the smaller, less-expensive, shorter-range 737, to allow Boeing to establish itself in the rapidly expanding market for small, regional jetliners. Boeing has also begun developing the 787 Dreamliner to compete in these markets.

For its part, Airbus recently completed its own four-year program of cutting costs and reengineering its production lines. Although its production capacity is still well below Boeing's, it increased production 30 percent in 1999, followed by further expansion of production capacity over the following years. Airbus has been buoyed recently with orders from British Airways and Scandinavian Airlines.
System (SAS), both of which previously flew only Boeing aircraft.

The creation of the current corporate entity that replaced the old Airbus resulted in substantial cost savings through elimination of many of the decision-making and production inefficiencies inherent in the former organization. In addition, a revamped Airbus has been in a better position to take in new partners, including American firms. The new structure has given Airbus the capability of raising capital in financial markets. Airbus now has much more flexibility by significantly reducing its dependence on government support. The reorganized Airbus is less vulnerable to the whims of government officials, and it has greater control over the amount and timing of its capital infusions. While Airbus works to consolidate and expand its market share in existing market segments just as Boeing, it has taken a different approach. It has expanded its fleet with the development of the A380.

The Different Vision of the Future

The Airbus A380

The Airbus A380 is a double-deck, four-engined airliner manufactured by Airbus S.A.S. It first flew on
April 27, 2005, from Toulouse in France. Commercial flights should begin in late 2006 after 18 months of testing, with the delivery of the first aircraft to launch customer Singapore Airlines. During much of its development phase, the aircraft was known as the Airbus A3XX, and the nickname Superjumbo has become associated with the A380. (Norris, 2006)

The A380 is double decked, with the upper deck extending along the entire length of the fuselage. This allows for a spacious cabin with 50% more floor space than the next largest airliner, providing seating for 555 people in standard three-class configuration or up to 853 people in full economy class configuration. Two models of the A380 are currently available; the A380-800, the passenger model, the largest passenger airliner in the world, superseding the Boeing 747 and the A380-800F, will be one of the largest freight aircraft and will have a payload capacity exceeded only by the Antonov An-225.

The A380-800 has a maximum range of 15,000 kilometers (8,000 nm, sufficient to fly from Chicago to Sydney nonstop), and a cruising speed of Mach 0.85 (about 900 km/h at cruise altitude), similar to that of the Boeing 747.
The development of this aircraft, at an estimated cost of at least $10 billion, takes Airbus in a direction quite the opposite of Boeing's. Boeing recently shelved plans to develop its own super-jumbo and pushed development of a supersonic aircraft to the back burner as well. Boeing's view is that in the future the market will demand smaller aircraft flying more frequently to more locations and that the 747 will be adequate to handle large-capacity needs.

The Boeing 787

The Boeing 787 Dreamliner is a mid-sized wide body, twin engined passenger airliner currently under development by Boeing and scheduled to enter service in 2008. It will carry between 210 and 330 passengers depending on the seating configuration, and will be more fuel-efficient than comparable earlier airliners. It will also be the first major airliner to use composite material for most of its construction.

Prior to January 28, 2005, the 787 was known as the developmental designator 7E7. On April 26, 2005, one year to the day after the launch of the program, the final look of the external 787 design was frozen. With a less rakish
nose and a more conventional tail, the final design is aerodynamic superior to the initial 7E7 concept.
8 Implications for Competition in the New Millennium

The rivalry between Boeing and Airbus has many implications for the competitive environment in the future. First, the growth of the global marketplace will require that many firms be larger and leaner. As barriers to international trade continue to fall and as firms increasingly see the world as their marketplace and themselves as transnational, heightened levels of competition, with the consequent reduction in pricing power, are forcing firms to cut costs and otherwise increase efficiency. Recent domestic and cross-border mergers between industry giants (Exxon/Mobil and British Petroleum/Amoco in the oil industry, Daimler-Benz/Chrysler and Ford/Volvo in the automotive industry, Travelers/Citicorp and NationsBank/Bank of America in financial services, and Rhone-Poulenc/Hoechst and Zeneca/Astra in the drug industry) are only a few of the recent consolidations in a trend that began early in the 1990s.

These larger firms have the potential to achieve economies by consolidating information processing,
marketing, distribution, and a myriad of other functions, and otherwise eliminating duplication of effort at all levels of the firm. Higher levels of output also allow for greater economies of scale and scope, and larger market share brings with it added political and financial clout. Firms that had been shielded from competition in the past, by protective governments or small market size, are finding that survival is now more difficult. The age of more open economies and rapidly developing information and communication technology is providing the opportunity to achieve greater economies of scale and scope with a likelihood of larger concentration ratios in many industries.

The effects of these phenomena have been seen clearly in the commercial aircraft industry. If Airbus had not been created, it is likely that the market structure would still be a duopoly, but it would be shared between Boeing and McDonnell Douglas. The tremendous barriers to entry, substantial economies of scale, and limited demand for the product dictate that this industry may be a natural duopoly, especially since governments would likely prevent the evolution to monopoly.
Second, government support for commercial enterprises will likely diminish in the future. The success of Airbus — indeed, its very existence — is attributable primarily to the massive direct subsidies it received. An enterprise like Airbus likely could not be created in the same way today anywhere in the world. The evolution toward a more globally competitive private marketplace has been accompanied by a trend toward the streamlining and downsizing of government as well. Hundreds of billions of dollars in privatizations have occurred worldwide during the past two decades. In addition, European governments have been cutting their budget deficits, primarily by slashing spending, in order to achieve or maintain compliance with the convergence criteria for monetary union. The Japanese government is already saddled with rapidly growing debt as it attempts to jumpstart its moribund economy, and emerging Asian and Latin American nations are pursuing contractionary fiscal policies in response to the global financial crisis.

Bilateral trade agreements, as well as more general trade-enhancing agreements adopted through the World Trade Organization in recent years, also militate against the level of government subsidization received by Airbus.
Governments and firms alike will surely be more vigilant and more aggressive in the future with regard to the possibility that governments elsewhere will attempt to create an artificial comparative advantage in a particular industry through subsidization, as was the case with Airbus.

Third, heightened competition will force firms to respond more quickly to changing conditions. Mostly by accident, Airbus discovered its own version of “Lean” production simply through the way in which it was organized. Various components of each aircraft are built throughout Europe and the United States, and then shipped to France, where they are pieced together by large machines. In the process, a variation of just-in-time inventory control is implicitly implemented. Boeing has been wedded to more of a mass-production, assembly-line process, and as a result the employees-to-aircraft-produced ratio is around 220 for Boeing, compared to only 143 for Airbus. Boeing was attempting to modernize its manufacturing process when it dramatically expanded its production three years ago and encountered numerous production bottlenecks.
9 Conclusion

In conclusion we can say that it is clear that Boeing should have recognized much earlier that its industrial model was outmoded and begun to make the necessary changes sooner and in a more orderly fashion. Boeing's failure to do so has resulted in its not meeting production deadlines, incurring substantial cost overruns, inability to integrate new age technology, and selling airplanes at significant discounts. Unfortunately for Boeing, it did not learn from what happened to U.S. auto manufacturers in the face of intense competition from Japanese producers in the 1980s or believed that it was immune to similar competitive pressures created by Airbus. Past Market power appears to have led to complacency in Boeing's case.

Increased market power of corporations will require governments to be more vigilant in promoting fair competition and reducing the amount of subsidies. Boeing needs to press this issue as Airbus can now be considered a stand alone entity no longer relying upon government subsidies.

The battle between Airbus and Boeing for market share has shown once again just how ruinous unbridled price
competition can be, and firms in similar situations in other industries may be more circumspect about engaging in such a strategy in the future.

Airbus will continue on its current streak of dominance unless Boeing counters the three major aspects discussed. The first item is the economical debate over subsidies. The playing field needs to be level for Boeing to succeed. Boeing needs to be more aggressive in seeking a common playing field. Without another company to disrupt the polarization created by Airbus and Boeing their competition will be looked upon as that between the European Union and the United States and their policies on the future of air travel.

The next aspect of the competition is technology. The past decades have seen an increase in the use of automation in the cockpit. Boeing and Airbus have taken two different approaches on the integration of automation in the cockpit. Boeing needs to take advantage of the new technologies that are present now and update its cockpits. One advantage of Airbus is that all of their cockpits have the same layout, thus making transitions from one type of aircraft to another easier. Boeing needs to continue updating its cockpits and offer airlines the possibility of common type
ratings in similar Boeing aircraft much like 737 series. The design of the cockpit of the Boeing 777 was a step in the right direction. The Boeing 787 must continue in that path.

The final aspect is the different visions of the future. The future of commercial aviation is plagued by multiple problems. Among these problems are crowded skies, increases in fuel prices, and increases in the number of travelers. Airbus’ and Boeing’s different vision of the future has produced two different types of aircraft. Each believes its product will be the answer to the problems faced by commercial aviation. Airbus thinks airlines will need bigger airplanes to handle more traffic; Boeing expects airlines to accommodate growth by flying more routes with slightly smaller airplanes. Although not an aggressive leap forward in technology, Boeing needs to sway the market towards the more efficient 787, especially during this time of increased fuel prices and increased commuter type travel. The future will show if Boeing’s vision will put Boeing back in front of Airbus as the “World’s leading commercial airline manufacturer.”
References/Bibliography
References


Bibliography


VITA

William Burns was born in Buckhannon, West Virginia but grew up in Oklahoma where he graduated from Tulsa Memorial High School. He was a 1995 distinguished graduate of the United States Naval Academy receiving a Bachelors of Science degree in Aerospace Engineering as well as his commission as a Naval Officer. Upon commissioning, he began flight training in Pensacola Florida.

William Burns completed primary flight training at NAS Whiting Field where he flew the T-34C Turbo Mentor. He then completed intermediate and advanced training in the T-2C Buckeye and the TA-4J Skyhawk at NAS Meridian, Mississippi. He earned his wings of gold in October of 1998 and began fleet replacement training for the F/A-18 with the Gladiators of VFA-106. In September of 1999 he reported to the Wildcats of VFA-131, AIRLANT’S “First and Finest”. He made two deployments to the Mediterranean Sea, Adriatic Ocean, North Arabian Gulf, and Gulf of Oman with CVW-7 first aboard USS DWIGHT D. EISENHOWER (CVN 69) during 2000 and then aboard USS JOHN F. KENNEDY (CV-67) during 2002.
In January 2003, William Burns reported to DLI in Washington DC in preparation for his exchange to the Ecole de Personnel Navigant d’Essais et de Reception (EPNER), French Test Pilot School in Istres, France. In June 2004, He reported to EPNER where he flew over 25 different aircraft. He completed Test Pilot School in July of 2004 and returned to Patuxent River, MD where he joined VX-23, Strike Aircraft Test. While at VX-23, He was assigned as an F-35, Joint Strike Fighter (JSF), test pilot conducting multiple test simulators and test flights in support of JSF development. In addition to being a project pilot for the F-35, he also served as project officer/project pilot for multiple F/A-18A-F programs. In March 2006, he reported as Safety Officer to VFA-25, the “Fist of the Fleet.”

William Burns has accumulated over 1900 flight hours and 375 carrier landings. He currently resides in Lemoore, California.