Commercial Air Wars: Strategies That Changed Commercial Aviation
VI
Airbus Industrie and early wide body competition

Jim Rauf
Airbus Origins

- The 1960s Jet travel was allowing more people to travel further than ever before
- Jet aircraft were more reliable than piston prop aircraft
- Airlines were calling for larger capacity aircraft
- European fear: U.S. aircraft manufacturers would dominate market
- The European commercial aircraft types had short production runs -difficult to recoup development costs and earn profits
- Market was fragmented with each country had its own aircraft industry producing for a small market
- In the mid-1960s aircraft manufacturers saw a need for a 200 seat airliner
- They looked at resizing their current aircraft
  - Hawker Siddeley looked at stretching their Trident
  - British Aircraft Corporation looked at stretching their BAC 111 to a BAC 211 and BAC 311
- The Plowden Report of 1965: shorter production runs came in at a 20% higher cost than those in the U.S.
- It was recommended that collaboration was the only way to address this problem
- American Airlines and Air France had already expressed interest in a 200 seat twin jet and European leaders were very keen to ensure that a European offering would be in the mix
- July 1967 a meeting among the ministers of France, U.K. and Germany resulted in their supporting the concept of collaboration to produce an Air Bus
- The Concorde SST was the earlier European collaboration in
  - First flight 1969
  - EIS 1976
Airbus Beginnings and Founders

- Today’s *Airbus SE* is the product of international consolidation in the *European* aerospace industry tracing back to the formation of the *Airbus Industrie GIE* consortium in 1970

- In 2000, *the European Aeronautic Defence and Space Company (EADS)* NV was established

- In addition to other subsidiaries pertaining to security and space activities, *EADS* owned 100% of the pre-existing *Eurocopter SA*, established in 1992, as well as 80% of *Airbus Industrie GIE*

- In 2001, *Airbus Industrie GIE* was reorganized as *Airbus SAS*, a simplified joint-stock company

- In 2006, *EADS* acquired *BAE Systems’* remaining 20% of *Airbus*

- *EADS NV* was renamed *Airbus Group NV* and *SE* in 2014, and 2015, respectively

- Due to the dominance of the *Airbus SAS* division within *Airbus Group SE*, these parent and subsidiary companies were merged in January 2017, keeping the name of the parent company

- The company was given its present name in April 2017

- **The founders of Airbus SE are:**
  - Franz Josef Strauss
  - Henri Ziegler
  - Felix Kracht
  - Roger Béteille
Airbus Origins

- SEP 26, 1967  U.K., France and Germany sign a memorandum of understanding to build an **Air Bus**
- APR 10, 1969  The U.K. withdraws from the agreement
- **Hawker Siddeley** maintains their role as wing maker as a sub-contractor.
- MAY 29, 1969  At the *Paris Airshow*, **French** Transport Minister **Jean Chamant** and **German** Economics Minister **Karl Schiller** signed an agreement between the two countries to produce the **A300**, the world’s first wide-body twin-engine airliner
- Each country would have a 50% stake.
- DEC 18, 1970 **Airbus Industrie** is formed to build the **A300**
- This was formed by **Aérospatiale** (merged **Sud Aviation and Nord Aviation**) of France and **Deutsche Aerospace** of Germany.

- **French engineer Roger Béteille** was appointed technical director
- He drew up a work share plan for what would become the **A300** project
- **France** would produce the cockpit, control systems and lower center part of the fuselage
- **Germany** would produce the forward, rear and upper part of the center fuselage
- The **Netherlands** would produce the moving parts of the wings
- **Hawker Siddeley** of the U.K. would produce the wings
- **Spain** would produce the horizontal tailplane
Airbus Origins A300

- **Roger Béteille** also specified:
  - Imperial measurements (inches, pound, etc) were to be used
  - English would be the working language
  - Latest technologies must be part of the new offering to create a differentiation from current offerings

- Some of the technologies incorporated into the A300 included:
  - First to use fiberglass reinforced plastics for wing leading and trailing edges
  - Redesigned wing to allow steeper climb out
  - First to use wind shear warning systems
  - Advanced autopilot
  - Electrically controlled braking
  - Cockpit redesign to remove the need for the flight engineer
  - Center of gravity control by pumping fuel to different locations around the aircraft
  - Electrical control of secondary flight systems

- SEP 3 1970  **Air France** becomes the launch customer with six airframe orders
- SEP 28 1972  The **A300** prototype was unveiled to the public for the first time
- OCT 28 1972  First flight of the **A300**
- MAR 15 1974  *Type certification* was granted for the **A300** by both German and French authorities
- MAY 23 1974  The U.S. Federal Aviation Authority (FAA) issued certification for the **A300**
- MAY 30 1974  EIS with **Air France**
Airbus Origins A300

2-4-2 Seating

A300 cross section

A300 3 crew flight deck

Later A300 2 crew flight deck
## Airbus Origins A300

<table>
<thead>
<tr>
<th></th>
<th>A300B4-200</th>
<th>A300-600R</th>
<th>A300-600F</th>
</tr>
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<tbody>
<tr>
<td>Cockpit crew</td>
<td>Three</td>
<td>Two</td>
<td>Two</td>
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<tr>
<td>Main deck seats</td>
<td>281/309Y @ 34/31 in</td>
<td>247 (46F + 201Y)/285Y @ 34 in</td>
<td>540 m³, 43 AYY ULD</td>
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<tr>
<td></td>
<td>max 345</td>
<td>max 345 (3-3-3 Y)</td>
<td>9 AMJ/LD7 + 16 AYY</td>
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<tr>
<td>Lower deck</td>
<td>20 LD3 + bulk</td>
<td>22 LD3 + bulk / 158 m³</td>
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<tr>
<td>Length ft</td>
<td>175.9</td>
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<tr>
<td>Height ft</td>
<td>54.9</td>
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<tr>
<td>Wing span ft</td>
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<tr>
<td>Width ft</td>
<td>17.35</td>
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<tr>
<td>MTOW lbs</td>
<td>363,763</td>
<td>378,534</td>
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<tr>
<td>Max payload lbs</td>
<td>82,662</td>
<td>91,214</td>
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<tr>
<td>Fuel capacity lbs</td>
<td>106,858</td>
<td>117,958</td>
<td>117,958</td>
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<tr>
<td>OEW lbs</td>
<td>195,120</td>
<td>195,387</td>
<td>180,133</td>
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<tr>
<td>Engines</td>
<td>CF6-50C2 or JT9D-59A</td>
<td>CF6-80C2 or PW4158</td>
<td>CF6-80C2 or PW4159</td>
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<tr>
<td>Takeoff thrust lbs</td>
<td>52,000</td>
<td>50,000-61,000</td>
<td>50,000-61,001</td>
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<td>Takeoff (MTOW, SL, ISA)</td>
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<td>7900 ft</td>
<td>7900 ft</td>
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<td>Speed</td>
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<td>Cruise Mach 0.82</td>
<td>Cruise Mach 0.82</td>
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<tr>
<td>Range nmi</td>
<td>2900</td>
<td>4050</td>
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</tr>
</tbody>
</table>
Airbus Origins     Aggressive A300 Sales

• **Eastern** wanted to test out 4 A300s for 6 months *at no charge*

• **Eastern** sold this as free advertising and though Airbus was initially sceptical George Warde, head of its US Sales department, saw the benefit

• Agreement was reached in August 1977 and training in France for Eastern crews began in November

• Only one month later on December 13, 1977 the first Eastern **A300** started operations

• The plane scored well across the board and showed significant fuel savings compared to the **L-1011s** and **727s**

• Internally some at Eastern still wavered but not the man in charge **Frank Borman**

• Negotiations began only 3 months after service entry for a permanent deal

• **Eastern** ordered 23 A300s, the first U.S. **Airbus** order

• MAR 2006 **Airbus** announced the intended closure of the **A300/A310** production line

• 18 APR 2007 The final production **A300**, an **A300F** freighter for **FedEx** makes its first flight

• 561 A300s were manufactured between 1974 and 2007
Airbus Origins A310 A Derivative

- The **Airbus A310** is a derivative of the **A300** wide body aircraft
- **A310s** have the same eight-abreast cross-section as the **A300** but is 22.8 ft shorter with a smaller wing area
- **Airbus** responded to airlines’ demand for a smaller longer range (~5,925 miles) wide body twin aircraft
- The **A310** was launched by orders from **Swissair** and **Lufthansa** in July 1978
  - Same year **Boeing** launched its **767** Twin Wide Body
- **A310** first flight was in April 1982 and it was certified in March 1983
- It was powered by the same **GE CF6-80A** then **CF6-80C2** or **P & W JT9D** then **PW4000** turbofan jet engines
- Capacity is 220 passengers in two classes, or 240 in all-economy
Airbus Origins A310  A Derivative

- The **A310** introduced a two-crew *glass cockpit*, later adopted for the **A300-600** with a common type rating.

- The **A310** entered revenue service with *Swissair*, and competed with the **Boeing 767-200**, introduced six months before.

- Its longer range and **ETOPS** regulations allowed it to be operated on transatlantic flights.

- 255 **A310s** were built between 1981 and 1998.

- The last **A310** was delivered in June 1998.

- It was succeeded by the larger **Airbus A330-200**.

- It was available as a cargo aircraft version.
ETOPS

- **ETOPS** is an acronym that stands for “Extended-range Twin-engine Operational Performance Standards”.
- In 1985, special allowance was given to Trans World Airlines to fly their twin-engine 767 transatlantic from Boston to Paris.
- This was the first ETOPS certification rating given: **ETOPS 120 minutes**.
- This means that twin-engine aircraft were allowed to fly no more than 120 minutes flying time away from the nearest airport suitable for an emergency landing.
- Decades prior to this, the **FAA** had a “60-minute rule” that restricted twin-engine aircraft to a 60-minute diversion area. This number was based on the piston engine reliability of the time but the rule had some flexibility pending special approval.
- Shortly after, the ICAO recommended a 90-minute diversion time for all aircraft, which was adopted by many regulatory authorities and airlines outside the US.
- **ETOPS 120** became the standard but this gave way to **ETOPS 180**.
- Achieving this increased rating was only possible after a year of trouble-free 120-minute ETOPS experience.
- Eventually, the **FAA** was convinced to allow **ETOPS 180** on an aircrafts’ entry into service.
- Now **ETOPS** certifications go as high as 370 with the **Airbus A350**.
ETOPS

- **Type certification**
  - To gain ETOPS certification for an aircraft, the manufacturer must be able to show that the plane adheres to a specific set of standards
  - They must prove that flying with only one engine is safe for the airframe and relatively manageable for the flight's crew
  - Reliability data must show that the need for one engine operation is statistically extremely rare
  - They need to add extra redundancy for certain systems, such as electrical, hydraulics, fire suppression, and communications
  - Certification of an aircraft before its introduction is known as **Early ETOPS**
  - The Boeing 777 was the first type to be introduced with an ETOPS-180 rating in 1995

- **Operational certificates for airlines**
  - Once the aircraft has ETOPS approval, airlines must apply for their own certification depending on the route it wishes to fly the plane on
  - They have to demonstrate adequate standards for crew training as well as aircraft and engine maintenance procedures
  - This means that pilots, dispatchers, and engineers must all undergo the certification
  - According to the FAA, the carrier must also "...demonstrate that it can operate the particular airframe and other airplane systems at levels of reliability appropriate for the intended operation. This can be achieved directly by a successful in-service operational history or by successfully validating all the required ETOPS processes according to the Accelerated ETOPS Application Method"
To obtain an EDTO / ETOPS approval of an aircraft, the Manufacturer must show:

- Adequate APU design (start capability within the overall flight envelope)
- Fuel availability
- Adequate communication systems
- Adequate cockpit & cabin environment
- Acceptable Crew Workload (under failure conditions)
- Adequate Cargo Fire Suppression System (capability & reliability)
- Safe flight and landing in EDTO / ETOPS icing conditions
- Single engine operation: adequate system redundancy
- Adequate Propulsion System Reliability
- Electrical power source redundancy & capability

IFSD Rate
The result was **ETOPS**, which began in 1985 with 120-min diversion authority and the requirement for an average engine in-flight shutdown (IFSD) rate of just 0.05 per 1,000 engine-hours.

With **180-min ETOPS** authority, which followed in 1988, an even more stringent reliability target of just 0.02 IFSDs per 1,000 engine-hours was specified.

In recent years the average IFSD rate of the worldwide **180-min ETOPS** fleet has typically been at or below 0.01 IFSDs per 1,000 engine-hours — twice the reliability required for such operations.

Airlines can apply for **ETOPS-75**, **ETOPS-90**, **ETOPS-120/138**, and **ETOPS-180/207**.

In some cases, **ETOPS-240**, **ETOPS-270**.

**ETOPS-330**, and **ETOPS-370** are available on a case-by-case, route-specific basis as well.
Boeing 767  Wide Body Twin

- 1972  Development study begins on the 7X7 which would replace the Boeing 707
- 1976 A twinjet layout was decided upon, much like the Airbus’ A300.
- February 1978  The 767 designator was decided upon and three variants planned. The 767-100 (190 seats), 767-200 (210 seats) and the 767-MR/LR (Medium Range / Long Range). The 767-MR/LR was proposed as a tri-jet to get around ETOPS restrictions. This was later redesignated the 777 with the tri-jet configuration dropped. The 767-100 was dropped as its capacity was too close to the 757.
- July 1978  The 767 was officially launched when United Airlines ordered 30 x 767-200s, soon followed by American Airlines and Delta Airlines
- July 1979  Assembly begins of the first 767
- August 1981  The first 767 prototype, a 767-200 rolled out of the factory By this time Boeing had 173 firm orders for the type.
Boeing 767 Wide Body Twin

- **September 1981** The first flight of Boeing 767
- **July 1982** The Boeing 767-200 powered by Pratt & Whitney JT9D engines received type certification from both the FAA and CAA (UK)
- **September 1982** Type certification was given to the 767-200 powered by GE CF6-80A
- **September 1982** United Airlines puts its first 767-200 into service on the Chicago to Denver route
- **December 1982** Ethiopian Airlines launches the order book for the extended range version, the 767-200ER
- **March 1984** El Al Israeli Airlines put the first 767-200ER into service

<table>
<thead>
<tr>
<th>767 Airplane Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variants</td>
</tr>
<tr>
<td>Cockpit crew</td>
</tr>
<tr>
<td>3-class seats</td>
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<tr>
<td>2-class seats</td>
</tr>
<tr>
<td>Cargo</td>
</tr>
<tr>
<td>ULD (35, 36)</td>
</tr>
<tr>
<td>Length</td>
</tr>
<tr>
<td>Wingspan</td>
</tr>
<tr>
<td>Wing</td>
</tr>
<tr>
<td>Fuselage</td>
</tr>
<tr>
<td>MTOW</td>
</tr>
<tr>
<td>Max. payload</td>
</tr>
<tr>
<td>OEW</td>
</tr>
<tr>
<td>Fuel capacity</td>
</tr>
<tr>
<td>Range</td>
</tr>
<tr>
<td>Cruise speed</td>
</tr>
<tr>
<td>Ceiling</td>
</tr>
<tr>
<td>Takeoff</td>
</tr>
<tr>
<td>Engines (+2)</td>
</tr>
<tr>
<td>Thrust (+2)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Boeing 767 Widebody Twin
Boeing 767 Wide Body Twin

- May 1985 TWA was the first airline to receive ETOPS 120 approval for 767 operations
- September 1983 Japan Airlines places the first Boeing 767 300 order
- January 1986 First flight of the Boeing 767 300
- October 1986 The 767 300 enters service with Japan Airlines
- December 1986 First flight of the Boeing 767 300ER (Extended Range)
- March 1987 American Airlines orders for the 767 300ER
- March 1988 767 300ER goes into service at American Airlines
- April 1988 A long-distance record flown by a twin-engine airliner set when an Air Mauritius 767 200ER flew non stop from Halifax, Nova Scotia to Mauritius--a distance of 10,042 miles
Boeing 767 Wide Body Twin

- January 1993  **UPS** launched the **767 300F** freighter version
- October 1995  **767 300F** freighter goes into service with **UPS**
- November 1995  **Boeing** announced plans for a third stretch of the **767**, the **767 400X** with a 12 per cent increase in capacity, greater wingspan and updated flight cockpit
- March 1997  **Delta** ordered **767 400ER** to replace its fleet of **Lockheed L1011s**
- October 1997  **Continental Airlines** ordered the **767 400ER** to replace its fleet **DC-10s**
- Airlines are replacing tri jet wide bodies with twin wide bodies
Boeing 767 Wide Body Twin and 757 Narrow Body Twin

- October 1999 **767 400ER** first flight
- September 2000 **767 400ER** EIS with Continental Airlines
- February 2011 The 1,000th **767** was rolled out of the factory
- It is only the second wide-body aircraft to have reached this milestone, the other being the **Boeing 747**
- February 2011 The USAF orders 179 **KC 767** Advanced Tankers - ensuring production beyond 2013
- December 2011 **FedEx** orders 27 **767 300Fs** to replace their **DC10-10** fleet
- June 2012 **FedEx** orders 19 **767 300F** freighters
- 21 July 2015 **FedEx** orders 50 **767 300ERs** with options for another 50 – deliveries between 2018 and 2023

- The **757** narrow body /single aisle was developed at the same time as the **767**
- The **757** was intended to replace the three engine **727**
  - Produced 1962-1984 (1,832 built)
- It used modern **Rolls Royce** or **Pratt & Whitney** high bypass turbofan engines
  - **757** flight deck common to **767**
  - Pilots trained to fly one were certified to fly the other
- Production was 1,050 (1981-2004)
Boeing 767 Wide Body Twin  The Boeing Company of Old

- The first 30 767s produced had 3 crew flight decks, i.e., they had stations for flight engineers
- They were converted to the 2-crew configuration before delivery
- This project received great recognition and became a Harvard business school case study
- Boeing felt it was in the best interest of the industry not to penalize its customers for the conversion

- A story is told that Tax Boullioun, then president of Boeing Commercial, walked into his conference room at the beginning of this process and found a group in deep discussion on this subject
- He asked what was going on, and was told it was a Price Board meeting to determine the price of the conversion to the 767 2-crew flight decks
- The story goes that he said as he left the conference room, "If the answer is not zero, send someone down to see me in my office"
Boeing Flight Decks

737-200

767

777
767 A310 Comparison

- The A310 competed against the 767
- A310 was an A300 derivative (shorter fuselage)
- 767 was a new design
  - Boeing’s only wide body was 747
- They had similar ranges
- 2 crew flight decks
- ETOPS certified
- The 767 had greater passenger capacity
- The A310 could carry the more common LD3 freight containers as it had a wider fuselage than the 767
- The 767 used 7 abreast seating (2-3-2)
- The A310 used 8 abreast seating (2-4-2)
- The 767 had better fuel burn characteristics due to its smaller cross section
- 767 production 1,245 (1981-present)
### 767 A310 Comparison

#### 767 Airplane Characteristics

<table>
<thead>
<tr>
<th>Variant</th>
<th>767-200</th>
<th>767-200ER</th>
<th>767-300</th>
<th>767-300ER/F</th>
<th>767-400ER</th>
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<tbody>
<tr>
<td>Cockpit crew</td>
<td>Two</td>
<td>220</td>
<td>243</td>
<td>265</td>
<td>285</td>
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<tr>
<td>3-class seats</td>
<td>214</td>
<td>216</td>
<td>218</td>
<td>220</td>
<td>222</td>
</tr>
<tr>
<td>2-class seats</td>
<td>214</td>
<td>215</td>
<td>217</td>
<td>220</td>
<td>222</td>
</tr>
<tr>
<td>1-class (lim)(15)</td>
<td>305</td>
<td>305</td>
<td>305</td>
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<td>305</td>
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<tr>
<td>Cargo</td>
<td>3.070 ft³ / 86.9 m³</td>
<td>4.030 ft³ / 114.1 m³</td>
<td>4.905 ft³ / 138.9 m³</td>
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<td>ULD (32-36)</td>
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<td>22</td>
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<td>22</td>
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<tr>
<td>Length</td>
<td>159 ft 2 in / 48.51 m</td>
<td>180 ft 3 in / 54.94 m</td>
<td>201 ft 4 in / 61.37 m</td>
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<tr>
<td>Wingspan</td>
<td>156 ft 1 in / 47.57 m</td>
<td>170 ft 4 in / 51.92 m</td>
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<tr>
<td>Wing</td>
<td>3.050 ft² / 283.3 m², 31.5° sweepback</td>
<td>3.130 ft² / 290.7 m²</td>
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<td></td>
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<tr>
<td>Fuselage</td>
<td>16 ft 6 in / 5.03 m</td>
<td>16 ft 6 in / 5.03 m</td>
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<td></td>
<td></td>
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<tr>
<td>OEW (119)</td>
<td>176,650 lb / 80.1 t</td>
<td>180,610 lb / 82.4 t</td>
<td>189,750 lb / 86.1 t</td>
<td>198,440 lb / 90.0 t</td>
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<td>Max. payload (218)</td>
<td>73,350 lb (33.3 t)</td>
<td>78,390 lb (35.6 t)</td>
<td>86,250 lb (40.0 t)</td>
<td>96,560 lb (43.1 t)</td>
<td>101,000 lb (45.4 t)</td>
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<tr>
<td>Fuel capacity (218)</td>
<td>3,900 n mi / 7,200 km</td>
<td>4,550 n mi / 8,320 km</td>
<td>9,200 n mi / 17,200 km</td>
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<tr>
<td>Ceiling</td>
<td>43,100 ft (13,100 m)</td>
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<tr>
<td>Takeoff (223)</td>
<td>6,600 ft (1,990 m)</td>
<td>2,610 ft (800 m)</td>
<td>9,200 ft (2,800 m)</td>
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<tr>
<td>Engines (211)</td>
<td>JT9D / PW4000 / CF6</td>
<td>JT9D / PW4000 / CF6 / RB211</td>
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<tr>
<td>Thrust (211)</td>
<td>48,000–52,500 lbf</td>
<td>48,000–56,000 lbf</td>
<td>56,750–61,500 lbf</td>
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#### A310 Airplane Characteristics[^44]

<table>
<thead>
<tr>
<th>Model</th>
<th>A310-200</th>
<th>A310-300</th>
</tr>
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<tbody>
<tr>
<td>Cockpit Crew</td>
<td>Two</td>
<td>Two</td>
</tr>
<tr>
<td>2-class</td>
<td>220</td>
<td>237</td>
</tr>
<tr>
<td>1-class</td>
<td>237</td>
<td>243</td>
</tr>
<tr>
<td>Edit limit</td>
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<td>281</td>
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<tr>
<td>Lower deck</td>
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<td>15</td>
</tr>
<tr>
<td>Length</td>
<td>46.66</td>
<td>50.4</td>
</tr>
<tr>
<td>Height</td>
<td>15.8</td>
<td>15.8</td>
</tr>
<tr>
<td>Wing</td>
<td>43.9</td>
<td>45.6</td>
</tr>
<tr>
<td>Cross section</td>
<td>5.64</td>
<td>5.64</td>
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<td>Maximum Payload</td>
<td>32,634 kg (72,387 lb)</td>
<td>37,293 kg (82,217 lb)</td>
</tr>
<tr>
<td>OEW</td>
<td>144,000 kg (317,466 lb)</td>
<td>164,000 kg (361,558 lb)</td>
</tr>
<tr>
<td>Max fuel</td>
<td>47,940 kg / 105,685 lb</td>
<td></td>
</tr>
<tr>
<td>Engines</td>
<td>JT9D-7R4 / GE CF6-60</td>
<td>JT9D-7R4E1 / PW4000 / CF6-80C2</td>
</tr>
<tr>
<td>Thrust (x2)</td>
<td>203.6–257.4 kN (45,600–57,900 lbf)</td>
<td></td>
</tr>
<tr>
<td>speed</td>
<td>Mach 0.8 (459 km/h; 850 km/h) cruise</td>
<td>Mach 0.84 (482 km/h; 892 km/h) MMc</td>
</tr>
<tr>
<td>Ceiling</td>
<td>41,100 ft (12,527 m)</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>3,500 n mi (6,500 km)</td>
<td>5,160 n mi (9,540 km)</td>
</tr>
</tbody>
</table>

[^10]: LOLL Spring 2022
Airbus A330 and A340

- The **A330** was first conceived in the 1970s as a replacement for **Airbus Industries** launch aircraft, the **A300**
- Airbus also were planning a four engine jetliner at this time for trans oceanic services (before **ETOPS**)
- Airbus found that Asian carriers favored the four engine layout and was a market for the **A340** quad jet, while the US market favored twin jets
- The **A330** and **A340** names were swapped around so that the four engine aircraft had a four in its name
- The fuselage barrel for the **A330** and **A340** as well as the wing configuration was the same for both aircraft thereby reducing development costs and ensuring parts interchangeability
- The **fly by wire cockpit** with side control stick that was pioneered on the **A320 (EIS in 1988)** and was also applied to the **A330** and **A340**
- This standardization of **Airbus** flight-decks enables flight crew to transfer between the aircraft types with only a few weeks training

<table>
<thead>
<tr>
<th></th>
<th>A330-200</th>
<th>A330-200F</th>
<th>A330-300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cockpit crew</td>
<td>Two</td>
<td>Two</td>
<td>Two</td>
</tr>
<tr>
<td>Capacity</td>
<td>246</td>
<td>150,000</td>
<td>300</td>
</tr>
<tr>
<td>Max seating</td>
<td>406</td>
<td>440</td>
<td>208</td>
</tr>
<tr>
<td>Length ft</td>
<td>192</td>
<td>208</td>
<td>208</td>
</tr>
<tr>
<td>Span ft</td>
<td>197</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuselage width in</td>
<td><strong>222/207</strong></td>
<td><strong>222/207</strong></td>
<td><strong>222/207</strong></td>
</tr>
<tr>
<td>MTOW lbs</td>
<td>534,000</td>
<td>514,000</td>
<td>534,000</td>
</tr>
<tr>
<td>OEW lbs</td>
<td>265,900</td>
<td>241,200</td>
<td>285,300</td>
</tr>
<tr>
<td>Max payload lbs</td>
<td>108,900</td>
<td>151,200</td>
<td>100,500</td>
</tr>
<tr>
<td>Fuel capacity</td>
<td>240,712 lbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engines</td>
<td>CF6/PW4000/RR Trent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrust</td>
<td>64,500-71,100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cruise</td>
<td>Mach .82 470 kn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>7,260 nm</td>
<td>4,000 nm</td>
<td>6,340nm</td>
</tr>
</tbody>
</table>
## Airbus A340

<table>
<thead>
<tr>
<th></th>
<th>A340-200</th>
<th>A340-300</th>
<th>A340-500</th>
<th>A340-600</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cockpit crew</strong></td>
<td>Two</td>
<td>Two</td>
<td>Two</td>
<td>Two</td>
</tr>
<tr>
<td><strong>Typ layout</strong></td>
<td>303 (30F + 273Y)</td>
<td>335 (30F + 305Y)</td>
<td>313 (12F + 36J + 265Y)</td>
<td>380 (12F + 54J + 314Y)</td>
</tr>
<tr>
<td><strong>Length ft</strong></td>
<td>194</td>
<td>208</td>
<td>220</td>
<td>245</td>
</tr>
<tr>
<td><strong>Wingspan ft</strong></td>
<td>197</td>
<td>208</td>
<td>208</td>
<td>208</td>
</tr>
<tr>
<td><strong>Fuselage in</strong></td>
<td>208</td>
<td>208</td>
<td>208</td>
<td>208</td>
</tr>
<tr>
<td><strong>MTOW lbs</strong></td>
<td>606,000</td>
<td>610,000</td>
<td>840,000</td>
<td>840,000</td>
</tr>
<tr>
<td><strong>OEW lbs</strong></td>
<td>260,000</td>
<td>289,000</td>
<td>370,000</td>
<td>384,000</td>
</tr>
<tr>
<td><strong>Max. Fuel</strong></td>
<td>243,395</td>
<td>286,292</td>
<td>386,292</td>
<td>342,905</td>
</tr>
<tr>
<td><strong>Engines (x4)</strong></td>
<td>CFMI CFM56-5C</td>
<td>CFMI CFM56-5C</td>
<td>Trent 553</td>
<td>Trent 556</td>
</tr>
<tr>
<td><strong>Thrust lbs</strong></td>
<td>31,200-34,000</td>
<td>55,780-61,902</td>
<td>55,780-61,902</td>
<td>55,780-61,902</td>
</tr>
<tr>
<td><strong>Speed kn</strong></td>
<td>493</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Range nm</strong></td>
<td>6,700</td>
<td>7,300</td>
<td>9,000</td>
<td>7,800</td>
</tr>
</tbody>
</table>
Airbus and Boeing Wide Body Aircraft

- **Boeing** launched new aircraft:
- October 1990 **United Airlines** was launch customer for the **777** a large aluminum twin engine wide body

<table>
<thead>
<tr>
<th></th>
<th>777-200/200ER</th>
<th>777-300</th>
<th>777-300ER</th>
<th>777-200LR/777F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew</td>
<td>Two (cockpit)</td>
<td>Two (cockpit)</td>
<td>Two (cockpit)</td>
<td>Two (cockpit)</td>
</tr>
<tr>
<td>2 class seats</td>
<td>313</td>
<td>396</td>
<td>242</td>
<td>317</td>
</tr>
<tr>
<td>Length ft</td>
<td>209</td>
<td>242</td>
<td>212</td>
<td>209</td>
</tr>
<tr>
<td>Wingspan</td>
<td>199</td>
<td>199</td>
<td>212</td>
<td>212</td>
</tr>
<tr>
<td>Speed</td>
<td>Cruise 482 kn</td>
<td>Cruise 482 kn</td>
<td>Cruise 482 kn</td>
<td>Cruise 482 kn</td>
</tr>
<tr>
<td>Range nmi</td>
<td>5,240</td>
<td>6030</td>
<td>7,030</td>
<td>8,555</td>
</tr>
<tr>
<td>Takeoff[k]</td>
<td>8,000 ft (2,440 m)</td>
<td>10,600 ft (3,230 m)</td>
<td>10,000 ft (3,050 m)</td>
<td>9,200 ft (2,800 m)</td>
</tr>
<tr>
<td>Engine</td>
<td>PW4000/TRENT800/GE90</td>
<td>PW4000/TRENT800</td>
<td>GE90-115B</td>
<td>GE90-110B</td>
</tr>
<tr>
<td>Thrust lbs</td>
<td>72,200</td>
<td>98,000</td>
<td>115,300</td>
<td>110,000</td>
</tr>
</tbody>
</table>
Airbus and Boeing Wide Body Aircraft

- April 2004 **ANA** was launch customer for **787**, a smaller composite frame and wing twin engine wide body
- Manufacturing problems delayed EIS until October 2011

<table>
<thead>
<tr>
<th></th>
<th>787-8</th>
<th>787-9</th>
<th>787-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cockpit crew</td>
<td>Two</td>
<td>Two</td>
<td>Two</td>
</tr>
<tr>
<td>Seating, 2-class</td>
<td>242</td>
<td>290</td>
<td>330</td>
</tr>
<tr>
<td>Length ft</td>
<td>186</td>
<td>206</td>
<td>224</td>
</tr>
<tr>
<td>Wing span ft</td>
<td>197</td>
<td>197</td>
<td>197</td>
</tr>
<tr>
<td>Cabin width ft</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>MTOW lbs</td>
<td>502,500</td>
<td>560,000</td>
<td></td>
</tr>
<tr>
<td>OEW lbs</td>
<td>264,500</td>
<td>284,000</td>
<td>298,700</td>
</tr>
<tr>
<td>Cruise speed kn</td>
<td>488</td>
<td>488</td>
<td>488</td>
</tr>
<tr>
<td>Range nmi</td>
<td>7,355</td>
<td>7,635</td>
<td>6,420</td>
</tr>
<tr>
<td>Engines (×2)</td>
<td>Genx-1B/TRENT1000</td>
<td>Genx-1B/TRENT1000</td>
<td>Genx-1B/TRENT1000</td>
</tr>
<tr>
<td>Thrust lbs</td>
<td>64,000</td>
<td>71,000</td>
<td>76,000</td>
</tr>
</tbody>
</table>
Airbus and Boeing Wide Body Aircraft

• In 2004 Airbus proposed an A330 derivative A350 with composite wings and new engines-market reaction was negative

• 2006 Airbus redesigned its A350 to incorporate composite materials in its structure calling it the A350XWB

• The A350-900 entered service with Qatar Airways January 2015

• The A350-1000 entered service with Qatar Airways February 2018

<table>
<thead>
<tr>
<th>A350-900</th>
<th>A350-1000</th>
<th>A350F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cockpit crew</td>
<td>Two</td>
<td>Two</td>
</tr>
<tr>
<td>Seating</td>
<td>315</td>
<td>369</td>
</tr>
<tr>
<td>Length ft</td>
<td>219</td>
<td>242</td>
</tr>
<tr>
<td>Wing span ft</td>
<td>212</td>
<td>212</td>
</tr>
<tr>
<td>Cabin width ft</td>
<td>18.5</td>
<td>18.5</td>
</tr>
<tr>
<td>MTOW lbs</td>
<td>623,908</td>
<td>696,661</td>
</tr>
<tr>
<td>OEW lbs</td>
<td>314,000</td>
<td>342,000</td>
</tr>
<tr>
<td>Cruise speed kn</td>
<td>488</td>
<td>488</td>
</tr>
<tr>
<td>Range nmi</td>
<td>8,100</td>
<td>8,700</td>
</tr>
<tr>
<td>Engines (2×)</td>
<td>Rolls-Royce Trent XWB</td>
<td>Rolls-Royce Trent XWB</td>
</tr>
<tr>
<td>Thrust lbs</td>
<td>84,200</td>
<td>97,000</td>
</tr>
</tbody>
</table>
Airbus A330 neo

• With the advent of the Boeing 787 and the A350 XWB competition – reduced operating costs – competition for the A330 had increased

• July 2014 Airbus announced they were launching the Airbus A330neo project

• NEO stands for New Engine Option

• The current A330 models are now CEOs Current Engine Options

• The A330neo has two variants; the A330 800neo and the A330 900neo both use Rolls Royce Trent 7000 engines

• Other features include: winglets based on the A350 design, longer wingspan, improved engine pylons and cockpit windows in the same design as the A350

• Airbus claims a 14% fuel saving per seat Adding newer more efficient engines to existing airframes is a tried and true way to meet competition and keep a production line open

• Airbus had to be careful not to water down their A350 order book with the upgrade of the A330

• A problem with families of similar aircraft

• Pressure by Delta and others for an updated and re-engined A330 was intense

• Delta Airlines was the launch customer for the A330 900neo with an order for 25 aircraft

• Hawaiian Airlines was the first to order the A330 800neo with an order for 6 aircraft

• The first flight of the A330neo was for October 2017

• EIS December 2018
## Wide Body Aircraft

<table>
<thead>
<tr>
<th>Model</th>
<th>Produced</th>
<th>MTOW (tons)</th>
<th>Length (ft)</th>
<th>Inner width (in)</th>
<th>Outer width (in)</th>
<th>Economy seats across</th>
<th>Number built</th>
</tr>
</thead>
<tbody>
<tr>
<td>767</td>
<td>1981–2021</td>
<td>206</td>
<td>159-201</td>
<td>186</td>
<td>198</td>
<td>2<em>3</em>2</td>
<td>1190 (June 2020)</td>
</tr>
<tr>
<td>A300</td>
<td>1974–2007</td>
<td>189.2</td>
<td>175-177</td>
<td>208</td>
<td>222</td>
<td>2<em>4</em>2</td>
<td>561 (discontinued)</td>
</tr>
<tr>
<td>A330</td>
<td>1994–2011</td>
<td>266.7</td>
<td>193-208</td>
<td>208</td>
<td>222</td>
<td>2<em>4</em>2</td>
<td>1497 (July 2020)</td>
</tr>
<tr>
<td>A340</td>
<td>2007–2011</td>
<td>418.8</td>
<td>186-224</td>
<td>216</td>
<td>227</td>
<td>3<em>3</em>3</td>
<td>1006 (June 2021)</td>
</tr>
<tr>
<td>A350</td>
<td>2010–2021</td>
<td>348.3</td>
<td>218-241</td>
<td>221</td>
<td>235</td>
<td>3<em>3</em>3</td>
<td>370 (July 2020)</td>
</tr>
<tr>
<td>DC-10</td>
<td>1971–1989</td>
<td>286</td>
<td>170</td>
<td>224</td>
<td>237</td>
<td>2<em>4</em>3</td>
<td>446 (discontinued)</td>
</tr>
<tr>
<td>MD-11</td>
<td>1990–2001</td>
<td>315.2</td>
<td>192</td>
<td>224</td>
<td>237</td>
<td>2<em>5</em>2</td>
<td>200 (discontinued)</td>
</tr>
<tr>
<td>L-1011</td>
<td>1972–1985</td>
<td>254.9</td>
<td>177</td>
<td>227</td>
<td>237</td>
<td>3<em>4</em>2</td>
<td>250 (discontinued)</td>
</tr>
<tr>
<td>777</td>
<td>1993–2022</td>
<td>387.4</td>
<td>209-242</td>
<td>231</td>
<td>244</td>
<td>3<em>3</em>3</td>
<td>1637 (June 2020)</td>
</tr>
<tr>
<td>777X</td>
<td>2019–2021</td>
<td>387.4</td>
<td>229-252</td>
<td>234</td>
<td>3<em>4</em>3</td>
<td></td>
<td>4 (January 2021)</td>
</tr>
<tr>
<td>747</td>
<td>1968–2022</td>
<td>493.4</td>
<td>184-250</td>
<td>240</td>
<td>256</td>
<td>3<em>4</em>3 (main)</td>
<td>1558 (discontinued)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3*3 (upper)</td>
<td></td>
</tr>
<tr>
<td>A380</td>
<td>2005–2021</td>
<td>633.8</td>
<td>238</td>
<td>257</td>
<td>281</td>
<td>3<em>43</em> (main)</td>
<td>246 (discontinued)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2<em>4</em>2 (upper)</td>
<td></td>
</tr>
</tbody>
</table>
**Airbus vs. Boeing**

**A330-900neo**
- Seats: 287
- Length: 63.66 m (208.9 ft)
- Wingspan: 64 m (210 ft)
- Height: 16.79 m (55.1 ft)
- MTOW: 553,000 lb (251,000 kg)
- Cruise speed: Mach 0.86 (496 kn)
- Range: 7,200 nm (13,334 km)

**Boeing 787-9**
- Seats: 290
- Length: 62.81 m (206 ft 1 in)
- Wingspan: 60.12 m (197 ft 3 in)
- Height: 17.02 m (55 ft 10 in)
- MTOW: 560,000 lb (254,011 kg)
- Cruise speed: Mach 0.85 (488 kn)
- Range: 7,635 nm (14,140 km)

*Which plane has the longest range?*

- **8700 nm**
  - Airbus | A350-1000
- **8100 nm**
  - Airbus | A350-900
- **8000 nm**
  - Airbus | A330-900neo
- **7730 nm**
  - Boeing | B777X-8
- **7525 nm**
  - Boeing | B777X-9
- **7355 nm**
  - Boeing | B787-8

*Primary Users*
- @aircanadausaofficial
- @skymiles
- @jetstarup
- @austrianairways
- @aircanada
- @airberlin
- @united
Airbus: The most complete product line
Next Session

• Boeing McDonnell Merger
• Narrow Body Battles
Airbus Origins

• The A300 was powered by two underwing turbofan jet engines

• One of the factors that helped keep down the development costs of the A300 was that a new engine did not need to be developed

• The underwing engine pods were designed so that engine types were interchangeable and quite capable of accommodating the Rolls Royce RB211 and Pratt and Whitney JT9D, both of which were developed for the original Boeing 747

• Airbus opted for a third offering in the form of the General Electric CF6-50

• It was decided to go this way as the Rolls Royce RB207 was not progressing due to their concentrating their efforts on the RB211 for the Lockheed L-1011

• The site for the construction of the Airbus A300 was Toulouse-Blagnac in France

• Airbus maintained a just in time system where components would arrive at the factory just as they were needed

• This eliminated the need to store these components onsite

• As well as the major components mentioned above, parts would arrive from all over Europe and the world

• For the larger parts, such as wings and fuselage sections, it was very cumbersome to try and bring them by road, so Airbus acquired two Super Guppies in the early 1970s to transport these parts by air

• The Super Guppy was produced by Aero Spacelines and was based on the military version of the 1950s Boeing 377 Stratocruiser
Airbus Origins

- **Air France** was the launch customer for the **Airbus A300** with an order of six air-frames in September 1970.
- By the time **Air France** put their first A300 into service in **May of 1974**, Airbus was finding it hard to get customers for their launch aircraft.
- The oil crisis of 1973 caused an aviation downturn and airlines had trouble filling their existing aircraft at the higher prices demanded by more expensive oil.
- This put a stop to spending money on newer aircraft, no matter how economical they might be.
- To broaden their market base, **Airbus** knew it had to break into the North American market.
- Here, they were fighting against an American perception of European plane makers, that they produced high performance but low dependability products.
- To highlight the dependability of the Airbus A300, Airbus decided to let the world’s only wide-body twin-engine airliner prove itself to its American doubters.
- In September 1973 the A300 embarked on a six week **Tour of North America**.
- To get there, they flew from Toulouse to Dakar and then via Brazil to Florida.
- This tour allowed airline executives and financiers to get a first-hand look and feel of the A300.
- One of those was **Frank Borman** of **Eastern Airlines** which was one of the Big Four in the U.S..
- It was becoming evident that the concept of a wide-body short haul jet might not be what the market was looking for.
Airbus Origins

- Airlines who flew the A300 were finding they were having to reduce the frequency of flights so that they could fill the larger jet up.
- This made the airlines that flew more frequent narrow-body services more popular due to their greater choice of departure times.
- The attraction of wide-body comfort was not enough of a drawcard.
- Sales were such that production was dropped to one aircraft every two months with four white-tailed aircraft kept in storage.
- The A300 had been flying across the North Atlantic, the Bay of Bengal, and the Indian Ocean under a 90-minute ICAO rule since 1976.
- In 1985, the FAA increased the ETOPS to 120 minutes at the single-engine cruise.
- Prior regulations were the reason that McDonnell Douglas and Lockheed had built tri-jet wide bodies.

- ETOPS which stands for Extended Range Twin Operations (or Engines Turn Or Passengers Swim).
- With the higher proven reliability of the A300, certification was granted for it to fly further from an available airfield then previously enjoyed by any twin airliner.
- This opened up a whole new market for over water medium haul flights.
Airbus A330

• The A330 was first conceived in the 1970s as a replacement for Airbus Industries launch aircraft, the A300

• Airbus also were planning a four engine jetliner at this time for trans oceanic services

• At this time the certification of twin jets to fly extended over-water routes was in its early days. ETOPS (Extended-range Twin-engine Operation) determined that before the aircraft type could be certificated to fly further than a given time from the nearest alternative airfield a certain number of proven flying hours had to be clocked up

• Airbus used the combined hours of the entire fleet of its launch customers to log up these hours

• The hours to achieve the ability to fly 120 minutes from an alternative was 25,000 hours flown and that for 180 minutes from an alternative was 50,000 hours flown

• Airbus found that Asian carriers favored the four engine layout and was a market for the A340 quad jet, while the US market favored twin jets

• The A330 and A340 names were swapped around so that the four engine aircraft had a four in its name

• The fuselage barrel for the A330 and A340 as well as the wing configuration was the same for both aircraft thereby reducing development costs and ensuring parts interchangeability

• The fly by wire cockpit with side control stick that was pioneered on the A320 family of aircraft was also applied to the A330 and A340

• This standardization of Airbus flight-decks enables flight crew to transfer between the aircraft types with only a weeks training

• This is a great saving to airlines, not having their crews tied up in training for long periods of time
Airbus A330

• **A330neo**
  • With over 1,200 A330s produced and over 200 in order backlog, the A330 is still a very successful
  • With the advent of the Boeing 787 and the A350 XWB however, the goal posts have been moved with new technology allowing for dramatic operating cost savings
  • Airbus announced at the Farnborough airshow in July 2014 that they were launching the Airbus A330neo project
  • NEO stands for New Engine Option and this then dubbed the current A330 models as CEOs, Current Engine Options
  • The A330neo has two variants; the A330 800neo and the A330 900neo
  • The neo uses the Rolls Royce Trent 7000
  • There will be only one engine type offered with the neo, with a possibility that other options may come available around 2020.

• While the name neo focuses on the updated engine, it is not the only new feature of this updated A330
  • Other improved features include; winglets that are based on the A350 design, longer wingspan, improved engine pylons and cockpit windows in the same design as the A350
  • According to Airbus, A330neo will deliver a 14% fuel saving per seat
Airbus A330

- The **A330 800neo** is the replacement for the A330 200ceo and the A330 900neo is the replacement for the A330 300ceo
- Airbus had to be careful not to water down their **A350** order book with the upgrade of the **A330**
- But pressure by Delta and other for an updated and re-engined **A330** was intense
- **Delta Airlines** was the launch customer for the **A330 900neo** with an order for 25 aircraft
- **Hawaiian Airlines** was the first to order the **A330 800neo** with an order for 6 aircraft
- The first flight of the **A330neo** was for October 2017
- **EIS** December 2018
Airbus A340

- **A340** is a four engine version of the **A330**
- First flight was October 1991
- EIS was March 1993
- 380 built between 1991 and 2012

**Wide Body production**

- 747 1968-2022  (1,570)
- L-1011 1968-1988  (250)
- DC-10 1968-1988  (386)
- A300 1971-2007  (561)
- A310 1981-1998  (255)
- 767 1981-present  (1,245)
- MD-11 1988-2000  (200)
- A340 1991-2012  (380)
- A330 1992-present (1,535)
- 777 1993-present  (1,683)
- A380 2003-2021  (254)
- 787 2007-present  (1,006)
- A350 2010-present  (480)
## Airbus A340

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cockpit crew</td>
<td>Delivered 28</td>
<td>218</td>
<td>TWO 34</td>
<td>97</td>
</tr>
<tr>
<td>typ. layout</td>
<td>303 (30F + 273Y)</td>
<td>335 (30F + 305Y)</td>
<td>313 (12F + 36J + 265Y)</td>
<td>380 (12F + 54J + 314Y)</td>
</tr>
<tr>
<td>Length[^161]</td>
<td>59.39 m / 194 ft 10 in</td>
<td>63.66 m / 208 ft 10 in</td>
<td>67.33 m / 220 ft 11 in</td>
<td>74.77 m / 245 ft 3 in</td>
</tr>
<tr>
<td>Wingspan</td>
<td>60.3 m / 197.83 ft</td>
<td></td>
<td>63.45 m / 208.17 ft</td>
<td></td>
</tr>
<tr>
<td>Wing[^162]</td>
<td>363.1 m² (3,908 sq ft), 29.7° sweep, 10 AR</td>
<td>437.3 m² (4,707 sq ft), 31.1° sweep, 9.2 AR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>17.03 m / 55.86 ft</td>
<td>16.99 m / 55.72 ft</td>
<td>17.53 m / 57.51 ft</td>
<td>17.93 m / 58.84 ft</td>
</tr>
<tr>
<td>Fuselage</td>
<td>5.287 m / 208.15 in in cabin width, 5.64 m / 18.5 ft outside width</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cargo volume</td>
<td>158.4 m³ (5,590 cu ft)</td>
<td>132.4 m³ (4,680 cu ft)</td>
<td>149.7 m³ (5,290 cu ft)</td>
<td>201.7 m³ (7,120 cu ft)</td>
</tr>
<tr>
<td>MTOW</td>
<td>275 t (606,000 lb)</td>
<td>276.5 t (610,000 lb)</td>
<td>380 t (840,000 lb)</td>
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</tr>
<tr>
<td>Max. PL</td>
<td>51 t (112,000 lb)</td>
<td>52 t (115,000 lb)</td>
<td>54 t (119,000 lb)</td>
<td>66 t (146,000 lb)</td>
</tr>
<tr>
<td>OEW</td>
<td>118 t (260,000 lb)</td>
<td>131 t (289,000 lb)</td>
<td>168 t (370,000 lb)</td>
<td>174 t (384,000 lb)</td>
</tr>
<tr>
<td>Max. Fuel</td>
<td>110.4 t / 243,395 lb</td>
<td>175.2 t / 386,292 lb</td>
<td>155.5 t / 342,905 lb[^8]</td>
<td></td>
</tr>
<tr>
<td>Engines (×4)</td>
<td>CFM International CFM56-5C</td>
<td>Trent 553</td>
<td>Trent 556</td>
<td></td>
</tr>
<tr>
<td>Thrust (×4)[^161]</td>
<td>138.78–151.24 kN (31,200–34,000 lb)</td>
<td>248.12–275.35 kN (55,780–61,902 lb)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>Mach 0.86 (493 kn; 914 km/h) max[^160]</td>
<td>Mach 0.82 (470 kn; 871 km/h) cruise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range, 3-class[^160]</td>
<td>12,400 km / 6,700 nmi</td>
<td>13,500 km / 7,300 nmi</td>
<td>16,670 km / 9,000 nmi</td>
<td>14,450 km / 7,800 nmi</td>
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<tr>
<td>Take off[^6]</td>
<td>2,900 m (9,500 ft)</td>
<td>3,000 m (10,000 ft)</td>
<td>3,350 m (10,990 ft)</td>
<td>3,400 m (11,200 ft)</td>
</tr>
<tr>
<td>Ceiling[^161]</td>
<td>41,100 ft (12,527 m)</td>
<td></td>
<td>41,450 ft (12,634 m)</td>
<td></td>
</tr>
</tbody>
</table>
Airbus A340
Airbus A340
Airbus A340
Airbus A340
Boeing 777
Boeing 777
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Airbus A350
Rise of Airbus

- In 1965 BEA issued a requirement to the UK industry for an ‘Airbus’
- It was the requirement that eventually led to the A300 and Airbus Industrie
- Airbus is a joint venture in Europe, involving EADS and BAE organizations. Its center is in France
- Since 1970’s, Airbus has become an aircraft producer for large civil jetliners and, currently, it is struggling for the market headship with Boeing, in a duopoly
- The corporation offers an array of aisles and broad, body aircrafts, which ferry from 110 to 555 travelers, a mark of sturdy diversification
- Airbus has the mark of the innovation leader, through using fresh technologies for lessening operating fuel burn, overheads, noise, emanations, and, concurrently, the escalating range
- Since 2002, the corporation has been experiencing regular revenues boost. In 2006, the company recorded €25.2 billion, a raise of 13.2% from the previous year (Airbus, 2006).

- The long-term strategic purpose of Airbus is in its strategic group vision of “creating the best and safest aircraft” (Airbus, 2006)
- The mission statement, which pursues the standard “to meet the wants of operators and airlines through producing the most recent and comprehensive aircraft family on the market, complemented by the highest standard of product support”(Airbus, 2006), substantiates the long term strategic purpose of the company.
- To specify this mission, Airbus planned in its goal that the corporation desires to deliver strong products in a sustained way, while dominating almost half of commercial aircraft market, in the globe, eventually
- This will thrive by objectives such as extra internationalization, centering on chief geographic markets, intensifying its client services offering, as well as, reinstating its competitive frame through focusing on competence and flexibility
Rise of Airbus

- Among its 55,000 workers, are employees from many nationalities
- The industry has become an international player, since 1970, beating Boeing in 2005, a firm that has been in function for an exceedingly long phase
- The incessant declaration to freeze the costs of spare parts is a key success of Airbus, regarding customer support
- This has been the case for three consecutive years

- The impedance of the A380 is a key weakness, presently, facing Airbus
- On October 2006, it caused the European Aeronautic Defense and Space Company (EADS), the parent corporation, to alter its administration
- Breiger, the earlier head of Eurocopter, is the principal operating officer and Hans Peter Ring, a former EADS chief financial officer is the CFO at Airbus (Norris, 2010)
- On top of the modifications in upper administration, Airbus, as well, plans to lessen the amount of suppliers it utilizes
- Airbus approximates that the strategy, which would cut the corporation’s supplier revolution, would lessen material prices by $2 billion over the subsequent three years
- The aircraft monster declares that the supplier consolidation will, as well, reduce administrative overheads by almost $446.5 million. At first, Airbus surprised clients and investors, in June, by increasing the A380’s construction impedance to a whole year, blaming wiring issues. However, in the beginning October, it doubled the delay, once more, to a sum of two years and alleged the delay would wash $6 billion off the proceeds of the parent group EADS in four years (Norris, 2010).
Rise of Airbus

• In the year 2006, additional ramifications from the impediment of the A380 harmed Airbus when the biggest, global express transportation corporation, FedEx, turned, into the earliest of Airbus’ clients, to withdraw ten double-decker orders, in preference of fifteen Boeing freighters.

• An ongoing achievement for Airbus is their dedication to environmental conservation

• This is a win/win condition for any corporation that desires to be at the vanguard of the next upheaval of clean technology, and obtain its benefits

• Building new technologies, which decrease an aircrafts existence carbon footprint, is an attractive aspect that every airline would desire to have

• The view of the public regarding the Earth and the impacts of global warming is changing, and the meeting, which Airbus and other corporations attended in 2006, is confirmation that they are ready for transformation

• Airbus takes pleasure, since it is one of the business leaders that are sensitive to the environment. In the current world, it is vital for a large company to be environmentally clean as clients like to do business with corporations that conserve resources for future use.

• As a business leader, Airbus dedicates to achieving environmental distinction, both for its products and in its production sites. Thus, the corporation dedicates its effort to enhancing environmental responsiveness incessantly, by ensuring that all its production sites conform to the latest values for environmental friendliness.

• Nine other Airbus developing sites obtained the ISO 14001 certification in 2005. This is an ingredient of a companywide strategy to execute an Environmental Management System, so as, to enhance its environmental performance (Norris, 2010).

• As a business leader, however, Airbus devotes to moving towards ecological excellence and the Ecological Management System will be the key provision to demonstrate how its methodically participating improved ecological practices into all areas of its commerce.
Rise of Airbus

• With the ISO 14001 warranty of Toulouse and Hamburg sites beleaguered for use in 2006, Airbus will, in that case, convert all these distinct sites certification into a general business certification, including spots and produces, by the end of 2006” (Airbus, 2006)

• Airbus has also setup a business to reprocess planes that may undergo withdrawal in the prospect. Airbus guesses that extra 4,000 airplanes may undergo superannuation in the subsequent twenty years, roughly 2000 per year. EADS works with associates, such as, SITA (a waste management company) to aid with the reprocessing of the mothballing of the aircrafts (Airbus, 2006).

• The projects technical manager of Airbus, proclaimed this regarding functioning with SITA, “We concentrate, in procedures, to reprocess and recuperate used materials like, tires, plastics and batteries” (Norris, 2010) However, Airbus attempts to delight the clients with being conserving the environment. It is extremely bracing to see that Airbus takes egotism in being harmless and clean to the environs.

• Lawsuit is a threat to Airbus industry. Just of late, Airbus pleaded guilty, alongside with Air France, for indemnities that stemmed close to the town of Strasbourg in the 1992 crash, whereby almost ninety individuals died

• Although the substantiation is unsuccessful to point to one individual intention that caused the plane to bang in to the mounts, it does appear that a mass of factors ranging from an inexpert crew to a possible broken down guidance system may have been at mistake. To date, Air France has now paid $27 million to many families of the victims (Airbus, 2006). It can request the corporation to pay their share of the dents.

• Since Airbus is a worldwide corporation, which has clients and providers from all over the sphere, a main economic risk they face is how money exchange rates affect profits. Parent institutions of EADS’ chief revenues are in U.S. dollars although a hefty portion of its incurred outlays is in the shape of Sterling Pounds, the legal tender of the United Kingdom, and Euro, that of the European Union.
Rise of Airbus

• The disparity of exchange rates may cause an adverse change in Airbus and, consequently, EADS income. So as to tackle this hitch, EADS runs a long-term equivocation portfolio that attempts to guard itself against noteworthy changes in the exchange rate, in addition to, irregular losses of revenue as a result of deferment, as in the situation of the A380, and order terminations, like in the circumstance of FedEx.

• Airbus has lots of peripheral risks out of their mechanism as the terrorist assaults in New York and Madrid, and the extent of the SARS (Severe Acute Respiratory Syndrome) virus has validated. Terrorism and epidemics can adversely affect public opinion of air travel security and ease, which can affect the mandate for air travel and manufacture of new profit-making aircraft (Norris, 2010).

• Moreover, significant airplane bangs may have a destructive effect on the public views, on the wellbeing, of an aircraft. As of endemics, terrorism and other tragic occasions, an airline may be confronted, with declined demand for air voyage, and be forced to take expensive security and safety techniques. Another peril inherent in the airline industry is rivalry. Most of EADS’ companies are subject to significant rivalry. Airbus, in particular, has suffered from the descending price pressure subsequent from the rivalry.

• EADS believe that the current falling of some of the essential causes of such price rivalry instigates the current failing of ultimatum which has led to superior control for certain clients to encourage rivalry in reverence of a variety of issues, most outstandingly price and imbursement terms (Norris, 2010). Airbus and its most direct opponent Boeing have both blamed each other of unlawful government backing. In previous years, Airbus and its main rivals have benefited from government funding for product investigation and expansion.
Rise of Airbus

• However, no declarations can be given that backing will last to be made accessible for future developments. In 1992, the European Union and the United States arrived into a consensual “Agreement on Trade in Large Civil Aircraft”, whose main impartial was to legalize the height of regime provision to both airliner industries.

• The autarchic departure from the 1992 pact by the US government in late 2004 finally led to denunciations back and out by the EU and the US, through the World Trade Organization (Norris, 2010). The US and the EU have, as well, arrived into deliberations, to seek steadfastness to the issues being doubtful in the official WTO process, with the goal of approving on a new structure that provides for a level on stage field when backing future airliner developments.

• In 2005, the EU and the US settled on terms for dialogues on grants affecting the civil airliner sector. The objective of these discussions was to eradicate dissimilar types of sponsorships and fair market-based rivalry among Boeing and Airbus.

• Peter Mandelson, the current Trade Commissioner for the European Union, expressed content because he was able to settle on a way onward, together with the previous US Deputy Secretary of State. He hoped that their talks in the subsequent three months would tip to an agreement ending endowments to development and production of large civil airplane.

• Airbus can arguably be delighted of the brilliant range of airliner it is manufacturing and is obviously capable of challenging in the worldwide market place. In the year and a half since repudiations first initiated, the two are no closer to deciding the disputes. In November 2006, America took the initiative of building the first suggestions to a WTO panel concerning government backings for Airbus.

• EU Trade spokesperson Peter Power said that EU has continuously sought to resolve the aircraft disagreement through arbitration rather than a court case, but, unfortunately, the exasperation from US and Boeing is vast. The EU will powerfully protect this case and follow its own case against the WTO illegal sponsorships agreed by the US administration to Boeing (Norris, 2010).

• Indirect rivals to the Airbus Corporation would comprise trains, ships and vehicles. For expenses above 1,500 miles, there exists no realistic substitute to flying.
Rise of Airbus

• Indirect rivals to the Airbus Corporation would comprise trains, ships and vehicles. For expanses above 1,500 miles, there exists no realistic substitute to flying.

• However, shorter distances increase rivalry. Besides, airplane crashes give the foremost edge to rivalry. Although an individual is far more prone to die in a car mishap, disastrous events in the carrier commerce underline and broadcast on a sophisticated level.

• Airbus Flight 587 collapsed to the earth, after leaving the airport, exterminating the 260 on board and 6 people on the ground, in 2001. The plane breakdown initiates the mishap. Catastrophes such as this give a false representation of flying, and are the springs of untrusting passengers, who then opt to move by other ways.

• Airbus also façades much rivalry right within the aircraft engineering industry. The “strength” of Airbus is their A320 kinfolk, which comprises the A318, A319, A320 and the A321. Direct rivals to these aircrafts are a sequence of the Embraer E-Jets and Boeing aircrafts. Embraer, is position four in the world manufacture of civil airliners, and second in local airliners (Airbus, 2006).

• Their chief focus is on jets and turboprops with area for 21-116 travelers. They also harvest transport, light attack, and observation airplane in which the Brazilian Air Force is their chief buyer. Bombardier, traced in Quebec, is the numeral three producers of national airliners.

• It leads Embraer in the manufacture of regional airliners and the number one. Bombardier’s conveyance division includes Daimler Chrysler’s Adtranz rail system, which is the chief railway gear maker in the world. They also preserved a reformation vehicle industry at one time, which they vended.

• Embraer and Bombardier are negligible rivalry to Airbus when related to Boeing. Boeing is the world’s biggest space corporation globally, while Airbus is the strongest opponent in the commercial airliner industry. The competing corporations are far from a welcoming connection. In 1992, a contract between the corporations quantified the limit of sponsorships endorsed from their governments, but the contract has been unworkable.
Rise of Airbus

• Each firm has blamed the other for not following the instructions in the contract, and, in 2004, Boeing filed an official protest. In reply, Airbus also filed an objection based on partial launch aid by the US administration. The court case is in the process, at present, and the ending will have a massive impact on the prospect of the aircraft business. Potential projects, for instance, Airbus’s A350 will rely on subsidy, through the administration, to assist with development and research overheads.

• For the present projects, the A380 airliner should go directly with the Boeing 747 (Sascha, 2007). Although 2005 was the fifth year in a ruckus, whereby Airbus obtained beyond fifty percent of the market share, problems with the A380 are likely to bring this line to a halt this year. The interruptions in the engineering and delivering of the A380 are proving to be extremely destructive.

• In June of this year, Airbus had stated a second delay in the conveyance of expected airliners, which is leading to a decline in orders and shares. In its place, the companies will acquire fifteen freighters from Boeing, each worth $235 million each (Airbus, 2006). Airbus still has 166 orders registered, but further deferrals and prevention can easily cause Airbus to drop more transactions to Boeing. The year 2006 is the crucial time yet in the conflict among Boeing and Airbus for market fragment.
Rise of Airbus

• The philosophy of the corporation is, at all times, to listen to its clients, which has positioned Airbus at the vanguard of the business. The value of excellence and innovation normally links with a tradition of partnership by management, as well as, amid the workers and the administrative levels- like towards clients and suppliers. The notion of leadership at Airbus is about sharing tasks and ideas amid all nationalities and levels, so as to obtain the best outcome.

• Functional-region strategies inside the division of Airbus signify the strong relation with the parent group EADS. Besides, it is expanding internationally with an inclusive strategy of improving the supply chain and market existence. EADS corporate strategy applies on Airbus since Airbus is a whole subsidiary of EADS and acts as its segment.

• The key management aims to emphasize EADS’ place as a leader in main international defense and aerospace economies. Airbus, in its business approach, in the division, follows diversification strategy as the finest cost source in each market division for outstanding jetliners, which are civil and commercial.

• The Airbus A380 is Airbus’ key to the increasing traffic linking main hubs, as well as, scarce resources and slot faculties at these centers. Therefore, Airbus upholds the notion of the hub strategy, which requires the volume of travelers at central airports be increased by added mass transportation and feeder traffic on extensive haul flights with extremely vast airplanes.

• In an endeavor to re-establish its competitive frame, Airbus aims at improving its customer receptiveness, value, efficiency and innovation. So as, to streamline the business and productions procedures and to form a system of international business partners, the company launched the Power 8 program (Sascha, 2007).

• To reinforce the partnership with main suppliers everywhere in the world, EADS established a supplier and procurement system. Data streams collectively in the EADS Global Innovation Networks so as, to improve cooperation, sharing practices and competence of the supply chain. Airbus, also, stress on the expansion of goods in reaction to customer desires.
Rise of Airbus

• Airbus does need to advance something on its new airliner the A380. Airbus needs to discourse the public complaint of the excessive deal of sound the A380 makes close to the airfields. Also, Airbus should think through changing/reconsidering its goals under its mission declaration about conveying on time, with high worth, done the first time, if, in fact, it cannot meet these typical it has set for itself.

• In the long-standing, Airbus may form a few modifications and enhancements reach its clients and even get in new ones. For the long-term, we feel that Airbus needs to try to defeat the overseas emerging markets. These markets would comprise nations like India and China, which are presently experiencing defeat by Boeing.

• Airbus also needs to certify that there is a vast deal of miscellany within the firm. We feel that people do notice when a global enterprise such as Airbus is willing to hire personnel of diverse nationalities. We feel that multiplicity is notable for a worldwide corporation because they hear diverse aspects from all over the sphere.

• In conclusion, the mission, objectives and strategies of Airbus are all connected to the long-term strategic vision. The chief strength of Airbus is the diversity of its workers. On the other hand, Airbus faces a key weakness due to the impediment of the A380. A key external strength for Airbus is their dedication to environmental conservation.

• Building new technologies, which decrease an aircrafts existence carbon footprint, is an attractive aspect, since the view of the public regarding the Earth and the impacts of global warming is changing. Lawsuit, exchange rates, terrorists and rivalry are some of the threats facing Airbus.

• The value of excellence and innovation normally links with a tradition of partnership by management, as well as, amid the workers and the administrative levels-like towards clients and suppliers. Also, the Airbus A380 is Airbus’ key to the increasing traffic linking main hubs, as well as, scarce resources and slot faculties at these centers.
Rise of Airbus
Rise of Airbus
Airbus vs. Boeing

A330-900neo
- Seats: 287
- Length: 63.66 m (208.9 ft)
- Wingspan: 64 m (210 ft)
- Height: 16.79 m (55.1 ft)
- MTOW: 553,000 lb (251,000 kg)
- Cruise speed: Mach 0.86 (496 kn)
- Range: 7,200 nm (13,334 km)

Boeing 787-9
- Seats: 290
- Length: 62.81 m (206 ft 1 in)
- Wingspan: 60.12 m (197 ft 3 in)
- Height: 17.02 m (55 ft 10 in)
- MTOW: 560,000 lb (254,011 kg)
- Cruise speed: Mach 0.85 (488 kn)
- Range: 7,635 nm (14,140 km)

Primary Users
@lapaperportugal
@delta
@airmaunlius
@azulinhosalariantis
@etopsaviation

Airbus A380-800
- First Flight: April 27, 2005
- Length: 72.72 m (238 ft 7 in)
- Wingspan: 79.75 m (261 ft 8 in)
- Height: 24.05 m (79 ft 0 in)
- MTOW: 575 t (1,268,000 lb)
- Cruise speed: Mach 0.85 (903 km/h; 488 kn)

Primary Users
@onair
@singaporedair
@Lufthansa
@british_airways

Boeing 747-8
- First Flight: March 20, 2011
- Length: 250 ft 2 in / 76.3 m
- Wingspan: 224 ft 7 in / 68.4 m
- Height: 63 ft 6 in / 19.4 m
- MTOW: 987,000 lb / 447,700 kg
- Cruise speed: Mach 0.86 (493 km; 914 km/h)

Primary Users
@Lufthansa
@KoreanAir
@cargoLufthansa
@OceanaPacificCargo
**Airbus Beluga XL**
- First flight: July 19, 2018
- Length: 207ft (63.1m)
- Wingspan: 197ft 10in (60.3m)
- Height: 62ft (18.9m)
- Max take-off weight: 227,000kg (500,449 lb)
- Cruising speed: Mach 0.69 (398kn or 737km/h)

**Boeing Dreamlifter**
- First flight: September 9, 2006
- Length: 235ft 2in (71.68m)
- Wingspan: 211ft 5in (64.4m)
- Height: 70ft 8in (21.54m)
- Max take-off weight: 364,235kg (803,001 lb)
- Cruising speed: Mach 0.82 (474kn or 878km/h)

**Airbus A321neo**
- Seats: 244 max
- Length: 44.51m / 146.0 ft
- Wingspan: 35.80m / 117 ft 5 in
- Height: 11.76m / 38.6 ft
- MTOW: 213,800 lbs / 97 t
- Cruise speed: Mach 0.78 / 450 kn

**Boeing 737 Max10**
- Seats: 230 max
- Length: 43.8 m / 143 ft 8 in
- Wingspan: 35.92 m / 117 ft 10 in
- Height: 12.3 m / 40 ft 4 in
- MTOW: 197,900 lbs / 89,765 kg
- Cruise speed: Mach 0.79 / 453 kn

*Source: Wikipedia*
**Airbus vs. Boeing**

**A330-900neo**
- Seats: 287
- Length: 63.66 m (208.9 ft)
- Wingspan: 64 m (210 ft)
- Height: 17.69 m (55.1 ft)
- MTOW: 553,000 lb (251000 kg)
- Cruise speed: Mach 0.86 (496 kn)
- Range: 7,200 nm (13,334 km)

**Boeing 787-9**
- Seats: 290
- Length: 62.81 m (206 ft 1 in)
- Wingspan: 60.12 m (197 ft 3 in)
- Height: 17.02 m (55 ft 10 in)
- MTOW: 560,000 lb (254,011 kg)
- Cruise speed: Mach 0.85 (488 kn)
- Range: 7,635 nm (14,140 km)
# Airbus 350 vs. Boeing 777X

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<tr>
<th></th>
<th>Airbus A350</th>
<th>Boeing 777X</th>
</tr>
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<tbody>
<tr>
<td>Seats</td>
<td>315</td>
<td>365</td>
</tr>
<tr>
<td>Length (m)</td>
<td>66.8</td>
<td>69.8</td>
</tr>
<tr>
<td>Wingspan (m)</td>
<td>64.75</td>
<td>71.8</td>
</tr>
<tr>
<td>Range (km)</td>
<td>15,000</td>
<td>16,090</td>
</tr>
<tr>
<td>Height (m)</td>
<td>17.05</td>
<td>19.5</td>
</tr>
<tr>
<td>MTOW (t)</td>
<td>280</td>
<td>387.5</td>
</tr>
<tr>
<td>Speed (kn)</td>
<td>488</td>
<td>64.5 folded</td>
</tr>
<tr>
<td>Price ($m)</td>
<td>317.4</td>
<td>410.2</td>
</tr>
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</table>

**Nota:**
- Airbus A350 modelo A350-900 vs Boeing 777X modelo 777X-9
- MTO: Máximo Peso de Vuelo

Rise of Airbus A321

- The A321, along with newer options of the A321neo and the A321LR, are a vital part of the A320 family
- It is a popular aircraft with many airlines operating both short and medium-range routes
- This article takes a look at the specifics of the A321 and how it has been so successful with its higher capacity and increasing range
Rise of Airbus A321

• **The A320 and the A321**

  • Airbus launched the A320 in the early 1980s, as part of a European program to develop a new single-aisle aircraft.

  • Different size options were part of this from the outset, with a smaller A319 and larger A321.

  • These would compete with other manufacturers' options and offer commonality across the family.

  • The A321 first flew in March 1993 and entered service with Lufthansa in January 1994.

  • The A321 is almost seven meters longer than the A320, with the same wing size (although a slight increase in wing area due to the modification of the flaps and the wing trailing edge).

  • This increased passenger capacity to a maximum of 220 (in single-class configuration), although 170 to 200 is more common.
Rise of Airbus A321

- The A320neo range was launched in 2010, designed to be 15% to 20% more efficient
- The same variants were retained, with the A321neo becoming the high capacity option
Rise of Airbus A321

- **Competing with Boeing**
- The A320 was conceived to be a family of different sized aircraft
- From its outset, it was designed to compete with the Boeing 737, and the A321 continued that focus
- The A320 matched well against the 737 options at the time, but Boeing had an advantage with the 757
- The 757-200 offered a single class capacity of around 228, much higher than the 164 offered by the A320
- The introduction of the A321 gave Airbus the ability to compete with this, and go further by providing cockpit commonality with the A320
- The A321neo offered similar competitive benefits
- This time though, Boeing had increased the size options within the 737 family
- Within the 737NG (Next Generation) family, the larger 737-900 offered capacity up to 220, matched by Airbus with 244 on the A321neo
Rise of Airbus A321

• The range has also been an important part of this competition
• The A321 added extra fuel capacity, but this did not increase its range over the A320
• The Boeing 757-200 remained significantly ahead (7,250 kilometers for the 757 versus 5,900 kilometers for the A321)
• This was improved only slightly by the A321neo.
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Rise of Airbus  A320 Family

• The A318 has a range of 5,750km (3,570mi) and a typical two-class capacity of 90-110.
• The A319neo has a range of 6,850km (4,250mi) and a typical two-class capacity of 120-150.
• The A320neo has a range of 6,300km (3,915mi) and a typical two-class capacity of 150-180.
• The A321neo* has a range of 7,400km (4,000mi) and a typical two-class capacity of 180-220.
• The A321XLR has a range of 8,700km (5,405mi) and a typical two-class capacity of 180-220.
Rise of Airbus A320 Family

![Diagram of Airbus A320 Family models with dimensions and changes]
Rise of Airbus A321
Rise of Airbus A321
Rise of Airbus A321
Rise of Airbus A321
Rise of Airbus A321
Rise of Airbus A321
Rise of Airbus A321

- **Boeing 737-700**
  - Single gap in windows in front of wing
  - Single exit door over wing
  - Capacity: 126-140 passengers
  - Southwest, Delta, United, Alaska, Sun Country Airlines
  - Range: 3,010nm

- **Boeing 737-800**
  - Two gaps between windows in front of wing (left side - 800 & 900 only), one gap (right side)
  - Two exit doors over wing
  - Capacity: 160-175 passengers
  - Southwest, Delta, United, Alaska, Sun Country, Miami Air, Swift Air, and American Airlines
  - Range: 2,933nm

- **Boeing 737-900ER**
  - Extra rear door outline, exterior
  - Large gap between windows in forward fuselage (left side/United Airlines only)
  - Capacity: 177 passengers
  - Delta, United, and Alaska Airlines
  - Range: 2,650nm

**Tail strike skid (800 & 900 only)**
Rise of Airbus A321
Number of jets added to the global aircraft fleet from 1999 to 2020, by manufacturer (in units)
Worldwide number of Airbus aircraft deliveries from 2002 to 2020
There is no duopoly in the world fiercer or a rivalry as complex as Boeing vs. Airbus. Both firms have been around for decades, developing many of the aircraft that we love and have ushered in a new golden age of air travel. But which company is more successful?

Before we dive in, there is a caveat about this comparison. Both firms are titans in their own right, having survived other commercial passenger attempts like Lockheed Martin and Convair. Airbus and Boeing are huge companies, both winning government contracts, powerful political sway, and have an in-depth history. To summarise them and their relationship in a single article is not easy and shouldn't be the end-all comparison, merely the beginning.
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• Both firms are titans in their own right, having survived other commercial passenger attempts like Lockheed Martin and Convair. Airbus and Boeing are huge companies, both winning government contracts, powerful political sway, and have an in-depth history. To summarise them and their relationship in a single article is not easy and shouldn't be the end-all comparison, merely the beginning.

• Airbus came into existence during the development of the A300 aircraft. State-run or influenced airlines in the 1960s wanted to upgrade their aircraft to the next generation (they had a mix of Boeing 707s and others). However, there weren't any suitable European aircraft available on the market to satisfy their needs. European governments wanted a slice of the growing airframe market, but Boeing and other builders were too big for any single European firm to take on.
• Thus they formed a conglomerate of European firms to build an aircraft with the express purpose of competing with American plane manufacturers. This conglomerate would become Airbus, and they would bring to the market the A300 as a Boeing rival.
• Right from the get-go, the European government had a plan to build a series of aircraft to compete with each Boeing offer. Once the A300 and its variant the A310 were complete, various tenders went out for a competitor to the Boeing 747 and Boeing 737.

• Interestingly, each tender failed to secure a new consortium on the market and defaulted back to Airbus (who logically, in retrospect, should have had the contract first). They would go on to develop the A320, A330, and A340, respectively. You can read about why Airbus built each aircraft here.

• By now, Airbus had become Boeing's enemy number one on the aircraft marketplace. Both firms were friendly to each other, although they were very much in competition.

• Airbus managed to strike a blow to Boeing when they secured a large Airbus A320 order with American Airlines (something that they repeated only last year), right in Boeing's backyard. Thus Boeing needed a new aircraft to compete and bring the ball back into their court.

• The Boeing 777 was to be the perfect aircraft platform to rival Airbus A330 and A340 series. Boeing consulted with several airlines to design the aircraft, and its technological improvements managed to undercut sales of the A340 dramatically.
• At this point, Airbus and Boeing faced a crossroads. With air travel demand on the rise, the firms had to design a new aircraft fit for the future of the market.

• Airbus chose to go bigger, build the A380 to compete with the Boeing 747, and focus on hub to hub travel.

• Boeing decided to focus on more efficient aircraft and point to point, developing the Boeing 787.

• The Airbus A380 was a game-changer in the market, able to carry more passengers than ever before and allow airlines to dominate long-haul routes. The Boeing 787 however, was fuel-efficient and allowed airlines to reduce costs. It also made smaller routes connecting two points (without traveling through hubs) more profitable.

• With rising fuel prices tipping the market towards the Boeing 787, the A380 never achieved its full potential. Boeing had backed the right horse in this particular race.

• Airbus would follow the success of the Boeing 787 with the Airbus A350 (successor to the A340) and the Airbus A330neo.

• This article would be amiss not to discuss crucial events that have occurred in recent history. The crashing of two Boeing 737 MAX aircraft dramatically changed the narrowbody landscape between the two competitors, but not for the better of either.
• Boeing's reputation did take a hit, but there were very few airlines that changed orders or decided to move away from the American firm. This may have something to do with the fact that Airbus has a colossal backlog of aircraft, and it would be too expensive for Boeing’s airlines to change to a competitive product (all crew would need to retraining). It is also likely that Boeing has cultivated relationships with its airline customers and will take care of them until the 737 MAX situation is resolved.

• The current aviation crisis in 2020 has also dropped the demand for new aircraft. With many countries under lockdown, and international travel forever changed, it is unknown what long term impacts this will have for both airframe makers. If their customer airlines go out of business, then it won't matter which firm is 'better.'

• What is the competitive landscape like between the two airframe builder
• We begin with the narrowbody marketplace. There is one significant rivalry here, the Boeing 737 vs. the Airbus A320 series. Technically the Boeing 757 also competes with the A321XLR, but the former is no longer in production, and the latter isn't flying yet.

• Both the A320 series and 737 series have been updated over time with new engines, winglets, and other improvements to remain competitive. It has helped these two narrowbody lines remain incredibly popular.

• Looking at sales, the Boeing 737 held the crown for the longest time as the best selling commercial aircraft and was only eclipsed by the Airbus A320 in the last year.
• The race between the two types is so tight that it is almost impossible to determine a 'winner.' The A320 was designed as a Boeing 737 competitor and has done its job marvelously. But we can't ignore the original 737 design has won hearts and changed the aviation industry for decades. Had both aircraft been released at the same time, we could have had a 'definitive' winner, but it would not be fair to compare them on market performance today.

• As for the future of this narrowbody competition, the ball is now firmly in Boeing's court to create a successor for the 737 design in the next decade that can rival the A321XLR improvements.
• Widebodies are where the real clash of the titans takes place between the two firms.

• There are three distinct markets:
  • Boeing 787 vs. Airbus A330
  • Boeing 777 vs. Airbus A350
  • Boeing 747 vs. Airbus A380

• The first, the 787 vs. the A330, has Airbus on the back foot. While the A330 was fantastic as a cheap, high capacity aircraft, the entry of the 787 (and its production ramping up) has made the A330 look old. The A330neo revamp is an improvement (and it sells cheaper than the 787), but sales numbers show the ball in Boeings court. You can read about the A330 vs. 787 here.

• The Boeing 777 vs. Airbus A350 is a different battle. Both aircraft lines have become flagships of each respective firm, and the winner in the future will determine who builds the most premium aircraft. Airbus has so far impressed airlines with its A350 series, but that may change with the 777X on the horizon.

• As for the battle of the jumbo jets, the Boeing 747 and Airbus A380, we only need to look at which is still available to order. Airbus has called it quits for the A380, and the Boeing 747 only has freighter orders remaining. We can firmly hand this win over to Boeing, but only because the 747 existed for many decades before the A380. Had the A380 been developed in the era of the 747, it may have been a different story.
• Which is the better aircraft builder is a thorny question, one that will divide up the comment sections and spur plenty of Facebook discussions. But this article would be amiss if it didn't give an answer to the Boeing vs. Airbus question. If we were to compare both firms, who would be logically better in each market?

• In the narrowbody market, it seems that Airbus' A320 platform has been more flexible and more popular with airlines. We can chalk this up to the A320 following the Boeing 737s footsteps, overcoming design flaws in the former (such as having wings higher up to accommodate more powerful engines) and allowing the aircraft frame to stretch (allowing more flexibility in market use).

• The widebody market is a bit more complicated. It seems that both firms are playing a game of chess, with each successor airframe beating the older rival. Depending on the date, it could be that Airbus is in the lead, or that Boeing has the better widebody design. All we can say is that, in the widebody market, both firms are balanced and could easily outmatch each other with each aircraft generation.

• Cargo aircraft is another market that is typically forgotten, despite being an area were Boeing excels. Boeing produces several different cargo aircraft, such as the Boeing 767, 747-8F, and the 777F. Airbus only produces the A330F and is so far behind Boeing's offerings that catching up would take many years.
• As Airbus was launched several years behind Boeing, it wouldn’t be fair to look at aircraft deliveries as a success metric. As of the end of 2019, they are:
  • Boeing with 19,913 aircraft deliveries.
  • Airbus with 12,626 aircraft deliveries.
  • This flipside of this would be aircraft orders, which we can see Airbus comes out ahead:
  • Airbus with 7,621 aircraft in its backlog.
  • Boeing with 4,744 aircraft in its backlog.
• Overall, when it comes to these two titans, there is no real winner but rather an integrated duopoly that provides airlines with a mix of comparable aircraft. It would not be suitable for the industry for one airframe maker to reach a monopoly, and nor would it be good for one to dominate a specific market.
  • This competition spurs innovation, lower prices for airlines, and cheaper ticket prices. With each new generation of aircraft, the industry as a whole gets better, and the passenger experience reaches new heights. Aviation fans should celebrate both Boeing and Airbus, and their competition encouraged as the friendly rivalry it
Airbus

• Between the signing of two documents – the memorandum of understanding in July, 1967, and the A300 launch agreement in May, 1969 – the bold and visionary venture that was Airbus could have foundered at several turns

• To operate the A300, Roger Béteille wanted a more powerful engine than was then available

• Rolls-Royce was already developing a new engine, the RB211, aimed at the American market, and it pledged to build a version with more thrust, the RB207, for Airbus

• As the months went on, however, it became clear that Rolls-Royce had overstretched themselves and were concentrating all their efforts – and funds – on the RB211

• Development work on the RB207 had all but stopped: Airbus had no engine
Airbus

- *Airbus Industrie* began as a consortium of European aviation firms to compete with American companies such as Boeing, McDonnell Douglas, and Lockheed.

- While many European aircraft were innovative, even the most successful had small production runs.

- In 1991, Jean Pierson, then CEO and Managing Director of Airbus Industrie, described a number of factors which explained the dominant position of American aircraft manufacturers: the land mass of the United States made air transport the favored mode of travel; a 1942 Anglo-American agreement entrusted transport aircraft production to the US; and World War II had left America with “a profitable, vigorous, powerful and structured aeronautical industry.”

- “For the purpose of strengthening European co-operation in the field of aviation technology and thereby promoting economic and technological progress in Europe, to take appropriate measures for the joint development and production of an airbus.”

- In the mid-1960s, tentative negotiations commenced regarding a European collaborative approach. Individual aircraft companies had already envisaged such a requirement; in 1959 Hawker Siddeley had advertised an “Airbus” version of the Armstrong Whitworth AW.660 Argosy, which would “be able to lift as many as 126 passengers on ultra short routes at a direct operating cost of 2d. per seat mile.”

- However, European aircraft manufacturers were aware of the risks of such a development and began to accept, along with their governments, that collaboration was required to develop such an aircraft and to compete with the more powerful US manufacturers.

- At the 1965 Paris Air Show major European airlines informally discussed their requirements for a new “airbus” capable of transporting 100 or more passengers over short to medium distances at a low cost.

- The same year Hawker Siddeley (at the urging of the UK government) teamed with Breguet and Nord to study airbus designs.
Airbus

- The Hawker Siddeley/Breguet/Nord group’s HBN 100 became the basis for the continuation of the project.
- By 1966 the partners were Sud Aviation, later Aérospatiale (France), Arbeitsgemeinschaft Airbus, later Deutsche Airbus (Germany) and Hawker Siddeley (UK).
- A request for funding was made to the three governments in October 1966.
- On 25 July 1967 the three governments agreed to proceed with the proposal.

- In the two years following this agreement, both the British and French governments expressed doubts about the project.
- The MoU had stated that 75 orders must be achieved by 31 July 1968.
- The French government threatened to withdraw from the project due to the concern over funding development of the Airbus A300, Concorde and the Dassault Mercure concurrently, but was persuaded otherwise.
- Having announced its concern at the A300B proposal in December 1968, and fearing it would not recoup its investment due to lack of sales, the British government announced its withdrawal on 10 April 1969.
- Germany took this opportunity to increase its share of the project to 50%.
- Given the participation by Hawker Siddeley up to that point, France and Germany were reluctant to take over its wing design.
- Thus the British company was allowed to continue as a privileged subcontractor.
- Hawker Siddeley invested GB£35 million in tooling and, requiring more capital, received a GB£35 million loan from the German government.
Airbus

- **Airbus Industrie** was formally established as a *Groupement d'Intérêt Économique* (Economic Interest Group or GIE) on 18 December 1970
- It had been formed by a government initiative between France, Germany and the UK that originated in 1967
- Its initial shareholders were the French company Aérospatiale and the German company Deutsche Airbus, each owning a 50% share
- 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
- Aérospatiale and Deutsche Airbus each took a 36.5% share of production work, Hawker Siddeley 20% and the Dutch company Fokker-VFW 7%. Each company would deliver its sections as fully equipped, ready-to-fly items
- In October 1971 the Spanish company CASA acquired a 4.2% share of Airbus Industrie, with Aérospatiale and Deutsche Airbus reducing their stakes to 47.9%
- In January 1979 British Aerospace, which had absorbed Hawker Siddeley in 1977, acquired a 20% share of Airbus Industrie
- The majority shareholders reduced their shares to 37.9%, while CASA retained its 4.2%
Airbus

- The **Airbus A300** was to be the first aircraft to be developed, manufactured and marketed by Airbus.
- By early 1967 the “**A300**” label began to be applied to a proposed 320 seat, twin engined airliner.
- Following the 1967 tri-government agreement, **Roger Béteille** was appointed technical director of the **A300** development project.

**Béteille** developed a division of labor which would be the basis of **Airbus’** production for years to come:
- **France** would manufacture the cockpit, flight control and the lower center section of the fuselage.
- **UK’s Hawker Siddeley**, whose Trident technology had impressed him, was to manufacture the wings.
- **Germany** should make the forward and rear fuselage sections, as well as the upper center section.
- The **Dutch** would make the flaps and spoilers.
- **Spain** (yet to become a full partner) would make the horizontal tailplane.

- On 26 September 1967 the **German, French** and **British** governments signed a Memorandum of Understanding in London which allowed continued development studies.
- This also confirmed **Sud Aviation** as the “**lead company**”, that **France** and the **UK** would each have a 37.5% work share with **Germany** taking 25%, and that **Rolls-Royce** would manufacture the engines.
In the face of lukewarm support from airlines for a 300+ seat Airbus A300, the partners submitted the A250 proposal, later becoming the A300B, a 250 seat airliner powered by pre-existing engines.

This dramatically reduced development costs, as the Rolls-Royce RB207 to be used in the A300 represented a large proportion of the costs.

The RB207 had also suffered difficulties and delays, since Rolls-Royce was concentrating its efforts on the development of another jet engine, the RB211, for the Lockheed L-1011 and Rolls-Royce entering into administration due to bankruptcy in 1971.

The A300B was smaller but lighter and more economical than its three-engined American rivals.

“We showed the world we were not sitting on a nine-day wonder, and that we wanted to realise a family of planes...we won over customers we wouldn’t otherwise have won...now we had two planes that had a great deal in common as far as systems and cockpits were concerned.”
Airbus

• In 1972, the A300 made its maiden flight and the first production model, the A300B2 entered service in 1974; though the launch of the A300 was overshadowed by the similarly timed supersonic aircraft Concorde.

• Initially the success of the consortium was poor, but orders for the aircraft picked up, due in part to the marketing skills used by Airbus CEO Bernard Lathière, targeting airlines in America and Asia.

• By 1979 the consortium had 256 orders for A300, and Airbus had launched a more advanced aircraft, the A310, in the previous year.

• It was the launch of the A320 in 1987 that guaranteed the status of 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.
Airbus

• The retention of production and engineering assets by the partner companies in effect made Airbus Industrie a sales and marketing company.

• This arrangement led to inefficiencies due to the inherent conflicts of interest that the four partner companies faced; they were both GIE shareholders of, and subcontractors to, the consortium.

• The companies collaborated on development of the Airbus range, but guarded the financial details of their own production activities and sought to maximise the transfer prices of their sub-assemblies.

• It was becoming clear that Airbus was no longer a temporary collaboration to produce a single plane as per its original mission statement, it had become a long term brand for the development of further aircraft.
Airbus

• By the late 1980s work had begun on a pair of new medium-sized aircraft, the biggest to be produced at this point under the Airbus name, the Airbus A330 and the Airbus A340

• In the early 1990s the then Airbus CEO Jean Pierson argued that the GIE should be abandoned and Airbus established as a conventional company

• However, the difficulties of integrating and valuing the assets of four companies, as well as legal issues, delayed the initiative
Airbus

- In December 1998, when it was reported that British Aerospace and DASA were close to merging, Aérospatiale paralysed negotiations on the Airbus conversion; the French company feared the combined BAe/DASA, which would own 57.9% of Airbus, would dominate the company and it insisted on a 50/50 split.

- However, the issue was resolved in January 1999 when BAe abandoned talks with DASA in favour of merging with Marconi Electronic Systems to become BAE Systems.

- Then in 2000 three of the four partner companies (DaimlerChrysler Aerospace, successor to Deutsche Airbus; Aérospatiale-Matra, successor to Sud-Aviation; and CASA) merged to form EADS, simplifying the process.

- EADS now owned Airbus France, Airbus Deutschland and Airbus España, and thus 80% of Airbus Industrie.

- BAE Systems and EADS transferred their production assets to the new company, Airbus SAS, in return for shareholdings in that company.
Airbus

- In mid-1988 a group of Airbus engineers led by Jean Roeder began working in secret on the development of an ultra-high-capacity airliner (UHCA), both to complete its own range of products and to break the dominance that Boeing had enjoyed in this market segment since the early 1970s with its 747.

- The project was announced at the 1990 Farnborough Air Show, with the stated goal of 15% lower operating costs than the 747-400.

- Airbus organised four teams of designers, one from each of its partners (Aérospatiale, DaimlerChrysler Aerospace, British Aerospace, CASA) to propose new technologies for its future aircraft designs.

- In June 1994 Airbus began developing its own very large airliner, then designated as A3XX.

- Airbus considered several designs, including an odd side-by-side combination of two fuselages from the Airbus A340, which was Airbus’s largest jet at the time.
Airbus

- Airbus refined its design, targeting a 15% to 20% reduction in operating costs over the existing Boeing 747-400
- The A3XX design converged on a double-decker layout that provided more passenger volume than a traditional single-deck design
- Five A380s were built for testing and demonstration purposes
- The first A380 was unveiled at a ceremony in Toulouse on 18 January 2005, and its maiden flight took place on 27 April 2005
- After successfully landing three hours and 54 minutes later, chief test pilot Jacques Rosay said flying the A380 had been “like handling a bicycle”
- On 1 December 2005, the A380 achieved its maximum design speed of Mach 0.96
- On 10 January 2006, the A380 made its first transatlantic flight to Medellín in Colombia
Airbus

• On 3 October 2006, CEO Christian Streiff announced that the reason for delay of the Airbus A380 was the use of incompatible software used to design the aircraft

• Primarily, the Toulouse assembly plant used the latest version 5 of CATIA (made by Dassault), while the design centre at the Hamburg factory were using the older and incompatible version 4

• The result was that the 530 km of cables wiring throughout the aircraft had to be completely redesigned

• Although no orders had been cancelled, Airbus still had to pay millions in late-delivery penalties.

• The first aircraft delivered was to Singapore Airlines on 15 October 2007 and entered service on 25 October 2007 with an inaugural flight between Singapore and Sydney

• Two months later Singapore Airlines CEO Chew Choong Seng said that the A380 was performing better than both the airline and Airbus had anticipated, burning 20% less fuel per passenger than the airline’s existing 747-400 fleet

• Emirates was the second airline to take delivery of the A380 on 28 July 2008 and started flights between Dubai and New York on 1 August 2008

• Qantas followed on 19 September 2008, starting flights between Melbourne and Los Angeles on 20 October 2008
Airbus

- In 2003, Airbus and the Kaskol Group created an Airbus Engineering centre in Russia, which started with 30 engineers and since has emerged as a model of success for Airbus’ globalisation strategy. It was the first engineering facility to open in Europe outside the company’s home countries. Equipped with state-of-the-art communications equipment and linked with Airbus engineering sites in France and Germany, the facility performs extensive work in disciplines such as fuselage structure, stress, system installation and design. In 2011, the centre employs some 200 engineers who have completed over 30 large-scale projects for the A320, the A330/A340 and the A380 programmes. Russian engineers also performed more than half of all design work on the A330-200F freighter, with its activity related to fuselage structure design, floor grids installation and junctions design. The centre currently is involved in the A320neo Sharklets design development and numerous design works for the A350 XWB programme.
Airbus

• On 6 April 2006 plans were announced that BAE Systems was to sell its 20% share in Airbus, then “conservatively valued” at €3.5 billion (US$4.17 billion). Analysts suggested the move to make partnerships with U.S. firms more feasible, in both financial and political terms. BAE originally sought to agree on a price with EADS through an informal process. Due to lengthy negotiations and disagreements over price, BAE exercised its put option which saw investment bank Rothschild appointed to give an independent valuation.
Airbus

In June 2006 Airbus was embroiled in significant international controversy over its announcement of further delays in the delivery of its A380. Following the announcement the value of associated stock plunged by up to 25% in a matter of days, although it soon recovered afterwards. Allegations of insider trading on the part of Noël Forgeard, CEO of EADS, its majority corporate parent, promptly followed. The loss of associated value was of grave concern to BAE, press described a “furious row” between BAE and EADS, with BAE believing the announcement was designed to depress the value of its share. A French shareholder group filed a class action lawsuit against EADS for failing to inform investors of the financial implications of the A380 delays while airlines awaiting deliveries demanded compensation. As a result EADS chief Noël Forgeard and Airbus CEO Gustav Humbert announced their resignations on 2 July 2006.
Airbus

- On 2 July 2006 Rothschild valued BAE’s stake at £1.9 billion (€2.75 billion), well below the expectation of BAE, analysts, and even EADS. On 5 July BAE appointed independent auditors to investigate how the value of its share of Airbus had fallen from the original estimates to the Rothschild valuation; however in September 2006 BAE agreed the sale of its stake in Airbus to EADS for £1.87 billion (€2.75 billion, $3.53 billion), pending BAE shareholder approval. On 4 October shareholders voted in favour of the sale, leaving Airbus entirely owned by EADS.

- 2007 restructuring
Airbus

• On 9 October 2006 Christian Streiff, Humbert’s successor, resigned due to differences with parent company EADS over the amount of independence he would be granted in implementing his reorganisation plan for Airbus. He was succeeded by EADS co-CEO Louis Gallois, bringing Airbus under more direct control of its parent company.

• On 28 February 2007, CEO Louis Gallois announced the company’s restructuring plans. Entitled Power, the plan would see 10,000 jobs cut over four years; 4,300 in France, 3,700 in Germany, 1,600 in the UK and 400 in Spain. 5,000 of the 10,000 would be at sub contractors. Plants at Saint Nazaire, Varel and Laupheim face sell off or closure, while Meaulte, Nordenham and Filton are “open to investors”. As of 16 September 2008 the Laupheim plant has been sold to a Thales-Diehl consortium to form Diehl Aerospace and while the design activities at Filton have been retained, the manufacturing operations have been sold to GKN of the United Kingdom. The announcements resulted in Airbus unions in France and Germany threat
Airbus

• At the 2011 Paris Air Show, Airbus received total orders valued at about $72.2 billion for 730 aircraft, representing a new record in the civil aviation industry

• The A320neo (“new engine option”) model, announced in December 2010, received 667 orders, which, together with previous orders, resulted in a total of 1029 orders within six months of launch date, also a new record.”
ETOPS

ETOPS is an acronym that stands for “Extended-range Twin-engine Operational Performance Standards”.

In 1985, special allowance was given to Trans World Airlines to fly their twin-engine 767 transatlantic from Boston to Paris.

This was the first ETOPS certification rating given: ETOPS 120 minutes.

This means that twin-engine aircraft were allowed to fly no more than 120 minutes flying time away from the nearest airport suitable for an emergency landing.

Decades prior to this, the FAA had a “60-minute rule” that restricted twin-engine aircraft to a 60-minute diversion area. This number was based on the piston engine reliability of the time but the rule had some flexibility pending special approval.

Shortly after, the ICAO recommended a 90-minute diversion time for all aircraft, which was adopted by many regulatory authorities and airlines outside the US.

ETOPS 120 became the standard but this gave way to ETOPS 180.

Achieving this increased rating was only possible after a year of trouble-free 120-minute ETOPS experience.

Eventually, the FAA was convinced to allow ETOPS 180 on an aircrafts’ entry into service.

Now ETOPS certifications go as high as 370 with the Airbus A350.
• **Type certification**
  
  To gain ETOPS certification for an aircraft, the manufacturer must be able to show that the plane adheres to a specific set of standards. They must prove that flying with only one engine is safe for the airframe and relatively manageable for the flight's crew. And, of course, that this would only happen on very rare occasions.

  Furthermore, they need to add extra redundancy for certain systems, such as electrical, hydraulics, fire suppression, and communications. The Airbus A350XWB has the highest rating to date, with an ETOPS-370 certification.

  Certification of an aircraft before its introduction is known as Early ETOPS. The Boeing 777 was the first type to be introduced with an ETOPS-180 rating in 1995. Meanwhile, the European Union Aviation Safety Agency (EASA) says that

• **Operational certificates for airlines**
  
  Once the aircraft has ETOPS approval, airlines must apply for their own certification depending on the route it wishes to fly the plane on. They have to demonstrate adequate standards for crew training as well as aircraft and engine maintenance procedures. This means that pilots, dispatchers, and engineers must all undergo the certification.

  The carrier must also, according to the FAA,

  “…demonstrate that it can operate the particular airframe and other airplane systems at levels of reliability appropriate for the intended operation. This can be achieved directly by a successful in-service operational history or by successfully validating all the required ETOPS processes according to the Accelerated ETOPS Application Method.”
• The result was ETOPS, which began in 1985 with 120-min diversion authority and the requirement for an average engine in-flight shutdown (IFSD) rate of just 0.05 per 1,000 engine-hours

• With 180-min ETOPS authority, which followed in 1988, an even more stringent reliability target of just 0.02 IFSDs per 1,000 engine-hours was specified

• During the past few years, in fact, the average IFSD rate of the worldwide 180-min ETOPS fleet has typically been at or below 0.01 IFSDs per 1,000 engine-hours — twice the reliability required for such operations
- A point-to-point network connects directly a set of locations without any interruption of services (e.g. pick up or drop off) even if the route itself may not be direct.

- A (pure) hub-and-spoke network connects every location through a single intermediary location called a hub. As a network structure, hub-and-spoke allows for greater flexibility within the transport system through a concentration of flows.
It’s no secret that Airbus and Boeing are running a modern day duopoly in the airplane manufacturing industry. These two companies account for 99% of large aircraft orders around the world, serving more than 4 Billion air travelers annually. Their dominance over the market has been a common trend throughout history and the future shows implications that it can continue.
• **Why Do Airbus and Boeing Dominate The Market?**

• Two main factors are the reason why Airbus and Boeing’s dominance over the airplane manufacturing industry: money and history. With both of these factors on their side, Airbus and Boeing can easily maintain their positions as the top companies.

• Manufacturing airplanes requires significant costs. The high barrier to entry includes costs associated with not only the parts, but customer support, maintenance, technology, and more. These two companies have dominance over domestic and international demand, but large overhead has even allowed them to buy into regional leaders, including Bombardier and Embraer.

• The early entry into the manufacturing market has allowed the companies to develop close relationships with their respective government and organizations affiliated with regulation of the industry. Boeing, for example, is the 2\textsuperscript{nd} largest spender on lobbying in the US, with more than a quarter billion dollars spent.

• Safety is perhaps the most important aspect in air travel. The deep history of success for the two manufacturers has solidified their reputation as the go-to airplanes in the industry.
• The Rise of Boeing

• The Boeing Company was started in 1916 and has dominated the market for more than a century of its existence. Boeing created a stake hold for airplane manufacturing by targeting the US government as their first major customer. The company sold planes to the Navy during World War I and expanded to the military and even air mail services in the following decades. As of 2018, they remain the 2nd largest contractor to the US government.

• Boeing became the preferred commercial aircraft for carriers in 1958, when it introduced its 707 model to the public. The model appealed to the public interest of a superior flight experience and a shorter travel time compared to other airplane manufacturers on the market.
• The Rise of Airbus

Airbus was developed in Europe as a response to the rapid growth of Boeing. Germany, France, and the UK came together in 1967 to produce an aircraft that promoted technology and symbolized economic growth. The original design of their first public airplane was positively received by the public. In 1972, its A300B model completed its first flight, allowing passengers to fly more for less.

The success of the early models allowed Airbus to take over the European market and other regions at a time when air travel was first becoming popularized as a means of transportation. Airbus had a more gradual growth compared to Boeing but being early to the market and consistency of reliability has made the company one of the top manufacturers in the world.
• **Airbus and Boeing Market Share**

• After having historical success, Airbus and Boeing both maintain year over year growths. Airbus delivered 800 planes globally in 2018, representing an 11% growth from the year before. Boeing set a record with 806 planes delivered in 2018, a 5.6% growth from 2017. Airbus and Boeing have even managed to significantly outperform the S&P 500 index over the past decade.

• Airbus and Boeing comprise a majority of the fleets maintained by all of the top air carriers around the world. Companies including Spirit and Frontier only use Airbus in their fleets, while Southwest solely uses Boeing. Legacy airlines such as Delta include a mix of the two companies to fill their fleets.
Airbus and Boeing

• It takes years to develop a modern aircraft. But which one of the two giants – Boeing and Airbus – manages to do it faster?

• Theoretically, it is not difficult to calculate the time it took to develop a particular model of aircraft. All we have to do is measure how many years, months or days were spent between the two points: when a particular airplane went into development and when its first production unit was delivered to the first customer.

• The chart below shows how many years particular aircraft spent in the development cycle, including several significant checkpoints: the official launch of the program (often coupled with the first official order) and the first flight of the prototype. The most popular models are shown here, including significant modifications that often come with their respective generations. Aircraft, developed by other companies, but sold by Boeing or Airbus (such as the Boeing 717 and the Airbus A220) are excluded, as are modifications of particular base model (such as the Boeing 737 MAX 9 or the Airbus A321 – derivatives of the 737 MAX 8 and the A320 respectively).
Airbus and Boeing

• **How we got here**

  • The rivalry began when Airbus was founded to consolidate the fragmented European aerospace sector in 1969. They have been slowly growing their market share ever since, while Boeing bought out and or out-competed other U.S. firms, leaving the two as the only major commercial aircraft manufacturers.

  • As the worldwide travel market expanded from just over 400,000 travelers in 1973 to 3.96 billion in 2016, Airbus and Boeing fought to gain market share in the rapidly growing industry, competing at every level over who would get the largest slice the rapidly-growing pie.

  Today, both companies are using every advantage they can find, driving innovation and efficiency. Boeing and Airbus each control around half of the global aircraft market, and analysts anticipate the booming travel industry needing as many as 39,000 new planes over the next 20 years. With a value of over $6 trillion over two decades, even small differences in market share add up to big business, so it is no wonder competition is so fierce.

  • One of the main ways Airbus has clawed valuable ground away from Boeing has been the success of mid-range models like the A340 and A320Neo, the latter of which currently enjoys a 59% market share in its class. This leads us to the first way the rivalry of these two companies and the new aircraft technologies they are developing is reshaping the air travel industry. That is, the changing shape of airline fleets themselves, and the types of planes you are likely to fly on.

  • In the early years of the new millennium, many airlines as well as Airbus thought the key to lower costs in the future would be size. Boeing’s 747 was the queen of the skies, oil was cheap and passenger numbers were steadily increasing. Larger airplanes would allow carriers to get the most out of their precious take-off and landing slots at crowded international hubs and the more passengers they could fit into each plane, the more profitable they would be. This was the theory behind Airbus’ huge, double-decker A380 superjumbo, designed to shuttle travelers between global hubs in large numbers. ‘We’ll sell a lot more than 250. We’ll sell 700 or 750’ Airbus Noel Forgeard opined back in 2005. Thirteen years on, only 217 A380 aircraft are in service, and it took a last-ditch deal with Emirates to stave off the shutdown of the program. So, what happened? Why are you not finding yourself inside a superjumbo more often
Airbus and Boeing

• **New Aircraft Buying Patterns**

  • Airlines changed their buying patterns, favoring a mix with greater emphasis on the narrow-body and smaller wide-body section of the market at the expense of the superjumbo. Boeing banked on a contrasting model of the future, anticipating higher frequencies on major hub-to-hub trunk routes along with a proliferation of services linking smaller cities to the network. Rising fuel costs and the pressure of the Global Financial Crisis on airline balance sheets pushed the industry in the direction Boeing had predicted. Now, smaller narrow-body aircraft make up the vast bulk of all those sold, currently accounting for more than 75% of total sales. But the way aircraft were deployed was also a big part of the change.

  • Smaller aircraft can be redeployed more easily to meet demand, are easier to fill with customers and have lower running costs, making them attractive propositions for carriers. That doesn’t mean that the Superjumbo is a thing of the past. “Given a purely commercial choice, most airlines would order mid-size, long-range aircraft to replenish their fleet” says David Richardson, Vice President of Air Strategy for FCTG Americas, “However, ordering new aircraft has a political dimension, particularly for state owned carriers. I would expect a continued trend of reduced but continued Superjumbo orders”.

  • But airline preferences alone don’t tell the whole story. The desires of customers also played a crucial role. Airlines realized that consumers, especially First and Business-class passengers on their prized intercontinental routes, wanted frequent rather than large services. Basically, Business travelers were much more interested in how soon the next service was than in how many people it was carrying. So, fleets of superjumbo jets increasingly gave way to more adaptable inventories of narrow-body craft flying more frequently. This trend seems set to continue as competition and excess capacity keeps ticket prices low.

  • But, this transition of buying patterns didn’t happen in a vacuum. Airlines took advantage of other, more suitable models being offered by Airbus and Boeing as they competed to offer the most compelling value proposition to their customers. In that sense, the superjumbos are victims of their own manufacturers success with other models, as well as changing demands of consumers. But what were the innovations that enabled this shift?
• Driving Innovation

• An important outcome of this intense rivalry has been the competition for more fuel efficient, cost-effective aircraft. Rising prices mean the cost of fuel now makes up almost half the of the operating costs of airlines, so small improvements in fuel efficiency can yield huge benefits to carriers. One reason superjumbos are less popular is that alternative narrow-body or smaller wide-body craft are so much more efficient than they used to be. Boeing’s latest version of the 787 consumes 40% less fuel per traveler carried than its equivalent aircraft did in the 1970s. That means those smaller aircraft can fly for longer without having to stop and refuel at intermediate destinations, enabling airlines to deploy them on services that would have needed a 747 or A380 before. More frequent services, operated by more adaptable, smaller aircraft became practical and cost effective. This allowed airlines to keep ticket prices low, while giving consumers more flights to the destinations they wanted, giving the more control over their time and their travel.

• One driver of this increased efficiency is the new generation of engines powering aircraft. Sustained demand for jet and the need for competitive advantage allowed companies like Pratt & Whitney to develop innovative new approaches to propulsion technology like the ‘geared turbofan’. This engine alone can yield 16% more fuel efficiency, with half the carbon-dioxide emissions and only 25% of the noise pollution of previous models.
Airbus and Boeing

• **New Routes**
  
  • These more efficient and longer-ranged, small to mid-sized aircraft have enabled airlines to expand route maps, add new services between previously unconnected city pairings and give travelers more choice. These new services, known as ‘long and thin’ routes, connect smaller airports with more distant hubs, or even link two ‘spoke’ cities together.
  
  • Rather than having to fly to a larger hub like New York and then getting a long-haul flight, more and more consumers can fly direct. Boston is an excellent example of how new aircraft technology is unlocking opportunities for airlines and travelers. What was previously thought of as a minor long-haul destination has had more than 12 new routes added to its roster over the last few years. Services from Boston now go to Tokyo, Shanghai, Beijing, London, Oslo and more all without stopping at an intermediate hub.

  This is particularly useful to business travelers, saving them the time and hassle of transiting in congested hub airports and providing direct routes to their destinations. And this story is being repeated at other airports around the country. San Diego, Austin, San Jose, St Louis, Portland, Baltimore, Hartford, Orlando and others are all being linked to hubs farther afield directly. 2017 saw more than 53 such services linking previously unconnected city pairings using the Boeing’s flagship 787 Dreamliner alone. This trend will only accelerate as more new aircraft roll off the production lines and airlines continue to find new ways to profitably employ them to serve the market.

  • These kinds of long-haul routes would once have been the preserve of four-engine, fuel-guzzling behemoths like the 747 or A380. But with the improvements in fuel efficiency and range unlocked by the Airbus-Boeing rivalry they are now being operated mostly by narrow-body or smaller wide-body dual-engine jets like the Dreamliner or the A320.

  • So next time you can catch a direct flight from a smaller city to a major hub, or head straight home from your trip without transiting through congested airports like LAX or JFK, you may have the innovative new planes of Boeing or Airbus to thank for opening the way.
Airbus and Boeing

• The Future

• This productive rivalry has a long way to go yet. Both Boeing and Airbus are plowing billions into research and development to try and gain an edge, pioneering new forms of air transportation and propulsion in the process. Airbus’ E-Fan all-electric prototype aircraft completed a demonstration flight over the English Channel in 2015. Not to be outdone, Boeing is investing in electric aircraft startup Zunum which plans to launch a hybrid-electric commercial air service by 2022. Airbus has also been issued a patent for a new hypersonic jet in the mode of the now defunct Concorde, which would be able to fly from London to New York in just over an hour by moving at 4.5 times the speed of sound.

• While it might be years before we see any of these projects come to fruition, if they prove viable at all, these aerospace giants and the ongoing rivalry between them will be changing the nature of air travel for airlines and consumers for years to come. They have already helped give travelers more frequent services, more destinations and more flexibility determining routes, all while lowering costs and reducing noise and pollution. Who knows what might be next?
From the start of the development to the first delivery (years)

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- From start to program launch
- From program launch to first flight
- From first flight to first delivery

OLLI Spring 2022
• The A310 used shorter A300 fuselage
• Seating and cargo configuration is the same