

Airbus A380 – Taking a 21st Century Flagship from Concept to Reality
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(lecture given to RAeS Loughborough Branch on 21st January 2014)

There were four reasons for building the A380; the growth in air travel, congestion (both in the air and on the ground), the environment (older aircraft are not environmentally friendly) and finally airline economics. Historically air traffic has been growing at a rate of 4.7% per annum. This growth is predicted to be even steeper in future leading to a doubling in air traffic over the next 15 years. Hence the need for a larger aircraft operating between major hub airports throughout the World (37 in all with 7 in Europe and 7 in the US). The A380 design requirements, as defined by potential customers, were:

1. 20% reduction in operating costs compared with existing in-service aircraft;
2. Lower environmental impact;
3. Improved performance;
4. Range of 8,000 miles.

In all 14 different concepts were considered as potential designs to meet the above requirements. The final concept, the one which was developed into production, is shown in Fig. 1. It incorporates a 2 deck fuselage capable of accommodating in excess of 800 economy class passengers or a lesser number in a combined economy/business/first class configuration.

The design makes extensive use of new materials including GLARE (a carbon fibre/aluminium laminate), thermo plastics, carbon fibre and laser welded stringers.

The aircraft also incorporates 5,000 psi hydraulics, interactive cockpit with electronic manuals, variable frequency electric power generation from the engines and modular avionics. It was the first aircraft to be developed using a full digital mock-up. This allowed the separate design teams to work in a fully integrated manor and will facilitate modular maintenance.



Fig. 1 – The final concept for the A380

A pyramid approach was adopted for the development test programme. Initially small items were tested. This was followed by the testing of sub-components and, finally by full scale aircraft. The testing included wing loading (5 m end of wing deflection under ultimate load conditions), fatigue testing (3 x design life), landing gear testing (must deploy under own weight) and engine tests. Aerodynamic testing was carried out in wind tunnels located throughout Europe.

5 flight test aircraft were built and they were used to conduct 3,700 hours of flight testing. This included minimum velocity for unstuck, i.e. minimum velocity at which aircraft can become airborne, landing on water logged runway (water trough test – Fig 2), hot/high altitude take-off (46°C, 2130 m), low temperature take-off (-26°C), long endurance flights, maximum energy rejected take-off velocity (190 mph), crosswind landing and take-off (42 knots cross-wind), and airport compatibility trials throughout the World.



Fig. 2 – The water trough test

The first test flight was on 27th April 2005. The test flights confirmed that the A380:

1. Emits significantly less hydro carbons than a Boeing 747;

2. Achieves a significant reduction in noise footprint compared with earlier in-service aircraft (46% landing noise footprint reduction was measured at Los Angeles airport);
3. Requires 17% less runway on take-off than a 747 and 11% less on landing;
4. Has a 4,000 ft higher cruise altitude than a 747 and the same cruise Mach No..

Type certification was obtained on 12th December 2006. A crucial factor in obtaining certification was the requirement to be able to evacuate the aircraft in 90 seconds in an emergency. A full size mock-up of the aircraft was used for this test. 853 tourist class passengers comprising a mix of male and female, young and old were successfully evacuated from the aircraft in 78 seconds in a dark environment.

The Airbus factories are located in Germany, France, Spain and the UK. There are 2 factories in the UK, one at Broughton near Chester, and one at Filton near Bristol. Of these, Filton is the development site. The A380 wings are manufactured in Broughton's West Factory. This is a dedicated building, dimensions 400 m x 200 m, constructed specifically for the construction of A380 wings. The A380 tail section is manufactured in a similar dedicated Airbus factory at Hamburg, north Germany. Final assembly is at the 490 m x 250 m A380 Airbus factory in Toulouse, France. A separate A380 customer acceptance building is also located at Toulouse.

The use of multiple manufacturing sites presents a considerable logistics problem as the sub-assemblies are too large to be transported in Airbus' A300 based Beluga transport aircraft. The solution has been to use a combination of river barges, a dedicated ro-ro ferry and finally specialist road vehicles for the final leg of the journey to Toulouse. The latter involves the removal of road furniture including signs and lamp posts in the numerous village en route. It also involves some 29 gendarmes. The A380 delivery rate of 4 each month means these disruptions occur on an almost weekly basis along the roads between the French coast and the Toulouse factory (Fig. 3).



Fig. 3 – The road convoy to Toulouse

Overall 29,000 new passenger aircraft are estimated to be required by the World's airlines over the next 15 years. Over the last 12 years Airbus has consistently manufactured more aircraft than each preceding year. This trend is expected to continue for the foreseeable future. The A380 currently constitutes 6% of Airbus' deliveries in terms of aircraft numbers but 16% in terms of value. The latter is expected to increase to 20%. Each aircraft has a book price of £450M.

Currently Airbus has received 304 firm order for the A380. This compares with Boeing only receiving approx. 100 orders for its latest version of the 747, the 747-8. The first A380 aircraft was delivered to Singapore Airlines on 25th October 2007. British Airways received its first A380 during 2013 and it is now being used on their London Heathrow to Los Angeles and Hong Kong routes. The A380 order book now includes an order for 50 aircraft from Emirates Airlines received at the end of 2013. A further 32 aircraft are due to be delivered during 2014.



Fig. 4 – A380 in flight over the Alps

There were numerous questions at the end of the lecture which confirmed the audience's interest in the topic. This audience of some 200 persons confirmed their appreciation by a rousing round of applause. The vote of thanks was given by Mac Maccabee, RAeS Loughborough Branch Treasurer.

Lecture notes by Colin Moss.