FLYING at a speed faster than sound seemed incredible, until 2 March 1969, when the first supersonic aircraft – the Concorde – took to the skies and blasted its path into history.

When it first made its entry, the supersonic Concorde created a sensation in the era of commercial aviation. If you look at it simply, this meant a speed where if you utter a word, by the time your voice reaches your ears, the aircraft would have flown by you. With the advent of the Concorde any fare-paying passenger was in a position to fly at supersonic speed.

The almost legendary Concorde was a marvel. The aircraft could carry more than 100 passengers and crew from London to New York, a distance of more than 7100 km, within an unimaginable three hours while cruising at an altitude of more than 18 km in the atmosphere (this was almost double the height at which commercial airplanes flew) with a mind-boggling speed of about 2150 km per hour.

Concorde was designed and manufactured entirely in Europe by a consortium of U.K. and France, and the first successful flight took place on 2 March 1969. The word Concorde in French (same as its English equivalent, ‘Concord’) means agreement, harmony or union.

This was the time when modern computers and modern electronics were almost non-existent or at least not so developed. The entire designing and construction of this marvelous aircraft was done on the basis of mechanical, electrical, pneumatic or hydraulic principles. Although the designers used electronic technology, it was of elementary nature. But they tried to achieve the maximum out of the available electronics. The aircraft was regarded by many people as an aviation icon and an engineering wonder.

This was the first civilian supersonic aircraft (Supersonic Transport or SST) ever built in the history of civil aviation and there was a general feeling that perhaps this aircraft would revolutionize the entire concept of passenger flights. It also posed a European challenge to the United States of America, which so far had monopoly over the design and manufacture of large commercial aircraft.

In order to fly non-stop across the Atlantic Ocean, Concorde was developed to have the greatest supersonic range of any aircraft. This was achieved by a combination of engines which were highly efficient at supersonic speeds, a slender fuselage (main body of the
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Concorde’s final flight; G-BOAF from Heathrow to Bristol, on 26 November 2003, www.wikipedia.com

aeroplane) with high fineness ratio, and a complex wing shape for a high lift-to-drag ratio. This also required carrying only a modest payload and a high fuel capacity. The aircraft was trimmed with precision to avoid unnecessary drag.

Unfortunately, Concorde had to face a lot of trouble right from day one, and finally succumbed after great struggle with all the majestic Concorde planes totally disappearing from the world’s skies from November 2003.

Unique Aircraft
Concorde was designed and produced with the dedicated efforts of France and U.K. during the 60s and 70s and was equipped with marvelous features, revolutionary techniques and novel ideas. The aircraft was the first aircraft based on the Fly-by-Wire technology as early as in 1969 which was later adopted worldwide in the A-320 aircraft in the late 80s.

Proposals to manufacture a supersonic passenger aircraft were jointly started in 1962 by the famous aircraft manufacturing companies, the Aerospatiale of France (manufacturer of Airbus aircraft) and British Aircraft Corporation of U.K. (manufacturer of Jaguar). After spending a lot of money, labour and research, these companies were able to complete the aircraft within seven years of dedicated efforts.

The Concorde faced many challenges. The first and foremost was designing its body and engines that could withstand the problems of flying at a speed faster than sound.

The other challenge was the problem of heating. When any object passes through air at high speeds, air molecules are heated, and the heat is transferred to the object. A craft at hypersonic speeds reaches temperatures at which aluminium would melt, and the temperature differences between different parts of the craft would create enormous stresses. A new material had to be designed to withstand such temperatures and temperature changes.

Not surprisingly, the Concorde made front-page headlines on newspapers worldwide. So far supersonic flights were supposed to be a monopoly of smaller single or two-seater Air Force aircraft, but nobody thought that a 125-seater passenger aircraft could also fly at such fantastic speeds. The manufacture of Concorde brought the European nations (particularly UK and France) at par with USA, which was known as the leader in the field of aviation.

Apart from UK and France, USA and USSR had also been trying to produce a supersonic aircraft during those days. USSR had even manufactured one such supersonic aircraft – TU144 – which however crashed during its very first appearance in 1973 at the Farnborough Air Show at France. USA had also suspended its SST (Supersonic Transport) plan due to high cost. Thus, Europe was extremely joyous with its success in commercial aviation.
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Concorde Challenges

The Concorde had a length of 61 m (200 ft.), wing span of 24 m (80 ft.) and a maximum height of 11 m (37 ft.). The fully-laden weight of the aircraft (including fuel, cargo and passengers) was 200,000 kg. The aircraft could accommodate 125-130 passengers.

The wings of the aircraft were ‘Delta shaped’ and its nose was pointed and drooping, giving it the majestic look of an eagle hovering and descending on ground. The aircraft had the capability to straighten its nose during flights to reduce air drag. Concorde was the first commercial aircraft to employ hybrid circuits.

Powerful engines of Concorde (Olympus Engines) were designed and manufactured by Rolls-Royce of U.K. and SNECMA of France. There were four such engines fitted in the aircraft, each having a power of 38000 pounds, which were capable of blasting the aircraft to supersonic speeds.
A moveable nose was designed for the Concorde, which had the capability to droop down while on ground, and would be straightened during flight. So, if one looked at the aircraft on ground, it appeared as if a huge eagle was moving with its head down, and after take-off, the eagle raised its head.

Top left: Concorde’s intake system, Left: Concorde rear undercarriage (images www.wikipedia.com)

The first successful test flight of Concorde was made on 2nd March 1969. Scheduled flight commercial services started in the year 1976.

**Mach Speed & Sound Barrier**

The speed of an aircraft closer or faster than the speed of sound is normally expressed in terms of ‘Mach Number’ and not in terms of kilometres or miles per hour. The Mach number is the ratio of the speed of the aircraft to the speed of sound.

For example, when the aircraft is flying at Mach 1, its speed is equal to the speed of sound. Thus, an aircraft flying at Mach 0.9 is traveling at 90% of the speed of sound (called Subsonic), and an aircraft travelling at Mach 2 is traveling at twice the speed of sound (known as Transonic or Supersonic). Mach number was named after the Austrian physicist Ernst Mach.

However, the speed of sound varies with the composition and temperature of the air. It decreases with altitude and increases with altitude, since gas molecules move more slowly at colder temperatures and faster through warmer air. The speed of sound on an average day at sea level under standard atmospheric conditions is approximately 1225 kilometres per hour. However, when the aircraft reaches at an altitude of 10,000 metres above ground level, sound speed becomes approximately 1090 km per hour. In other words, if an aircraft is flying near the ground level, it will reach the speed of sound (‘Mach 1’) at 1225 km/h, and when it attains a height of 10,000 m it will be at ‘Mach 1.13’ or 1.13 times the speed of sound at the same speed of 1225 km/h.

When an object reaches close to the speed of sound, it starts facing one of the biggest hurdles known as the Sound Barrier, since air compression is extremely high at this speed. Thus, when an aircraft crosses the speed of sound, it experiences a retarding force, which is practically like crossing a solid wall made of stones. A sonic boom is the sound associated with the shock waves created by an object traveling through the air faster than the speed of sound. Sonic booms generate enormous amounts of sound energy, sounding much like an explosion. These sound energy waves travel at the speed of sound, and as the speed of the object increases, the waves are forced together, or compressed, eventually merging into a single shock wave, which travels at the speed of sound. Since the boom is being generated continually as long as the aircraft is supersonic, the sonic boom will keep on getting generated till the aircraft is flying at or above the supersonic speed.

When an aircraft flies at supersonic speed near the ground, the noise created and pressure waves generated by the sonic boom can play havoc, resulting in a blasting noise that may cause damage to ears, break glass windows and cause damage to weak houses.
Challenging Design
All the Civil Airliners of the modern era, such as B-747, Airbus-320, etc. (with the exception of Concorde) fly at subsonic speeds of approximately 950 km/h, which is Mach number less than 1. Concorde on the other hand, was to fly at Mach 2 speed, which roughly equals 2,100 km/h. Therefore, it had to be designed to withstand problems associated with supersonic speed.

Air compression on the outer surfaces caused the cabin to heat up during flight. Every surface, such as windows and panels, was warm to the touch by the end of the flight. Besides engines, the hottest part of the structure of any supersonic aircraft, due to aerodynamic heating, is the nose. The engineers used a specially designed aluminium alloy known as Hiduminium R.R. 58 to overcome the problems.

Concorde went through two cycles of heating and cooling during a flight, first cooling down as it gained altitude, then heating up after going supersonic. The reverse happened when descending and slowing down. This had to be factored into the metallurgical and fatigue modelling. A test rig was built that repeatedly heated up a full-size section of the wing, and then cooled it, and periodically samples of metal were taken for testing. The Concorde airframe was designed for a life of 45,000 flying hours.

Owing to air friction, as the plane travelled at supersonic speed, the fuselage would heat up and expand by as much as 300 mm (almost 1 ft). The most obvious manifestation of this was a gap that opened up on the flight deck between the flight engineer’s console and the bulkhead. The flight engineers would place their caps in this expanded gap, wedging the cap when it shrank again.

To keep the cabin cool, Concorde used the fuel as a heat sink for the heat from the air conditioning. The same method also cooled the hydraulics. During supersonic flight the surfaces forward from the cockpit became heated, and a visor was used to deflect much of this heat from directly reaching the cockpit.

The Concorde used reheat (afterburners) at takeoff and to pass through the upper transonic regime and to supersonic speeds, between Mach 0.95 and Mach 1.7. The afterburners were switched off at all other times. Due to jet engines being highly inefficient at low speeds, the Concorde burned two tonnes of fuel (almost 2% of the maximum fuel load) taxiing to the runway. Due to the high thrust produced even with the engines at idle, only the two outer engines were run after landing for easier taxiing.

Another interesting feature of Concorde was its ‘Nose’, a long pointed nose that obstructed the view during ground movement of the aircraft (i.e. during taxi, takeoff, and landing operations). On the other hand, during flights, the nose was required to be straightened to reduce drag and achieve optimum aerodynamic efficiency.

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The Concorde would attain supersonic speed over the sea and oceanic area (that too on reaching above a particular altitude), and maintain subsonic speed over land areas.

A total of 20 Concorde aircraft were built in France and the United Kingdom; six of these were prototypes and development aircraft. Seven each were delivered to Air France and British Airways.

In 1976, the aircraft started

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commercial operations. The Concorde started flying regular transatlantic flights from London Heathrow Airport and Paris to New York, Washington, Dulles and Barbados. It took less than half the time than other airliners.

The Demise

Soon after its launch, the creators of Concorde received the biggest jolt when they learnt that their dream aircraft was being discarded by various countries, oddly enough due to its fast speed. The other negative factors were high cost of operations and pollution caused due to high noise, sonic boom, etc. So, the biggest advantage of the aircraft – its supersonic speed – became its greatest discredit.

In India, during the early experimental flights of the Concorde aircraft in the 70s, when the aircraft made low supersonic flights near Kolhapur (Maharashtra), damage was observed in weaker buildings of the area and window panes got cracked. Similar reports were received from other countries too.

Initially, when the Concorde was introduced in the market, about 16 countries including Iran, Japan, China, Australia and Singapore were willing to purchase 74 Concorde aircraft. However, subsequently all these countries started backing out. Many countries even prohibited flights of the Concorde over their territories (which included India also) due to supersonic problems.

The fare of the Concorde was quite high as compared to normal airfare due to high operational costs. Ultimately, only two airlines were left in the world, which were using Concorde for passenger flights. Naturally, these were British Airways and Air France – they had a total of nine Concorde aircraft with them.

Another problem with this aircraft was that the operational expenditure and original cost was more compared to normal subsonic aircraft. However, British Airways and Air France were of the view that many businessmen and affluent people might give importance to the fast speed that could cut down the hours between distant destinations and therefore would patronize these flights. However, the results were not very encouraging.

By 1979 (within four years of starting passenger flights), the nine Concorde aircraft belonging to these two airlines carried about 500,000 passengers averaging 500 passengers per week per aircraft. But by 1980, the two airlines suffered a loss of 47 million pounds. The estimated loss on the Concorde projects was about 420 million for UK and France by 1983.

By the end of the 21st Century, it almost became clear the these airlines could no longer withstand the blow dealt by the loss of its Concorde revenues, since most of the world airlines were already struggling to maintain their competitive edge and attract more high-paying customers. The manufacturers also could no longer bear the loss suffered on production of Concorde.

The final ending came on 26th November 2003 when the Concorde was officially retired from commercial service and it became history. To keep the retired fleet of Concorde, a number of venues were selected including Grantley Adams Airport in Barbados, Airbus UK at Filton in Bristol, Manchester Airport, Sinsheim Auto & Technik Museum in Germany, Museum of Flight in Scotland, Heathrow Airport in London, Museum of Flight in Washington, USS Intrepid in New York, etc. In addition a lot of offers have come from fans of the Concorde who have purchased parts of their favourite aircraft as souvenirs by paying heavy amounts at auctions.

In the history of civil aviation till date, the only supersonic aircraft to see regular commercial service have been the UK-French Concorde (Russian Tupolev Tu-144 was another one, which, however, failed in its first demonstration flight itself). So, following the permanent retirement of Concorde, there are no remaining supersonic aircraft in commercial service.

Even after the passage of more than 11 years, no other aviation company has dared to enter the field of supersonic commercial aircraft. Perhaps, the Concorde could be the sole representative of its kind in the history of aviation for a long time to come.

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