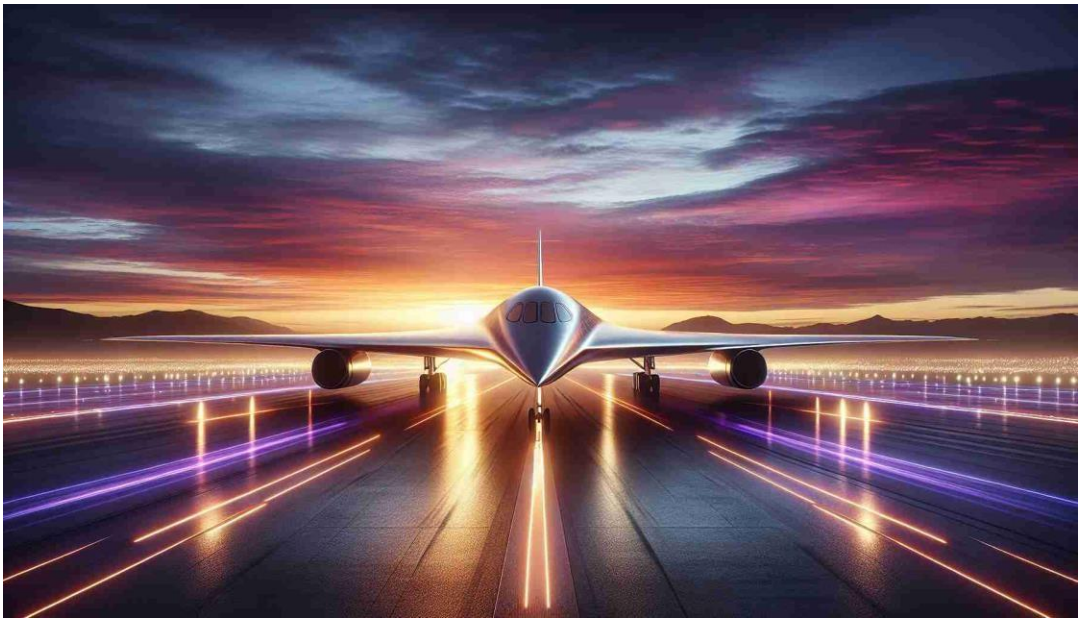

The Next Generation of Supersonic Passenger Aircraft

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Contents

Introduction

Supersonic travel is ways of travel or aircrafts designed to transport passengers like regular aircraft at speeds greater than that of sound/ being able to break the sound barrier. This has challenged engineers' minds for decades, truly testing the limits of development. Moreover, the Concorde never goes unmentioned when the topic of supersonic travel is discussed, yet after it was retired from service in October of 2003 primarily due to a downturn in demand, the idea of supersonic passenger flight was put on pause by most of the public worldwide.

This two-decade pause (2003-2023) has provided aerospace communities around the world to develop the already pioneering technology of the Concorde which will allow the next generation of supersonic passenger aircraft to be more reliable, have a greater technological success and to be more sustainable compared to previous models.

Street, Francesca. Concorde taking off. CNN Travel, CNN, https://www.cnn.com/travel/article/what-it-was-like-to-be-a-concorde-pilot/index.html.

In continuation, constant iterations and evaluations of the potential designs of supersonic aircraft in progress are required to ensure further development and refinement, although success isn't always guaranteed. Through this process, engineers can identify any potential weaknesses or flaws in the design and make necessary adjustments. This process can also help to ensure that the design meets all the desired specifications and requirements. Ultimately, this helps to maximize the chances of success.

This article aims to discuss the history, advantages and disadvantages of supersonic passenger flight while also evaluating how supersonic travel could return (more sustainably), possibly within this decade.

The History of Supersonic Travel

Supersonic travel refers to travel at a speed greater than the speed of sound, which is approximately 343 meters per second (1,235 kilometres per hour) at sea level. Supersonic travel has a long history, dating back to the early 20th century. Here is an overview of the history of supersonic travel:

Early Research: In the early 20th century, scientists such as Ernst Mach and Theodore von Kármán began researching the properties of supersonic flight. Mach is famous for his work on shock waves, which occur when an object travels faster than the speed of sound. Kármán was instrumental in the development of the first supersonic wind tunnel in the 1930s.

The first supersonic flight: On October 14, 1947, U.S. Air Force Captain Chuck Yeager became the first person to break the sound barrier in a Bell X-1 aircraft. Yeager flew the X-1 at a speed of Mach 1.06, or 1.06 times the speed of sound. This was a major milestone in aviation history and paved the way for further supersonic research.

Bell X-1: The first supersonic aircraft. Bell X-1, Wikipedia, https://en.wikipedia.org/wiki/Bell_X-1.

The Concorde: In the 1960s, the British and French governments began working on the Concorde, a supersonic passenger airliner. The Concorde made its first flight in 1969 and entered service in 1976. It could fly at twice the speed of sound and was known for its sleek design and luxury amenities. However, it was retired in 2003 after a crash in 2000 that killed 113 people.

Gibbs, Yvonne. TU-144: The Russian Concorde. Past Projects: TU-144LL Flying Laboratory, NASA, https://www.nasa.gov/centers/dryden/history/pastprojects/TU-144/index.html.

Other Supersonic Aircraft: In addition to the X-1 and the Concorde, there have been several other supersonic aircraft developed over the years. These include the Russian Tu-144, which was developed in the 1960s and entered service in the 1970s, and the NASA X-43, an experimental unmanned aircraft that set a new speed record in 2004.

The Future of Supersonic Travel: Currently, there are several companies working on developing new supersonic aircraft that could potentially enter service in the next decade. These include Boom Supersonic, Aerion Supersonic, and Spike Aerospace.

Overall, the history of supersonic travel is a fascinating one, marked by innovation, technological advancements, and some notable successes and setbacks. As companies continue to work on developing new supersonic aircraft, it will be interesting to see what the future holds for this exciting mode of travel.

Advantages and Disadvantages of Supersonic Transportation

Supersonic flight is a concept that radically changed civilian aviation as it was known at the time. Even though this technology had many advantages over the subsonic airliners that were used at the time, it also had some serious disadvantages that played a crucial factor in the retirement of planes such as the Concorde.

The introduction of supersonic flight technology, which was only previously used in fighter jets, created a new field inside the aerospace industry, creating many new job opportunities and attracting the attention of big airlines such as British Airways (Tsounis & Vlatakis 2015). Moreover, the speed at which a supersonic airliner can fly is a fraction of the time that a subsonic plane would need. This can be seen when comparing the Boeing 747 and the Concorde. Even though these 2 planes were both built during the 70s, the Concorde could fly from London to New York City, in only 3 hours, which is about a third of the time that it takes the 747 to perform the same flight ("Concorde: technical feat, financial fiasco").

Wang, Ben. British Airways Concorde with B747. Ben's Air Blog, http://benairblog.blogspot.com/2014/02/my-flight-on-concorde.html.

However, there are times when being fast is not always beneficial, especially for commercial airliners. To reach speeds faster than sound engineers, designers, and airlines have had to make sacrifices to many crucial factors, such as the number of passengers that a plane like the Concorde can carry. The 747 can carry around 400 passengers, which is 4 times more than the Concorde (Concorde) (Amir and Weiss). In addition to that the Concorde was less efficient. During take-off it was consuming on average about 20 tons of kerosene per hour of flight, which is about 100 times more than an airliner today ("Concorde: technical feat, financial fiasco"). In other words, the Concorde had about ⅓ of the range of a 747 but also the tickets for a flight from London to New York City were about 2 and a half times higher in the supersonic plane (Concorde) (Singh).

As a result of the extremely high price of the tickets, more people preferred more economical alternatives, such as the A300 or the B747. This was not very profitable for the airlines. In fact, according to British Airlines, about 57 hours of maintenance for all 7 of their Concordes for every hour of flight, an amount that is far longer than the maintenance process of every other airliner (Tagliabue). For instance, the maintenance cost for a Boeing 747 is estimated at $1,000 per hour of flight, compared to $7,400 for the Concorde.

It should be noted that the average cost of a ticket for a Concorde flight was quite different from the average cost of a ticket for a commercial flight. Today, the average ticket for a Concorde flight would cost $2800, while the average ticket for a regular commercial airplane flight would cost $550.

New Technologies in Supersonic Travel

Nearly two decades ago the age of supersonic commercial aviation appeared to come to an end. The Anglo-French Concorde, which flew passengers at Mach 2 for 27 years, was retired in 2003. Concorde was a technological marvel but plagued by high operating costs. The limited production run prevented carriers from achieving economies of scale, and Concorde failed to attain widespread commercial success. Factors such as increases in maintenance costs for the aging Concorde airframes, the fatal accident of July 2000 in France, and the slump in air travel after the terrorist attacks of September 11, 2001, all contributed to Concorde's retirement.

NASA's Quest Mission: X-59 Quiet Supersonic Technology Aircraft Gets Its Tail. SchiTechDaily, https://scitechdaily.com/nasas-quesst-mission-x-59-quiet-supersonic-technology-aircraft-gets-its-tail/.

Several manufacturers are now working on supersonic aircraft, to ensure that Concorde's retirement did not mean the end of the supersonic transport era. NASA's Quest mission (X-59 vehicle) aims to produce a barely audible sonic thump to people on the ground, around 75 PLdB, equivalent to a car door slam 20 feet away. Moreover, the start-up company Boom Technology Inc. has been working on developing a supersonic passenger aircraft, which will fly at a speed of 2.2 Mach, carrying up to 45 passengers.

Successive generations of subsonic aircraft have become steadily quieter, thanks to continued improvements in propulsion technology as well as government-mandated phaseouts of noisier aircraft (FAA 2018). A key technological factor in this "quieting" of aviation is the move from turbojet engines to turbofan engines, and then from low-bypass turbofans to higher-bypass turbofans. As for supersonic aircraft, one proposed strategy to reduce supersonic aircraft noise during departure is programmed lapse rate (PLR), a computer-managed reduction in thrust after the take-off roll. PLR and accelerating climb-outs may offer significant benefits in noise reduction. Another approach is to vary the wing's flaps and slats by computer, enabling the aircraft to operate closer to its best lift-to-drag ratio at all times. Whatever technologies are employed, supersonic jets should aim to meet noise standards similar to those for subsonic aircraft, taking into account trade-offs with fuel efficiency.

Sustainable aviation fuels (SAFs) are a key solution and a growing share of airline fuel use. These types of fuels can be potentially used in supersonic engines as well, as it conforms to the same specifications as Jet A fuel. Fulcrum BioEnergy, with investment from BP and United Airlines, uses municipal waste as a feedstock for fuel. LanzaTech, a partner of Virgin Atlantic, uses genetically modified bacteria to synthesize fuel from waste gases at steel, cement, and other industrial plants. Others, such as Carbon Engineering and Prometheus, turn directly to atmospheric carbon capture, recycling CO2 from ambient air into hydrocarbon fuels. These novel methods add to the existing supply of more traditional biofuels, produced from corn, soy, forest residues, algae, and other sources.

Furthermore, government and industry commitments to net-zero aviation have led to pledges by supersonic manufacturers and their launch customers to operate supersonic aircraft on "e-kerosene" generated from renewable electricity. E-fuels can reduce lifecycle CO2 emissions by about 90% compared to Jet A, but their use in supersonic aircraft would only modestly

reduce (6 to 24%) CO2 per seat kilometre compared to more fuel-efficient subsonic designs operating on Jet A.

Conclusion

To conclude everything that has been stated so far, supersonic travel has always fascinated engineers, and research based on supersonic wind tunnels can be traced back to the 1930s. Although the Concorde was eventually retired, it was a pioneering aircraft for its time, and even though it was grounded, research for solutions continued. On the bright side, based on thorough research and analysis, it seems that supersonic aircraft will make a comeback in the not-too-distant future. The Concorde was retired from commercial service in 2003 after 27 years of service. Air France Flight 4590 crashed shortly after take-off in 2000, resulting in the only fatal incident involving the Concorde. Interestingly, American Airlines has already placed orders for 20 new supersonic aircraft, which are slated to be operational by 2029. This decision reflects a commitment to progress and innovation, while also being responsive to the ever-evolving needs of the aviation industry. Taking a well-informed and thoughtful approach, it is evident that the introduction of supersonic aircraft has the potential to have long-term benefits for the aviation industry.

Koenig, David. Boom Overture: Supersonic passenger airplane of the future. American Airlines Places Deposit on 20 Supersonic Planes, APNews, https://apnews.com/article/airlines-ac252ce19285e355e8207b3b29da39ed.

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