The Aurelia: The Supersonic Transport of Today

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Abstract

The design of a Supersonic Transport with an initial operational capability of 2020 which addresses specific environmental, efficiency, and performance goals has been described. The final design of the SST was begotten from the research of many aerodynamic characteristics that are capable of withstanding the conditions of subsonic, transonic, and supersonic flight. The SST has been designed to allow for an acceptable and comfortable passenger experience. Through the research of the SST, it was discovered that swept wings with enough area are the most efficient during all stages of flight. It was also discovered that a long and slender fuselage as well as structural additions to the nose of the plane will reduce the size of sonic booms.

Introduction

Wilbur and Orville Wright flew the first airplane at Kitty Hawk, North Carolina in 1903. The first supersonic flight took place on October 14, 1947. Since then the world has done many more things to add to the magnificent and colorful history of flight. In 2003 though, the world took a step backwards when the Concorde(1) made its last flight. A new design for an SST is desperately needed in order to retrace that step and move forward.

Wings

The original design called for a variable sweep wing which would be able to change the planform of the airplane as it gained speed and entered the supersonic range. The design then began to take the shape of a delta wing, which would also work well in all ranges of speed. The delta wing was the basis for the wing design of the Concorde(1) as well as many other supersonic aircraft. The final design involves a hybrid of a delta wing and a trapezoidal wing similar to that found on the F-102 Delta Dagger(2). The leading edge of the wing resembles that of an ogival delta wing. The wing, instead of coming to a point, curves and becomes parallel to the fuselage. From that point, the wing begins to take on its trapezoidal characteristics as it sweeps into the fuselage near the rear of the aircraft. (See drawing. This is a basic design and is not drawn to scale; it is subject to minor improvements.) It is believed that with this wing design, maximum lift and efficiency will be achieved.

Additional Lift-Enhancing Characteristics

After the study of lifting canards and other sources of additional lift, the research pointed in the direction of chines which are found of the SR-71 Blackbird(3). While testing the chines on the SR-71, Lockheed aerodynamicists discovered that the chines produced vortices which caused a significant increase in lift near the front of the aircraft. This additional lift would allow for there to be sufficient airflow over the wings while having a high angle of attack which would decrease the length needed for take-off and landing.

Stabilizers

The SST will have a vertical stabilizer which will be used, along with the rudder, to control the horizontal movement of the aircraft. The SST will also consist of elevons, a combination of ailerons and elevators, which will be found on the trailing edges of the wings. The elevons will be used to control both roll and pitch movements. The elevons on the trailing edge of the wings will eliminate the need for a horizontal stabilizer which will in effect eliminate unnecessary drag.

Engines

In order for the SST's engines to function efficiently at transonic and supersonic speeds, it is necessary to slow the air before it enters the engine inlet. This would call for intake ramps with the addition of an auxiliary flap which could be found on the Concorde. As the aircraft's speed increases, the flap will close and the ramps will move downward creating shockwaves which in turn slow down the air so that the engine can

digest it. It would also be useful for the engines to be capable of supercruise in order to increase efficiency once the desired speed is reached. In order to decrease unnecessary takeoff length, the use of thrust vectoring engines would be recommended. The thrust vectoring system would be similar to that of the F-22 Raptor(4).

Airport Noise Reduction and Efficiency

The use of electric drive motors, such as the Wheeltug motor system(5), would also be desired in order to reduce the overall emission of noise at the airport. The motors will power the wheels while the aircraft is taxiing and the use of fuel will only occur during takeoff and flight which will increase the SST's efficiency. The drive motors will be powered by batteries located in the aft section of the SST. The use of regenerative braking would also be highly useful and could recharge the battery during landings. When the aircraft lands, it will release large amounts of kinetic energy which can then be used to charge the batteries powering the drive motors. After the vehicle has landed, the batteries will be turned on and the aircraft will proceed to the terminal. The space that the batteries will occupy will decrease the amount of space for the storage of fuel, but it will eliminate the waste of fuel while taxiing which will nullify the smaller capacity for fuel.

Boom Reduction

The SST is designed in a way that will reduce the intensity of the sonic boom it produces as it breaks the sound barrier. The SST will have a long and slender fuselage that will decrease the area of which air will be compressed which will create smaller shock waves. The SST will also have structural additions such as the chines which will also be able to reduce the sonic boom's intensity. The addition of a telescopic "spike",

similar to that of the Quiet Spike Program(6), will create smaller shock waves which will decrease the intensity of the sonic boom when compared to the large shock wave produced by the nose of the aircraft.

Measurements of the SST

The maximum interior width of the SST will be 3 meters. This will be occupied by four seats with a width of 53 centimeters each. This will allow for an increased amount of comfort for the passenger when compared to the seats of an average aircraft. The seat pitch will be 100 centimeters which will give the passenger about 20 more centimeters of legroom than in a standard airliner. The center aisle will be 88 centimeters wide. The first 4.5 to 4.75 square meters of the interior will consist of the cockpit and its crew. The next 9 square meters will consist of the kitchen area and the flight attendant area with an aisle leading to the cockpit. With the exclusion of the area of the aisle, there will be a total of 3.18 square meters on each side of the aisle for the kitchen and flight attendants. From this point, the passenger area will begin, and it will go on for 54 square meters and will be capable of holding 68 passengers. The first row of seats will start 100 centimeters from the aft wall of the kitchen area. The next 3 square meters will contain two bathrooms for the passengers. The bathrooms will be a 1.06 square meters each with the aisle separating them. There will then be 9 square meters for the storage of luggage. The last section of the interior will be an empty section of about 4.5 square meters. (The areas described above only consist of the floor measurements.) The height of the total interior of the SST will be 4 meters, but the cabin will be about 1.8 meters high this will allow for a floor thickness of about 20 centimeters and the bottom half will be able to

carry fuel as well as the batteries for the drive motors used during taxiing and it will be able to house the landing gear. The overall length of the SST will be about 37 meters, not including the "spike" on the nose of the aircraft. The total fuselage width will be about 3.25 meters. The wingspan will come to be about 22 to 23 meters (open for alterations). Fuel will also be able to be stored inside the wings as well.

Passenger Experience

Passengers will be served gratuitously with wines and snacks (additional beverages will be served as well to those who do not wish to have wine). Passengers will also be allowed to use their laptops onboard with special connections for a small charge which will be included in the total when tickets are purchased. (This will be included in the charge only for the additional cost of the technology that will be needed for the connection. The connection will be similar to the airline telephones.) The flight attendants will respond to the presence of the passengers with politeness and will constantly and swiftly reply with solutions to any passenger problems that may arise.

Conclusion

In conclusion, the production of a new and more efficient SST will be necessary in order to continue the world's forward movement through aviation. The use of a long and slender fuselage along with other structural additions will decrease the intensity of sonic booms. Efficiency and environmental protection is the main concern of the modern world's transportation industry and if the world can't increase them both, there will be a significant decrease in fossil fuels which will lead to the complete inexistence of those fuels. It is necessary for the people to develop new modes of acquiring renewable energy sources *before* the inexistence of non-renewable fuels instead of *after* it has occurred. It is not being said that this causes Global Warming, that is a natural process that the earth has gone through multiple times, but it is being said that the depletion of natural fuels is real and needs to be handled. The production of electrically powered aircraft is highly recommended. The study of the Busemann biplane(7) should also be furthered, for this will eliminate N-type shock waves which will lead to the inexistence of sonic booms. It is also recommended for a large scale hypersonic project which can lead to the creation of manned hypersonic aircraft that will not endanger the pilot's life or well being. The production of commercial aircraft that can travel into Low Earth Orbit would also be a great project. The cost of this would be extremely high, but with the future studies of much more efficient methods, the price could greatly decrease.

Credits

(1) The Concorde was the result of an Anglo-French treaty which combined the efforts of Aerospatiale and BAC.

(2) The F-102 Delta Dagger is a United States interceptor jet designed by Convair.

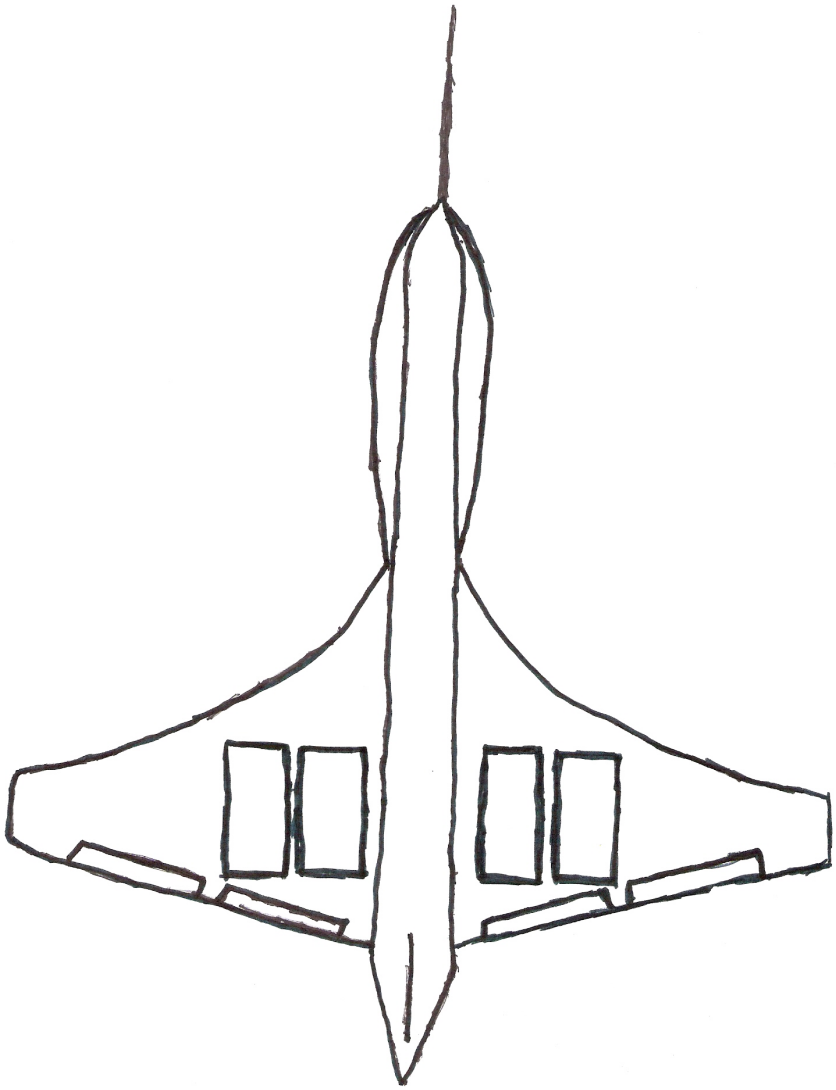
(3) The SR-71 Blackbird was a strategic reconnaissance aircraft developed by Lockheed Skunk Works.

(4) The F-22 Raptor was designed by Lockheed Martin. Its thrust vectoring engines were designed by Pratt & Whitney.

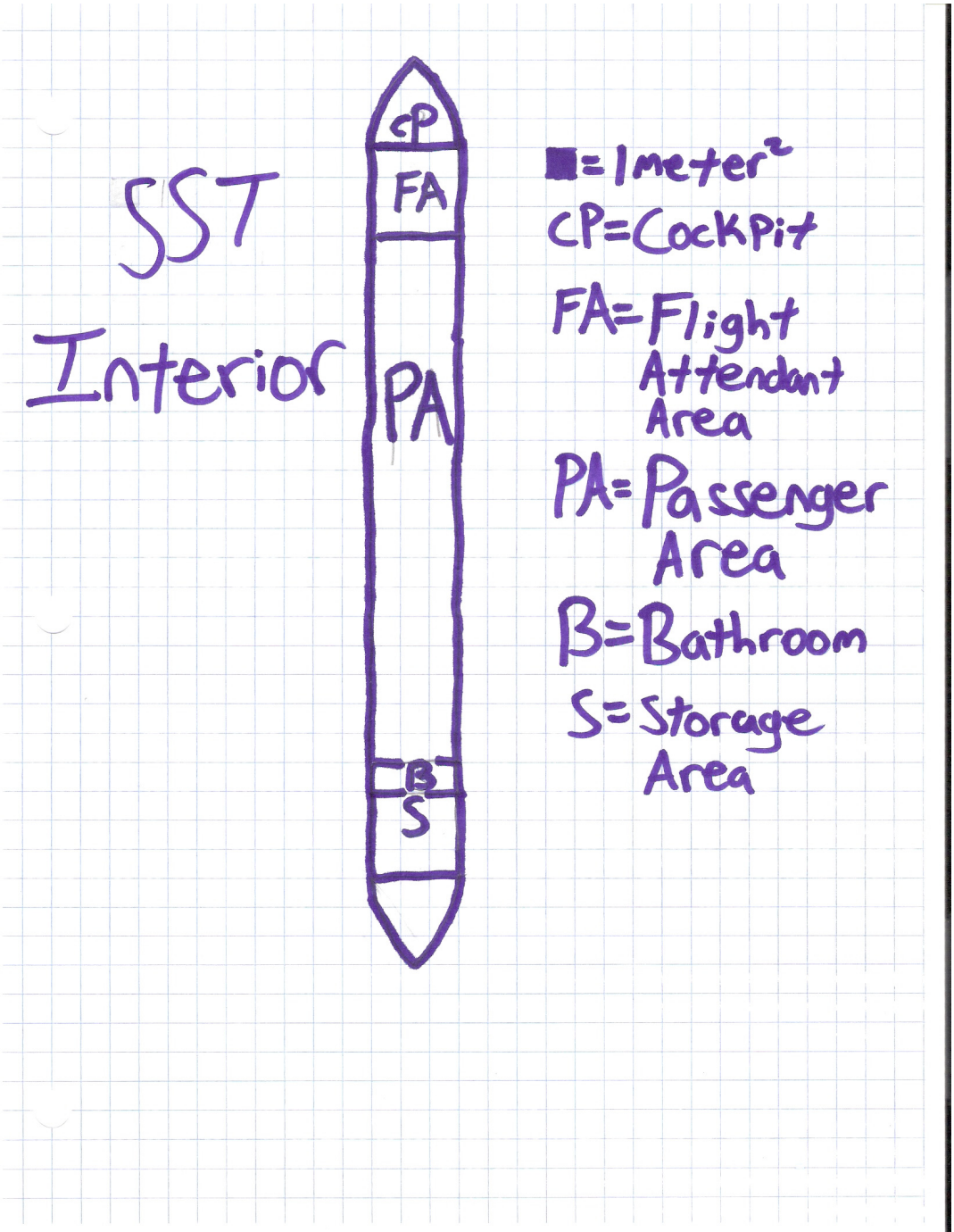
(5) The Wheeltug drive motor system was developed by Chorus Motors who has partnered with Boeing to develop and market the Wheeltug technology.

(6) The Quiet Spike Program is a program between GulfStream Aerospace and NASA's Dryden Flight Research Center to test the reduction of the intensity of sonic booms with the use of a telescopic spike at the nose of the aircraft, the tests were done with the use of F-15B.

(7) The Busemann Biplane is an design created by Adolf Busemann which will eliminate the development of N-type shock waves causing the absence of sonic booms.



General Design of the Aurelia



Basic measurements of the interior of the SST

I fully endorse this student's work for the 2009 Fundamental Aeronautics Competition. His work is original and informative and addresses the efficiency and environmental goals that have been proposed.

Shirley Horne 3-13-09