SUPERsonic COMmErcial Transport (Super Comet)

For

NASA Supersonic Business Jet Design Competition

Aerospace Systems Design Laboratory

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Executive Summary

Since the retirement of the Concorde, there has not been a supersonic civil transport aircraft to take up the gauntlet as the fastest way to travel. Several concepts have been proposed but they were all terminated without coming to fruition. Supersonic civil transports have unique challenges from sonic boom noise to fuel efficiency and airport community noise. Since sonic boom is proportional to size and weight, the focus has recently shifted to supersonic business jets. However, these come with the additional challenges of a smaller market and demand, which dictate the economic success of the program. With the advancement of noise mitigation technologies, lighter structural materials, propulsion and aerodynamic improvements, along with higher fidelity modeling and simulation capabilities, successful introduction of a supersonic business jet fleet has become realistic. This report proposes a design aimed to start operations in 2025 and that is aligned with NASA's N+1 or Near Term vision.

Due to the lack of historical data and the need for a novel concept, traditional design approaches are not feasible for a supersonic business jet. Thus, the airplane's architecture or configuration is first selected based on heuristics. Then advanced design methods are employed through a multi-disciplinary integrated design environment that uses primarily Physics-based tools. This involves an iterative process that models the aerodynamic, propulsion, weights, and performance characteristics and requirements of the aircraft. Taking advantage of the reduced cycle time for a single design point, the analysis is performed for multiple sets of inputs in an automated fashion in order to explore the design space. To obtain sufficient data with a minimum computational cost, these sets of inputs are selected using a Design of Experiments. Once the results are obtained, surrogate models are created for all responses of interest, to allow for faster manipulation of the analysis for optimization and further investigation. Because at this point no design can successfully meet all requirements, technologies with sufficiently high readiness level are added to the design using technology evaluation and infusion techniques. The final design point is selected using multi-objective decision making methods, then more detailed analysis is performed to address challenges such as stability and control, emissions, sonic boom and airport noise, as well as life cycle cost.

The final design successfully achieves the performance goals described in NASA's N+1 – cruise speed, design range, payload, fuel efficiency, and take-off field length. The other environmental responses – sonic boom and cruise emissions – are analyzed and the margin from the N+1 goals is presented as well as the sensitivity of these results to the design variables.

The aircraft has a capacity of 15 passengers or 14 passenger and a flight attendant. It cruises at Mach 1.62 and performs a cruise climb from 43,200 ft to 53,100 ft. It provides a spacious cabin of the same dimensions as similar range business jets. It integrates well with the airspace without requiring significant changes in operations. It Is powered by two mixed-flow turbofan engines, each providing just over 24,000 lb of thrust. With a take-off gross weight of just above 110,000 lb, the aircraft is similar to other supersonic business jet concepts. In terms of fuel consumption, it needs around 59,700 lb for the design range of 4,000 nmi, which puts it at 1lb of fuel per passenger per mile. With a thrust-to-weight ratio of 0.44 and a wing loading of 75.3, the Super Comet aircraft offers competitive performance, speed, and comfort.