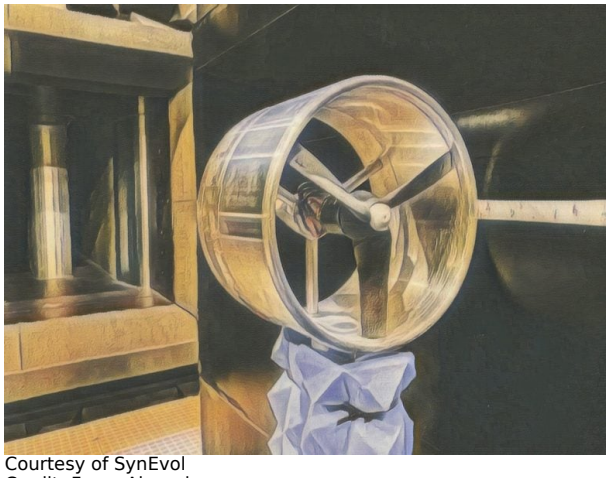
Recent Research Marks the Way for Silent Skies

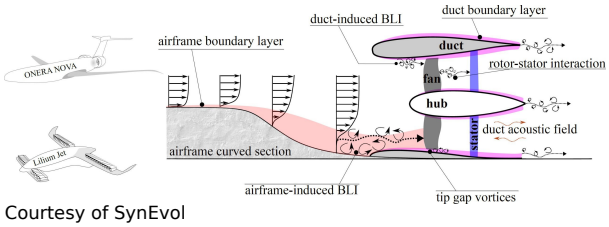
Posted by Okachinepa 04/30/2024



Courtesy of SynEvol
Credit: Feroz Ahmed

Scientists at the University of Bristol have solved the puzzle of why futuristic aircraft with energy-saving integrated engines make such noise.

For the first time, the study explains how noise is produced and dispersed by these engines, which are also referred to as boundary layer ingesting (BLI) ducted fans. Though they are partially integrated into the main body of the aircraft rather than under the wings, BLI ducted fans are comparable to the big engines found in contemporary aircraft. The plane uses less fuel since they dont have to work as hard to move it because they are taking in air from both the front and the surface of the airframe.



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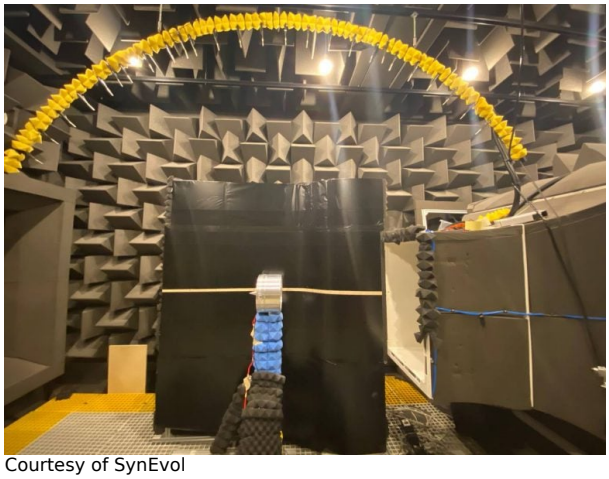
Under the direction of Professor Mahdi Azapeyvand, Feroz Ahmed of Bristol's School of Civil, Aerospace and Design Engineering conducted the study using the University National Aeroacoustic Wind Tunnel Facility. They were able to distinguish between noise coming from the fan, the duct, and the air passing over the airframe's curvature.

They discovered that the amount of push the fan is creating affects the noise pattern. They noticed a noise pattern resembling that of fans without ducts when the fan is exerting high thrust. However, the noise pattern alters when the fan is delivering less thrust because the duct itself becomes noisier.

Dr. Ahmed stated: "By revealing the physics underlying the noise these configurations produce, our study addresses this pressing issue of noise, which poses a major obstacle in obtaining certifications." Understanding the noise mechanisms in BLI ducted fans is expected to help develop industry guidelines for future aircraft concepts, ranging from large-scale conventional aircraft to small-scale electric vertical take-off and landing, or eVTOL, aircraft, that have quieter airframe-integrated propulsion systems.

Advanced aircraft projects including the Bell X-22A, Embraer X, Airbus E-fan, Lilium Jet, Green Jet, and Hybrid Air Vehicle are setting the standard for the development of these technologies. Powerful electric motor advances have led to a rise in their popularity.

However, there is a catch with embedded ducted fans, according to Dr. Ahmed: "It's still unclear how quiet or loud they are, especially when they're consuming airflow from around the curved airframe surface."



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The boundary layer arises across flat aircraft surfaces in fans without ducts, which was the main focus of earlier research on BLI arrangements. Nevertheless, as demonstrated by the ONERA NOVA, NASA/MIT Aurora D8, and Airbus Nautilus programs, there remains a knowledge gap regarding the ducted fans' ability to absorb air around curved airframe surfaces.

Therefore, we have carefully investigated in this study the several aspects that contribute to the noise generated by the integrated ducted fans that are mounted on curved airframe surfaces.

The researchers replicated the arrangement of embedded engines found in concepts such as the ONERA NOVA aircraft concept by designing a BLI test rig with an electric ducted fan placed next to a curved wall. They measured the thrust output of the fan and the quantity of noise it produced, among other kind of data, using the rig. Through analyzing the intricate mechanics of noise interaction among many sources, this approach facilitated the discovery of the fundamental physics underlying the creation of the noise and its evolution as the fan ran at varying thrust levels.

"There is a need for quieter aircraft due to the increasing demand for a pleasant flying experience with minimal environmental impact," Dr. Ahmed said. The development of measures to lower noise emissions in the aviation industry may benefit from this research.

Additionally, our thorough examination of how noise contributes to BLI ducted fans may direct important future research in the field of fluid mechanics. This could therefore lead to a better comprehension and further investigation of aeroacoustics phenomena in ducted fans subjected to a wide range of incoming turbulent flows.

"Our study provides important insights for quieter next-generation aircraft design by shedding light on how noise is generated by futuristic embedded ducted fans mounted on curved airframe surfaces and revealing that noise patterns vary with fan thrust levels."
