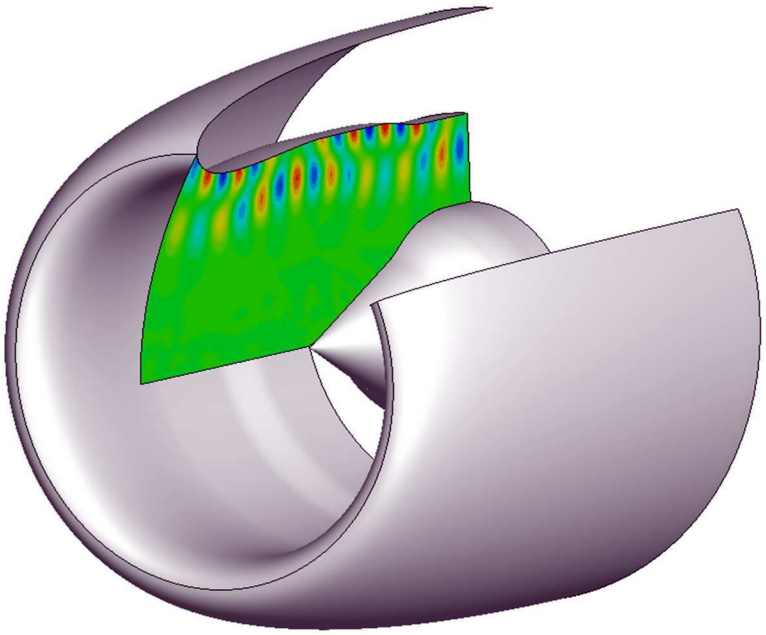


National Aeronautics and Space Administration

Aeronautics

Turbofan Engine Acoustic Liner Design and Analysis Tools

Statistical and graphical based software tools to design and analyze turbofan acoustic liners

NASA Langley Research Center has developed two tools for turbofan engine acoustic liner design and analysis. The first is a statistical approach for broadband liner design and assessment. The second is graphical software to design and analyze resonant channels in acoustic liners.

BENEFITS

- The Statistically-Based Approach to Broadband Liner Design and Assessment allows simulation and analysis of broadband fan noise, rather than being confined to specific tones. The approach computes the noise propagation field within the duct, as well as the radiation field outside the duct
- The Graphical Acoustic Liner Design and Analysis Tool provides real-time analysis of liners and allows designs to target specific acoustic impedance spectra. The tool also makes use of previously unused engine spaces with complex geometries for purposes of noise reduction.

APPLICATIONS

- Aircraft Engine Noise Reduction

technology solution

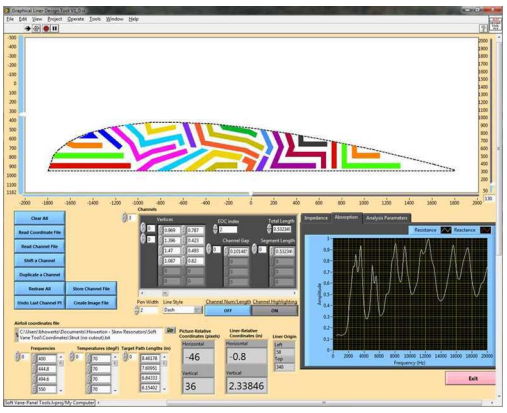
THE TECHNOLOGY

The technologies address the reduction of fan noise in aircraft engines through two avenues:

The first invention is a statistical approach to liner design when detailed fan source noise information is not available. This invention uses a statistical representation of the fan source with a duct acoustic propagation and radiation code to determine the optimum impedance spectra for acoustic liners embedded in the walls of the engine nacelle. This optimization may be based on predicted in-duct or far-field acoustic levels. Acoustic liner models are then used to identify geometric liner parameters needed to produce impedance spectra that most closely match these optimum spectra, and therefore provide maximum fan noise reduction.

The simulated statistical fan source model accounts for the variation of the fans sound spectrum as the flight conditions change and provides the added benefit of generating confidence intervals for the predicted liner performance. Increased weighting may be applied to specific frequencies and/or operating conditions within the liner design. Thus, the entire broadband frequency spectrum may be targeted simultaneously. This can offer a major advantage over current liner design approaches that focus on narrow-band attenuation spectra (i.e., target individual fan tones) and are generally not broadband in character.

The other invention is a graphical tool that allows real-time design and analysis of acoustic liners to achieve optimized broadband acoustic liners. Thus, it takes advantage of recently improved manufacturing techniques to allow implementation of liners in unconventional locations. One example is liners mounted in the body of fan exit guide vanes to reduce engine fan noise. Referred to as ILIAD, the software uses a point-and-click interface to graphically create acoustic chambers within a 2-D representation of the liner design space while predicting the resulting acoustic parameters. Variable-depth chambers are accommodated to maximize the number and length of chambers that can be put in the available space. At the same time, the software computes all of the modeling predictions of the acoustic characteristics to maintain performance levels. Designers will see the acoustic effects of geometry changes instantly. Although the prediction capability is relatively well-known, the ability to perform this calculation in an interactive design environment is new. ILIAD enables the exploration of numerous liner design possibilities quickly and efficiently.



Screenshot of ILIAD being used to design a novel liner (related to second invention).

PUBLICATIONS

Patent Pending

More Information

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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