the leading edge

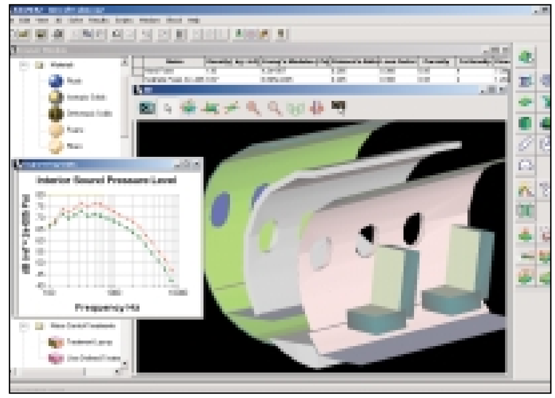
R&D program targets improved soundproofing systems

E-A-R has launched a six-month R&D program aimed at developing optimum aircraft interior noise control systems. The trade study will identify the system-level impact of various acoustic treatments within an aircraft, and optimize the weight versus noise-level reduction. E-A-R engineers are employing VibroAcoustics AutoSEA2 software to assist in the project.

According to E-A-R's market manager, Brian Joyal, the recent development of predictive, modeling software, such as AutoSEA2, has significantly facilitated such R&D projects. "Previously, we could address the interior noise control systems only at a component level, not a system level," Joyal explains. "Moreover, all of the acoustic inputs could not be tested or simulated at the same time. Separate component tests can provide design confidence, but not adequate information about the actual interior noise level or the weight impact on the aircraft. These limitations require that flight testing be performed before the final system design is in place."

Joyal says the most common test employed today is the Transmission Loss test, which provides the design engineer with before-and-after comparison noise levels for mass-dependent systems. The typical Transmission Loss test does not measure, however, vibration-induced radiation or boundary layer-induced effects on the fuselage. It also fails to address the radiation of acoustic energy from the floorboards.

The AutoSEA2 software is allowing E-A-R engineers to consider the contribution of all acoustic sources and acoustic treatments, enabling them to select treatments that achieve the lowest noise level per pound of material installed. Joyal says the resulting trade matrix should provide an invaluable tool for aircraft owners and manufacturers, because it will illustrate the various options on quieting aircraft interiors without expensive flight tests.



Today's modeling software allows design engineers to virtually create and test structures, such as a fuselage.

E-A-R's Aircraft Damping Composites tackle structural vibration

Materials designed for vibration control can be tested in various ways in order to determine performance. Most methods involve applying the materials to a metal structure, inducing vibration into the composite and measuring the composite's response in order to determine the amount of energy dissipated. Historically most applications for damping materials have been on thin, resonating metal panels. In aircraft, vibration materials are applied not only to the aluminum skin, but also the trim panels and floorboards, which are a composite structure.

One of the reasons it is extremely important to control vibration in these composite structures is their *critical frequency.* A structure's critical frequency is that point at which the bending wave speed equals the speed of sound in air. Above this frequency, the structure couples very efficiently to the surrounding air, and radiates most efficiently. This critical frequency is much lower in composites than in structures such as aluminum or steel. A damping material can be

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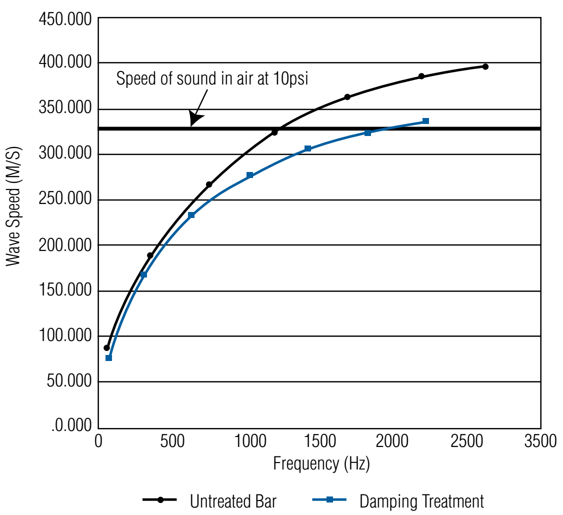
used to lower the bending wave speed of the panel and increase the critical frequency of the structure.



This graph depicts a typical trim panel structure's bending wave speed vs. frequency, both untreated and with different types of damping treatments applied. The addition of the damping materials lowers the bending wave speed and increases the critical frequency of the panel.

Today's overframe blankets work wonders with noise

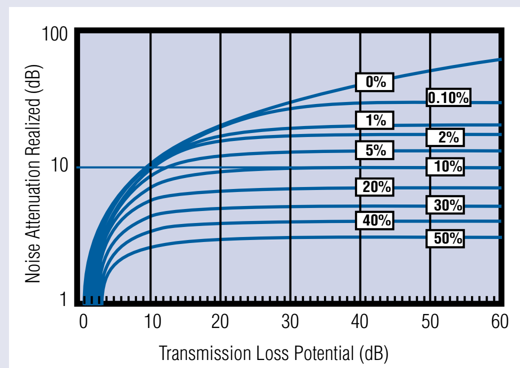
An overframe blanket system forms an integral part of an effective aircraft interior acoustic treatment. Overframe blankets have been used for many years now in business jets, but the introduction of new materials into the market has placed new emphasis upon them.

The traditional overframe blanket consisted of fiberglass or a fiberglass/barrier combination, but the fiberglass has given way to Nomex® felts. These new materials offer better acoustic performance as well as better burn resistance. Although the materials have changed, the basic function of the overframe system has remained unchanged.

An overframe blanket system serves two purposes: vibration isolation and acoustic close-out. As the name implies, the overframe blanket is designed to fit over the frames and outboard of the interior. This helps prevent interior components from touching the fuselage and eliminates the vibration path that can result in strong radiated sound levels. In addition, the overframe is used to "cocoon" the interior and eliminate acoustic holes. Because of tolerance stack-up, protrusions and air ducts, the interior of an aircraft contains acoustic holes that allow a direct path to the exterior fuselage. These acoustic holes limit the effectiveness of any acoustic treatment. The overframe blanket is used to close out these holes and eliminate the direct path, thus reducing the overall noise of the aircraft.

What happens when you don't plug the holes?

Without proper close-out, large gaps in the interior of the aircraft allow for a direct acoustic line for sound to enter the interior. The greater the gaps, the greater the limits placed on the acoustic system. Just take a look at the graph below.



The x-axis represents an acoustic treatment's *expected* Transmission Loss, either calculated or measured. The lines on the graph represent the *percentage of openings* in the actual system. The y-axis is the *realized* Transmission Loss.

Example: A sidewall acoustic system that was designed to have an ideal Transmission Loss value of 30 dB actually realizes a Transmission Loss of only 12 dB when installed, because 5 percent of the total surface area constitutes openings, for mounting points, plumbing, wire protrusions, etc. Thus using the original system would add unnecessary (unproductive) weight.

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