Case Study: **Volvo Group**

**Volvo Improves Truck Cabin Acoustic Design by Using Simulation to Diagnose Noise Sources and Transmission**

**Overview**

Cabin acoustics is one of the most challenging aspects of the truck design process because the acoustic environment in the cabin results from many noise sources including the engine, exhaust, air intake, and others which all interact with each other and which may be transmitted over multiple air-borne and structure-borne paths to the cabin.

The Volvo Group has made major strides in improving the acoustic performance of its trucks by utilizing simulation software to understand the major noise sources and transmission paths that affect cabin noise in a particular design. The company’s engineers evaluated the ability of several acoustic simulation packages to predict the noise radiated by a large truck engine. Actran acoustic simulation software developed by Free Field Technologies (FFT), an MSC Software Company, was the simulation tool that generated the most accurate results compared to experimental measurements. “Volvo engineers are now using Actran to study many aspects of cabin acoustics, such as the noise radiated by the engine air intake,” said Frederic Andre, Feature Development Manager at the Volvo Group Trucks Technology (VGTT) center in Lyon, France. “By studying simulation results, engineers obtain insight into which design generates the greatest potential improvements and evaluate the impact of acoustic modifications without having to build expensive physical prototypes.”

“Among the several simulation tools that Volvo engineers used to model the physical experiments of truck engine acoustics, Actran was the one that delivered the most accurate results.”
“By studying simulation results, engineers obtain insight into which design generates the greatest potential improvements and evaluate the impact of acoustic modifications without having to build expensive physical prototypes.”

Frederic Andre, Feature Development Manager, Volvo Group Trucks Technology (VGTT)

Challenge
Cabin acoustics plays a critical role in the selection process for over-the-road trucks by customers. These trucks are used as transport solutions that may last a week or longer, so the vibration and acoustic level inside the cabin is essential to driver comfort, productivity and safety. The diesel engines used in heavy trucks typically generate high levels of airborne noise and structural vibration in close proximity to the cabin. Also, noise from the transmission, tires and wind contribute to cabin noise levels.

In order to create low cabin sound levels, Volvo uses a variety of technical solutions. The acoustic engineering process is challenging because there are many different sources of noise and many possible noise remediation tools. Moreover many different design choices affect acoustic performance and these effects need to be understood early in the design process to avoid late-stage changes that can drastically increase product development costs and lead-time. Prototypes are not usually available at this stage of the design process so Volvo sought a simulation tool that could accurately predict the various contributors to cabin noise.

Solution/Validation
Several years ago, VGTT engineers selected some benchmark test cases covering different acoustic topics, such as the noise radiation from a truck engine into a semi-anechoic room, or the noise radiation from the air intake system. Actran is now used on a regular basis for both applications. ‘Among the several simulation tools that Volvo engineers used to model the physical experiments of truck engine acoustics, Actran was the one that delivered the most accurate results,” Andre said.

Today, with the help of Actran, Volvo engineers also work on the simulation of low frequency acoustic transfer to the truck cabin interior (Figure 1). The noise sources, located outside the cabin, come either from the exhaust outlet or from the air intake inlet, or even from the entire air intake system (Figure 2). To simulate properly the complex acoustic phenomena, Actran models, using finite and infinite elements, include not only the truck cabin but also its chassis components. Actran allows calculation of acoustic pressure on the cabin panel surface by using a specific cabin “acoustic skin” (Figure 3, 4). Then, the Nastran ACLOAD procedure is used to transform that acoustic pressure into loading force, applied on the cabin structural mesh in a subsequent Nastran calculation. This methodology has been validated by tests with calibrated noise source (Figure 5) and is now used for project applications at Volvo Trucks.

Key Highlights:

**Product:** Actran
**Industry:** Automotive
**Benefits:**
- Improvement of truck cabin acoustics
- Reduction of expensive physical prototype
- Predict the performance of design alternatives and rapidly move towards an improved design.
- Deliver technical requirements in the early phases of projects

Results/Benefits
Since validating the ability of Actran to accurately simulate truck engine acoustics and cabin acoustics, VGTT engineers have used the software extensively to address the cabin noise issues on new truck designs. VGTT engineers set feature targets and deliver technical requirements in the early phases of projects using a concurrent test and simulation process. Oleg Danilov, NVH Engineer based in Lyon, France, is using Actran to perform acoustic simulation on the air intake of truck engine. “Air intake performance is critical to the overall noise level in the cab,” Danilov said. “With Actran we can accurately predict the relative performance of design alternatives and rapidly move towards an improved design. Our objective is to minimize the noise radiated from the air intake to the cab while delivering a sufficient volume of air to meet the requirements of the engine. Actran simulation takes several hours and measures the transmission loss, segregation of the structure and impact of the air intake to the cabin interior. We use Actran in conjunction with physical testing to evaluate many different alternatives in a fraction of the time that would be required for physical testing alone. We select the best design and fine-tune the geometries and material properties.”

![Figure 1: Volvo truck cabin](image1.png)

![Figure 2: Truck air intake components](image2.png)
About Volvo Group

The Volvo Group is one of the world’s leading manufacturers of trucks, buses, construction equipment and drive systems for marine and industrial applications. Volvo designs and builds trucks under the Volvo, Renault, Mack and UD Truck brands. All research, engine development, product design and most of the purchasing takes place in Volvo Group Trucks Technology. Volvo Group Trucks Technology has approximately 10,000 employees, mostly engineers, working in global teams with offices, workshops and laboratories in many countries worldwide.

For more information on Actran and for additional Case Studies, please visit www.mscsoftware.com/actran