Acoustics in the cabin

In general, acoustic comfort is a factor of safety. Driver and passengers arrive relaxed at their destination. This rule must however have a fine distinction: a passenger compartment which is too quiet deprives the driver of useful sensory information. It is all a question of dosage **to conserve useful information while at the same time removing nuisance noise.**

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BASIC FACTS

The level (and type) of noise inside a car's passenger compartment has a considerable impact on comfort. Driver and passengers also often consider that the acoustics of a car is enough to reveal its overall quality and the care given to its design and manufacture.
However, mastering noise in the cabin is a highly complex issue. There are many sources of vibration, and hence noise, in a moving car. Although the engine alone is a significant source of noise owing to combustion phenomena and the movements of its many moving parts, it is far from being the only one. Aerodynamic noise due to the friction of air on the body appears as speed increases. Tyres also cause vibrations and rolling noise. Finally, the body itself may vibrate due to both aerodynamic and mechanical phenomena from the drive axle transmitted through the suspensions.

The noise present in the cabin can be divided into three major categories: low-frequency noise, medium-frequency noise and high-frequency noise.

Low-frequency noise corresponds to booming, which can be very tiring on long journeys. The engine is the primary source of this noise. Medium-frequency noise, more tolerable yet still a source of irritation, usually comes from mechanical elements such as the transmission and some engine components. Finally, high-frequency noise is often due to aerodynamic phenomena: whistling, air noise • • •

●●● in the air conditioning circuits, etc. This noise makes it difficult to have a conversation in the passenger compartment and to listen to the car radio.

Fighting the effects of these internal and external noise sources requires specific solutions for each problem.

IN SHORT

Controlling noise levels inside a car's passenger compartment calls on several skills. Aerodynamics, vibrational analysis and simulation are used to provide a specific response to each source of noise.

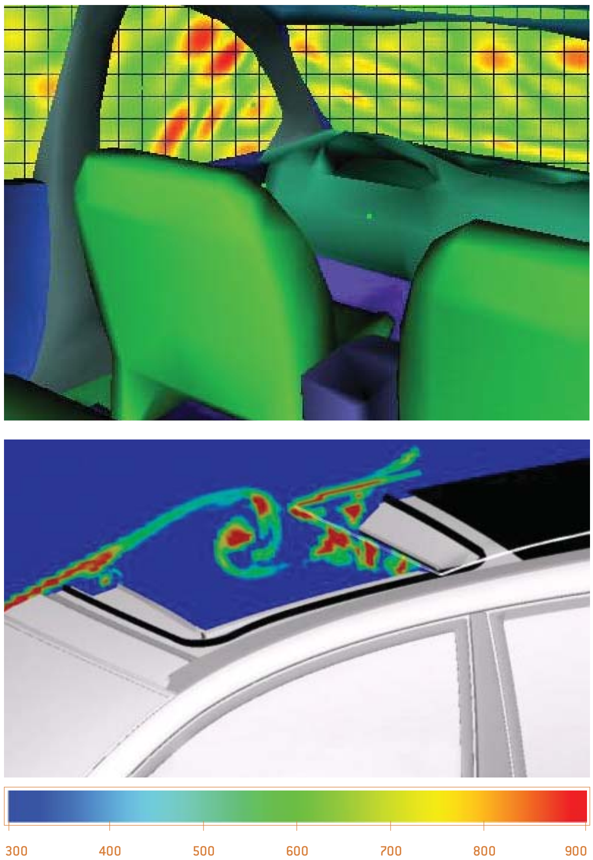
HOW DOES IT WORK?

Reducing noise from the engine means making changes to internal design, as well as installing elastomer parts which separate it from the vehicle and limit vibration from the transmissions. They are used to damp vibrations where the engine is in contact with the chassis of the car, hence limiting their transmissions to the cabin. Increasing the thickness of sound-proofing at the dashboard (the wall between the engine compartment and the passenger compartment) also reduces noise propagation, especially for medium and high frequencies.

For the drive axle, the use of elastomer parts enables the vibrations from the wheels to be filtered.

Mastering vibration in the body requires digital modelling combined with measurements taken on prototypes. Some problems can be resolved by adding reinforcements on the body, so as to increase its stiffness, or devices which provide structural insulation. To do so, the origin of this noise must be accurately identified. Digital modelling of the body is used to simulate vibrations by amplifying them until the points where it is possible to act are determined very precisely, and the effectiveness of the solution envisaged can be assessed. This is a particularly complex problem where any action on a component may cause harmful effects by generating new vibrations in another zone of the body. Hence, modelling is used to assess the impact of each intervention until a satisfactory solution is found.

Reducing high-frequency noise, and in particular air noise, requires many aerodynamic studies. For example, a door mirror may be a significant source of aerodynamic noise. As well as the whistling it may cause, it may transmit vibrations to the body through its attachment. Door mirrors are therefore subject to considerable aerodynamic modelling. Similar modelling is used for window or windscreen joints. They must effectively act as dampers for the windows and ensure air



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Below: simulation of the airflow above a sunroof (Mégane). Top: velocity field on the windows of a Laguna subjected to airflow.

and water tightness, without breaking the continuity of body lines, which may cause noise-generating air swirls.

All the air circuits for air conditioning are subject to aerodynamic studies, from the air inlets at the ventilation nozzles to the air propulsion fan, to ensure silent operation.