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“Rolling noise does not evoke an emotional response”

Suppliers are working to develop new materials and technologies that will improve vehicle acoustics. In the ATZ interview Dr Maurizio Mantovani, Head of Research and Technology at Autoneum, explains which noises predominate in electric vehicles, how the WLTC has influenced development processes, and how analog and digital methods of reducing noise can complement one another.

ATZ _ New cars are becoming less noisy, but do we really want a completely silent interior?
MANTOVANI _ Driving is all about experiencing emotions. The engine gives the driver feedback about the car’s acceleration and how quickly it is accelerating. But we believe that people will want their cars to be increasingly quiet, particularly in the case of the new mobility models, such as autonomous driving. However, many customers still feel the need for acoustic feedback, even from electric cars.

What are the differences in terms of acoustics and NVH between electric cars and vehicles with combustion engines?
Our comparative analysis has shown that there are no major differences between the noise packages of the cars currently on the market. Most of these models have been developed using traditional methods and that includes the acoustic package. But we are also beginning to understand the different challenges presented by electric cars. For example, electric motors produce high-frequency noises under acceleration and under regenerative braking. The noise package must be able to compensate for these sounds.

Electric cars are hardly any quieter than conventional models, particularly at high speeds, which leaves many customers feeling disappointed.
Electric cars are very quiet at low speeds and under acceleration, because the noise of the engine is missing. But at higher speeds other sounds, such as wind noise, become louder and then electric cars are almost as noisy as combustion-engined cars. That can genuinely lead to disappointment among customers.

Rolling noise is particularly irritating. How can it be reduced?
Tire noise is louder in electric cars, which are heavier as a result of their large batteries. It is also more noticeable because there is no engine noise. And rolling noise does not evoke an emotional response. The contact between the tires and the road produces low-frequency vibrations that spread throughout the structure of the car. Vehicle manufacturers are working with tire suppliers to reduce the noise. They are also improving the suspension systems and the stiffness of the body. If the body panels still begin to vibrate, we can help to lower noise levels. We have developed simulation methods that allow us to identify the ideal combination of stiffening in certain areas of the body, vibration-damping materials, and acoustic insulation to reduce the transmission of noise. The absorption and reflection properties of the passenger compartment also have to be taken into consideration.

So a combination of different measures is needed. It’s not enough just to turn a screw.
There are a number of different measures that can be used to find the ideal solution. Staying with rolling noise, it is also made up of high-frequency sounds that are transmitted from the contact point. One effective method of dealing with the noise as close to its source as possible is to use textile wheel arch liners that absorb the sound. Absorbent underfloors are also a highly efficient solution. The underfloor has a very large surface area and, if it is covered with absorbent panels instead of reflective panels, noise levels can be reduced even further.

“The acoustic system is highly complex”

Which noises are most difficult to reduce?
In the case of aerodynamic sounds, the important factors are the shape of the body, together with components such as door mirrors and windshield wipers. The door and window seals also play an important role. The methods used to reduce rolling noise and engine noise are similar, but when it comes to aerodynamics the simulations on the test bench are different from the other simulation methods. The acoustic system is highly complex and all the components interact so closely with one another that all the noises are equally difficult to manage.

What are the main challenges you face during the process of identifying this solution?
One major challenge is the downward pressure on prices in the automotive industry. This is why we need to keep introducing new innovations onto the market which are both highly efficient and also cost-effective. Another problem is the lack of installation space. Often we only have a few millimeters available to use and this makes it difficult for physical reasons to achieve high levels of insulation and absorption. We have to produce better and better performance with solutions that are as lightweight and as inexpensive as possible and take up very little space.

That sounds quite difficult. How do you manage it?
We invest around 3 % of our annual turnover in product innovation and product development. To ensure that we constantly improve our portfolio, we patent about ten new technologies and materials every year. Here in Winterthur alone we employ around 100 engineers from different fields.

Does it make a difference where you suppress the noise? Is it better to do it right at the source or further away, for example on the bulkhead?
We have carried out a number of studies which have shown that insulation works

Dr Marco Mantovani (born in 1963) has been Head of Research and Technology at Autoneum in Winterthur in Switzerland since 2014. Mantovani has a degree from the Polytechnic University of Turin, where he also completed a master’s in nuclear engineering and a doctorate in vibration engineering. In addition, he has an MBA from Bocconi University in Milan. From 1990 to 1998 he worked at the Fiat research center near Turin, most recently as head of the NVH simulation department, before holding a range of positions at Autoneum in the field of acoustics and thermal management in the period up to 2014. Until 2013 Mantovani, who has dual Italian and Swiss citizenship, was also scientific director of the Automotive Acoustics conference run jointly by ATZ and Autoneum.

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best at the source of the noise, for example with engine encapsulation. In the case of combustion engines, encapsulation has the added advantage that the engine stays warm for longer after it is switched off, which reduces CO_2 emissions during any journeys made shortly afterwards.

Despite this many engines are not well encapsulated.
This is because good encapsulation is expensive and not easy to develop. Engines are highly complex and have a lot of pipes and wires leading into and out of them, as well as auxiliary units. Designing an enclosure of this kind is a difficult task. You need a thorough knowledge of thermal management, because the engine must not be allowed to get too hot. We have developed the necessary methodology and materials. Stricter legislation on external noise, also known as passing vehicle noise, will be introduced in future and engine encapsulation will be more widely used as a result.

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The acoustic package of electric vehicles must above all be matched to the high-frequency sounds of the electric motor, says Maurizio Mantovani (left) in an interview with ATZ editor Mathias Heerwagen.

“The ideal solution is an acoustic package consisting of ANC and lightweight components”

How do you develop new materials?
Our physicists, simulation experts, and material specialists work together with customers, universities, research institutions, and suppliers to develop new combinations of materials. Even parts that look relatively simple from the outside can be difficult to develop. Fiber components are one example: There are many different fibers, which differ in material, dimension, shape, properties, etc. By combining fibers we can produce different properties.

How much of the development work is carried out by simulation programs?
In the past there were usually several prototype phases, but now most car manufacturers take the noise package directly into volume production with hardly any prototypes. We need to be absolutely certain that the product functions as it is supposed to and that the simulation methods are correct. That is the reason why we have invested so much money in this area over the last 20 years and developed our own simulation tools. We are using fewer and fewer commercial software packages and more and more programs that we have developed in-house. Overall the development phases have become much shorter…

… and the customers’ requirements specifications have become more comprehensive. Which aspects are particularly hard to implement?
We are presented with a wide range of requirements that include the materials, VOC emissions, fire prevention, durability, ease of cleaning, and noise insulation properties. None of these things are easy to implement. If you change something in one area, all the other properties must remain unchanged or improve, but nothing is allowed to get worse.

In recent years there has been a trend for models with small, turbocharged engines. How has this affected Autoneum?
In many cases the specifications for the noise package have become stricter. Exhaust turbochargers are an additional source of high-frequency noise which needs to be reduced. Downsizing is no longer as important as it was, because the introduction of the new WLTP, which is more dynamic and requires more engine power, means that the benefits of small engines are less significant.

Let’s move away from conventional insulation materials and take a look at digital measures. Will active noise canceling (ANC) systems have a negative impact on Autoneum’s business model?
Not at all. They are an addition to what we already have to offer. For reasons relating to the laws of physics, these systems function effectively with low and medium frequency sound. Long waves are easier to cancel out than short waves. At higher frequencies, where the wavelengths are shorter, these systems no longer work well. If you move your head out of the “quiet area,” the sound field is completely different. Although Autoneum offers products and optimization methods that cover the full frequency spectrum, we can exploit at best our innovation strenghts in the development of lightweight components which work very effectively in particular at medium and higher frequencies. The combination of ANC and our light components would allow to create the best possible acoustic package without increasing the weight.

Dr Mantovani, thank you very much for talking to us.

INTERVIEW: Mathias Heerwagen