

"Fan noise wasn't an issue in the Beetle": quieter technology and lighter vehicles pose a whole new set of acoustic problems for developers

The downside of today's lightweight materials and ever-quieter motors is that unwanted noises in appliances and vehicles are becoming increasingly noticeable. No amount of tinkering is sufficient to satisfy modern-day standards. Rather, acoustic issues need to be addressed at a very early stage of conceptual design if the development process is to be economic and the product successful. At P+Z Engineering GmbH, one of Germany's leading development service providers, the aspect of acoustics is dealt with by an interdisciplinary team of experts in the early concept and development phases. Here, noise cancellation specialists carry out closely coordinated simulation and testing, create new calculation tools for aeroacoustics, and analyse the acoustic properties of new materials.

"Nowadays the consumer, and hence also the manufacturer, have very high expectations in terms of vehicle and machine acoustics," reports Dr. Marinus Luegmair, Senior Engineer Acoustic Simulation and Head of the Centre of Competence (CoC) Acoustics at P+Z Engineering. The main reason for this is that any user can detect noise and evaluate it subjectively, whereas you need to be a specialist to assess something like crash safety, for example. As drives become increasingly quiet – particularly in the case of electric motors – previously undetected noise sources suddenly come to the fore. As Luegmair points out: "The hum of the radiator fan wouldn't have been an issue in the VW Beetle – you wouldn't have been able to hear it anyway." Added to that, lightweight materials such as composites or aluminium may be leading the way on weight and consumption, but they can be a problem when it comes to noise emissions. "In acoustics the general rule is: the more mass, the better. So when it comes to lightweight engineering we need to re-evaluate existing design standards and find suitable solutions," explains Team Leader CAE and Simulation Florian Seifferth, also part of the specialist team.

To tackle this new and constantly expanding field with the necessary professionalism, the development service provider P+Z Engineering is adopting an interdisciplinary approach: the core team of CoC Acoustics pulls together specialists from all fields, ranging from simulation to testing and structural dynamics to sound design, in order to coordinate the know-how and skills of the various departments. This avoids the need for interfaces, so there are no breaks in the flow of information and projects can be implemented more quickly and comprehensively. "In the case of one order for a commercial vehicle manufacturer for example, the simulation and test results deviated by a factor of 100," Seifferth recalls. "Usually in a situation like this, a lot of time would be spent doubting the results and trying to locate possible errors. But in our case it quickly became clear in the team meeting that the test sensors are mounted on special supports. Once the calculation was adjusted to take this into account, the results converged."

Pre-prototyping noise elimination

A key aspect of the acoustic expert's job is that of noise prevention, as unwanted noise is usually associated with poor quality and can therefore undermine the perceived value of the product. Trying to tackle such problems just before series production generally incurs high costs for tool modifications and

reworking. Just to retrofit a rattling car door with sound-absorbing felt would mean an additional cost of around 1.6 million euros based on 150,000 doors per year. To avoid this, it pays to deal with acoustics issues as early as possible in the development process, ideally before the initial prototyping stage.

"Thanks to our interdisciplinary approach, we can coordinate simulation and testing very closely and therefore provide feedback to the designers early on," explains Daniel Plum, Team Leader at P+Z Engineering responsible for test/project supervision within CoC Acoustics.

If you want to make a wall thinner, for example, you can simulate various alternatives and evaluate them. But conventional testing is still necessary in order to validate the results conclusively. Bringing together these two often simultaneously divergent strands of development thus has the advantage of allowing any modifications, along with process-related geometric problems, to be analysed at an early stage: "For instance, in the in-house paint shops the bodies-in-white are immersed in a bath (CDP: cathodic dip coating). To ensure a proper coating, and also to allow residues to drain off effectively afterwards, clearance holes are left inside the body. However, these lead to acoustic problems further on in the vehicle's development which need to be solved," explains Plum.

Sound design based on subjective demand

Another – relatively recent – topic area is that of psychoacoustics and sound design. Questions as to how various noises are perceived by the user, how impressions can be objectivised and which sounds are perhaps even expected, are becoming increasingly important for manufacturers as technology in general gets quieter – and not just in the automotive industry. "Sound design is now an issue for the white goods sector too. If the user doesn't hear a click when they switch on their washing machine, this may worry them, and cause them to doubt the reliability and/or quality of the appliance," explains Plum. Consequently, acoustics experts are now developing situation-specific strategies to generate noises artificially. Based on psychological assessments, they can thus pinpoint an agreeable acoustic spectrum appropriate to the area of application and which satisfies the customer's expectations.

Looking to the future: new acoustic fields and new materials

The acoustics specialists at P+Z Engineering are also currently doing some intensive work on aeroacoustics, i.e. the analysis of aerodynamically generated noise. Up to now, this field has mainly been the province of universities, and is only just beginning to gain ground in industry. As the topic is still very new, systematic methods first have to be developed for projects of this kind. "Wind tunnel tests would be very expensive, so simulation will tend to be the method of choice," says CoC Head Luegmair. "That said, the flow calculations have to be more accurate than for other applications by several orders of magnitude. To achieve this without unacceptably long calculation times, we are currently investigating how much can be done using approximations and which aspects might be dispensable." Initial projects are already under way: for example, a full-vehicle CFD simulation has been conducted in order to evaluate the vehicle in its current stage of development and identify improvements.

Work is also ongoing on the integration of new materials. This may involve the acoustic optimisation of a CFRP component, for example, or the production of material cards documenting the reactions of various substances to each other. The CoC Acoustics cooperates closely here with the P+Z expert committees for Composites and Interior Design. "By pooling our know-how in this way, we can offer complete solutions instead of just covering partial areas," Seifferth concludes. The accumulated knowledge and experience is also passed on to staff through in-house presentations, and to interested students through collaborations with technical colleges and universities in Munich and Ingolstadt, with the aim of inspiring a new generation of engineers to embrace the multifaceted topic of acoustics.



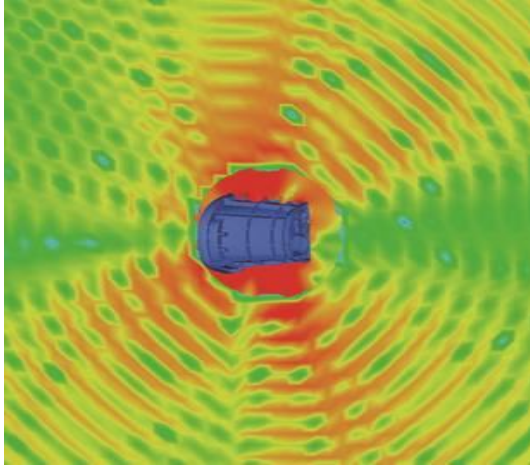
Caption: You don't have to be an expert to judge when a noise is a nuisance. That's why the field of acoustics is becoming increasingly influential in terms of the perceived value and quality of a product.

Source: P+Z Engineering



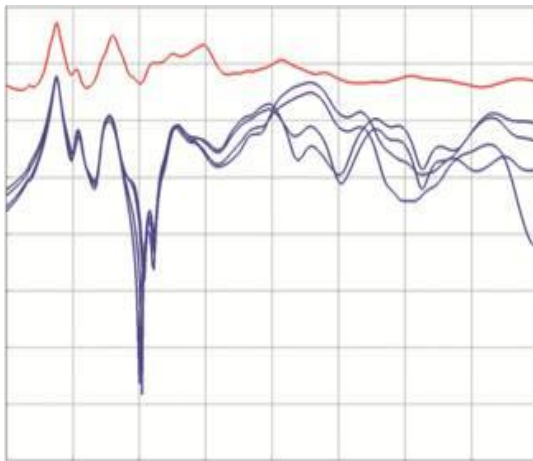
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Caption: The electric car problem: the silence of electric motors throws incidental noises into sharper relief, while lightweight construction materials may be more prone to vibration. In the case of materials such as CFRP, acoustic properties therefore need to be analysed at the outset and modified design strategies devised where necessary.



Caption: Noise cancellation is a key area for the acoustic experts at P+Z Engineering due to ever-quieter technology.

Source: P+Z Engineering



Caption: Noise perception is influenced not only by technical variables such as surface radiation and sound pressure level, but also by psychological factors. Objectivising these factors and translating them into a suitable sound design is one of the major challenges of modern acoustics.

Source: P+Z Engineering