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“It has been essential to keep noise levels low in the Kuga”

The development of hybrid cars presents engineers with specific challenges relating to noise, vibration and harshness, because the characteristics of the electric motor and the combustion engine are often very different and have to be reconciled. In the interview Dr. Christian Schuster, Head of NVH Programs at Ford Europe, explains the acoustics strategy for the third generation of Ford's Kuga SUV.

ATZ _ Dr. Schuster, what are the differences in the aerodynamics of the new Kuga compared with the previous generation of the SUV?

SCHUSTER _ By making targeted use of the latest aero-acoustic CFD (Computational Fluid Dynamics) methods during the early stages of developing the new third generation of the Kuga, we have

been able to influence the design of important features and components to achieve the best possible compromise between the differing requirements. One example of this was the positive impact we had on wind noise by designing the key components, including the radiator grille, engine hood, A-pillars, windshield and mirrors, with this in mind. We have

also used acoustic laminated glass for the windshield and the side windows of the new Kuga.

What is the situation with the tires? Does choosing a particularly quiet tire not represent a safety risk?

We are proud to supply the new Ford Kuga with tires that have very good

acoustic properties but do not compromise in any way on the other important features. They also highlight the dynamic design of the car with their low rolling resistance.

How does active noise cancellation work at Ford?

The active noise cancellation or ANC system in the Ford Kuga uses signals from microphones in the roof liner to identify the noise levels in all the seats and to produce antiphase sound via real-time digital signal processors. This is broadcast over the loudspeakers of the car's audio system, which means that the noise of the combustion engine can be effectively reduced, if in addition the speed signal of the electric motor is used as the reference variable for ANC. Ford has successfully introduced ANC technology to its CD segment cars over the last few years. Now it is being deployed in the latest generation of the Kuga too.

What are the other components of your "whisper strategy" for the Kuga?

It has been essential to keep noise levels low in the Kuga in all the key areas, in other words, powertrain, wind and rolling noise. We have taken a number of different approaches. Firstly, in the powertrain we have introduced primary measures, which make the noise quieter at its source, and also secondary measures, which include reducing the vibration of the powertrain, designing low-noise components, for example with the

help of resonators, and fitting exhaust mufflers with a large volume. Other moves include using acoustic materials in the interior, for example in the bulkhead insulation, roof liner, carpet, door trims and seats, and making improvements to the exterior. The engine mounts have been specially designed for good acoustic characteristics and adapted to the different variants of the Kuga including front-wheel/all-wheel drive, diesel/gasoline, combustion engine/hybrid drive. Secondly, the rolling noise has

"The use of CAE simulations is growing very rapidly at Ford"

been reduced by isolating the rear axle and redesigning the front axle geometry. I have already mentioned the special role played by the tires in this respect. Thirdly, lowering wind noise levels has also made the car quieter.

One surprising feature is the perforations in the premium leather upholstery to reduce noise. Does something like this really make a difference and, if so, what is the reduction in decibels?

To make the overall sound absorption package more effective we had to pay a lot of attention to detail and make a large number of small improvements. The premium leather upholstery that is available

for certain Kuga variants improves the intelligibility of the occupants' speech in the interior by several percentage points, which is particularly noticeable on long journeys.

The Kuga plug-in hybrid is said to be especially quiet in electric mode. Are there conflicts in terms of NVH between electric models and cars with combustion engines which have to be reconciled in a hybrid?

Yes, there are and taking these requirements into account in good time for the different powertrain variants is a key factor in the development of hybrid models. This is why we focused on the best compromises for customers at an early stage of the development process for the Kuga plug-in hybrid. For example, we designed the engine mounts to provide highly effective insulation against low-frequency structure-borne noise from the combustion engine and high-frequency noise from the electric motor.

Which tools do you use to analyze and improve the NVH? What percentage of the NVH improvements at Ford come from CAE simulations and what percentage from conventional test rigs in a semi-anechoic chamber?

In addition to the work we carry out at our acoustics center in Cologne, we also spend a lot of time on test tracks where we have the very latest measurement and analysis systems for acoustics and vibration available to us. The use of CAE

Dr. Christian Schuster (born in 1968) became Head of NVH Programs at Ford Europe in 2014. Schuster completed his mechatronics and mechanical engineering degree at the University of Duisburg-Essen in 1993. From then until 1998 he worked as a research associate and assistant in the mechatronics department at the university. In 1998 he gained his doctorate in mechatronics and mechanical engineering. During the period 1998 to 2007, he worked first as Development Engineer and ultimately as Group Leader in the NVH department at Ford in Cologne (Germany). He headed the Vehicle and Powertrain Acoustics department at Volvo Cars in Gothenburg (Sweden) from 2007 to 2009. After this he was Project Leader for the Global Platform Medium-class Vehicle Architecture for three years and then Head of Vehicle Architecture Development for two years at Ford Europe.

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Developers can make use of a number of features to improve the NVH characteristics of a car, including key components such as the radiator grille and engine hood, explains Schuster, speaking during the coronavirus lockdown

simulations is increasing very rapidly at Ford. The proportion of CAE simulation in the overall development process is well over 50 % and is constantly growing. Our aim is to carry out NVH investigations and analyses using mainly digital methods with only a few modifications to the real vehicle. But, of course, every development is verified on the actual car and we will continue to do this in the future.

How accurate are the NVH simulations at predicting the actual noise levels? What was the situation five or ten years ago? To what extent do you still need to use people to tell you whether certain sounds and noises are good or bad?

We have significantly improved the accuracy of our CAE simulations over the last few years. The prediction accuracy is much better, particularly in the higher frequency ranges, which will become more important as a result of electrification. We still need people for the final acceptance, but we also have

new metrics that enable us to record even complex sound phenomena in a digital format.

Electric cars will soon have to be equipped with an Acoustic Vehicle Alerting System (AVAS). What do you think of the concept of fitting quiet cars with an artificial alert system? Particularly in the future when there will be so many of these cars on the roads in our cities.

“Only a few modifications to the real vehicle are needed”

The absolute top priority for us is the safety of the drivers and passengers in our cars and of the pedestrians on the streets. We are doing a lot of work on developing an AVAS signal for our cus-

tomers and other road users that provides an effective external warning and, at the same time, is perceived as being discreet and pleasant inside the vehicle. This is definitely a challenging task and we have put a great deal of effort into it.

Dr. Schuster, thank you very much for this interesting discussion.

INTERVIEW: Frank Jung

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