



## **Fine-tuning the characteristics of the Audi steering system**

- **Interview with driving characteristics developer Carsten Jablonowski**
- **Basic calibration carried out virtually to create the typical Audi steering feel**
- **Different steering systems build on each other**

**Ingolstadt, May 10, 2021 – Whether driving on winding roads in the Alps, a busy highway, or city streets filled with potholes on the way to the supermarket – a good steering wheel has to cover the entire spectrum of driving situations. In this interview, Carsten Jablonowski, Driving Characteristics Development Team Lead, explains the complex process of fine-tuning the chassis and steering, which is what gives an Audi its unique steering feel.**

### **Mr. Jablonowski, how would you describe the typical Audi steering feel?**

When we're behind the wheel of a car, its individual steering feel depends on a variety of factors. Among other factors, the overall design, vehicle weight and weight distribution play a role, as do the individual chassis components, the tires, and the steering system used. Now when I get into different Audi models, I get that familiar feeling after only a short time – the car steers effortlessly, smoothly, and precisely with little effort. And this is true regardless of whether I'm parking, driving through hairpin bends, or simply cruising around the city. Because an Audi steering wheel generates greater torque, I'm able to negotiate curves precisely and with agility. Our models change direction with a high degree of precision, especially when driving fast through alternating turns. On the other hand, an Audi will smoothly drive straight ahead at fast highway speeds and isn't jittery at all. This means I can always feel how the car is interacting with the road. The steering wheel gives me direct feedback regarding the car's balance, level of grip, and road unevenness such as bumps and ruts. All in all, this is important for a safe and pleasant driving experience.

### **The vehicle development process takes up to five years. How do you ensure that steering feel is given sufficient consideration during this time?**

First, we define the handling characteristics for the corresponding series. Each model has a defined target range for the required steering angle. This determines, among other parameters, the necessary steering ratio or the transmission ratio curve of the front steering axle. Next, we design the front axle steering system accordingly. With increasing demands on driving dynamics and handling in larger vehicles such as the Q7 and Q8, we also use rear-axle steering.

### **How is a steering system calibrated – on a computer or in the real world?**

Both. What we refer to as basic calibration is largely carried out virtually. We have developed standardized driving and steering maneuvers that we simulate over a vehicle's entire speed range. We mainly focus on the range in which the average customer drives, as the linear range with low lateral forces and normal steering frequencies. But we also push the limits to evaluate the vehicle's handling at high levels of lateral acceleration and fast steering frequencies. Basic



calibration works extremely well with this approach, especially for complex systems such as dynamic all-wheel steering. But it obviously does not deliver results worthy of final approval.

**What's the next step in the fine-tuning process?**

It isn't yet possible to fine-tune and harmonize all the chassis components with each other via simulations. We can only properly assess the steering feel by testing it out on the road. This requires trial runs to determine whether the settings we've selected during basic calibration are headed in the right direction. For this purpose, we first test-drive the vehicle on different test tracks. Both objective and subjective criteria are taken into account during the calibration process. We ask ourselves questions like: how is the car's self-steering behavior? Does the steering wheel transmit the driver's commands directly or indirectly to the wheels? Does it give the driver a good feel for the road surface? Is the steering wheel responsive or sluggish?

**And what do you do if you discover that the wheel hasn't been properly calibrated?**

If a test drive reveals that something needs to be changed or that we should try a different setting, we make the necessary modifications and promptly head out for the next test drive. We adjust parameters in the control units, taking different tires and drive systems into account. Much of the fine-tuning and calibration is performed on public roads. After all, this is exactly where the cars will later operate on a day-to-day basis. With each calibration run, we refine the criteria and the overall system until it finally reaches production status.

**In this context, how do you specifically deal with the issue of original tires?**

It's ultimately the tires that put our cars' technological edge on the road. Selecting different tires can significantly change the vehicle's driving and steering behavior. This means it's critical that the chassis and steering system operate together in perfect harmony. It takes several years before a new Audi and a type of tire are a perfect match. Together with leading manufacturers, we develop a suitable tire made of state-of-the-art materials specifically for each Audi model. In this process, we harmonize our specifications with the range of tires offered by our partner companies. The list of criteria that an original Audi tire must satisfy in extensive testing is quite long.

**What criteria does this include?**

The design of the summer and winter tires is fine-tuned over several stages until we are satisfied with its performance as it pertains to runout quality, rolling resistance, driving dynamics and handling, braking characteristics, fast running, aquaplaning, winter testing, and uniformity. In the process, the design of the tire substructure, the carcass, and the rubber compound for the tread are continuously tailored to the vehicle model. During the development process, we set the bar above the legal requirements. Only after around 50 tests is a tire allowed to be sold on an Audi. In total, we cover 40,000 kilometers in our endurance tests.

**Audi currently has various steering systems in its range. What are the benefits of this?**

Our electromechanical power steering system has laid the groundwork for all of our steering systems. Thanks to this system, it is possible to vary the steering assistance depending on the



speed. Progressive steering was developed on the basis of this system. This operates – as the name suggests – with a progressive transmission ratio. This means that steering movements are transmitted in different ways depending on the steering angle. This noticeably reduces the effort required to steer the car during maneuvering and parking. On winding rural roads and when turning, however, the driver will notice a more dynamic response as a result of the more direct steering. The increase then came with the introduction of dynamic steering. It makes it possible to vary the steering ratio independently of the steering angle. This resolved numerous technical compromises. In addition, drivers can also adjust the steering ratio to suit their needs via Audi drive select.

**Then there's all-wheel steering and dynamic all-wheel steering – your current top technology among steering systems. What are the benefits of adding rear-axle steering?**

The addition of rear-axle steering, known as all-wheel steering at Audi, significantly improves the vehicle's handling. Each and every one of us has accidentally driven over the curb with the inside rear wheel while driving up to the next level in a narrow parking garage. Thanks to the all-wheel steering, this no longer happens as easily. At low speed, the rear axle is steered in the opposite direction of the steering wheel angle. This makes the path driven by the vehicle smaller and noticeably reduces its turning radius when maneuvering. If, on the other hand, you're traveling faster, the steering direction is reversed. The fact that the wheels turn in the same direction on both axles results in significantly improved driving stability, especially when passing. Dynamic all-wheel steering ultimately combines the advantages of dynamic and all-wheel steering. In that sense, we always benefit from the previous technologies.

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