Behind the scenes:
The development of the Audi steering wheel

- **From a 3D print to the production model – four to five years of development work**
- **Audi-specific criteria for the wheel's ergonomics, design, and feel**
- **Functional analysis a key part of the process**

Ingolstadt, May 10, 2021 – An innovative spirit and passion for detail characterize the work of the steering wheel experts at Audi. The entire process, from designing the layout and selecting the materials to manufacturing the initial prototypes to conducting the endurance test and manufacturing the production model, can take between four to five years. A look at the development of a new generation of Audi steering wheels.

"The evolution of the steering wheel is progressing rapidly. Within the span of three decades, a leather-clad steel skeleton has been transformed into a high-tech command center that meets the highest standards of design and quality," says Marcel Bruch, responsible for steering wheel development at Audi. "In the past eleven years, we've launched four steering wheel generations encompassing well over 200 versions for the different Audi models."

From the feature list to the basic design

The next generation of an Audi steering wheel is developed from a variety of initially competing design drafts and package requirements. The arrangement of all the different functions is one of the major challenges of this process. "Despite the wide variety of functions, we need to ensure that we don't clutter up the steering wheel. Instead, drivers need to be able to operate it intuitively so that they can fully focus on the road," says Bruch. "A steering wheel's operating and convenience functions are defined specifically for each model. The steering wheel in the new Q4 e-tron, for example, can be used to control 18 different features. That's a major challenge."

First, the development team draws up an overview of all the necessary functions, before clustering related functions together in the second step. The next step is to roughly decide where to position the clusters and, within the process of creating the overall design, select suitable control elements. Only then do they make a decision on how the functions will be operated – i.e. via touch versus physical elements. "The result is a basic design with modifications specific to the model and features," says Bruch. "For example, the standard steering wheel differs from the optional versions with respect to its cover, decorative trim, colors, applications, and technical functions." There are 16 different versions of the steering wheel for the Q4 e-tron alone. A new feature for the compact electric SUV is the steering wheel rim, which is optionally available with a flattened top and bottom. The design is not only very sporty, but especially adapted to the new shape of the display and it makes it easier to get in and out of the vehicle.. "We constantly have to balance the conflicting demands of design and ergonomics. After all, the steering wheel needs to remain easy to handle and meet defined ergonomic requirements," explains Bruch. "The key here is to find the best solutions early in the development process."

Ergonomic, design, and safety criteria

Generally speaking, steering wheel development at Audi is governed by a number of fundamental principles.

- The rim shape and center must be designed to be as small and compact as possible
- When it comes to the steering wheel's diameter, 375 millimeters across has become the standard
- The oval design of the rim cross-section corresponds to the natural outline of a closed palm. The diameter of the rim measures approximately 30 – 36 millimeters.
- It has to be possible to operate inner functions with the thumb without interfering with the actual process of steering the vehicle
- The focus is on a sporty design. The spokes are comparatively slim
- Surfaces and gap dimensions must meet Audi's high standards of premium quality

As part of the driver restraint system, steering wheel development must comply with more than 35 laws and guidelines, some of which overlap with each other depending on the country. These include specifications governing occupant safety and crash behavior, flammability, as well as design, materials, and assistance systems. At Audi, all the steering wheels have the same design worldwide. The only difference from country to country relates to the driver's airbag due to different crash requirements.

The steering wheel in Audi vehicles has come standard-equipped with a driver's-side airbag since 1993 – a milestone in passive vehicle safety. "The introduction of an airbag in the steering wheel posed major challenges to designers and developers, because the impact absorber needed to remain as small as possible," says Bruch, "but in this case, as well, the technology and manufacturing processes have undergone significant advances and have become increasingly space-saving." In the event of a collision, the steering wheel must be able to withstand enormous stresses without causing the steering wheel rim or other components, such as the panels, to break. This is verified in strength and crash tests. Specifically, these include knee penetration tests or what are known as body block tests, in which crash test dummies impact the steering wheel skeleton at speeds of up to 26 km/h in various positions. This makes it possible to localize highly stressed areas and specifically optimize rib structures and wall thicknesses.

Touch it!

The feel of the steering wheel also plays an important role at Audi. All Audi steering wheels with hands-on detection and/or steering wheel heating have two layers of foam cushioning to achieve an outstanding level of surface quality and a non-slip feel. This standard is applied down to the smallest detail and to every control element. Drivers feel this, for example, through extremely precise rotation/pressing operations or the unique click of the steering wheel buttons specific to Audi.

When selecting materials, Audi focuses on three criteria: high-quality, durable, and long-lasting.

All the leathers used by the company are a by-product of food production, tanned in a chrome-free process, breathable, and completely dyed. Laboratory testing encompasses abrasion resistance, lightfastness, shrinkage behavior, flexural strength, tensile strength, interior emissions, and burning behavior, among other properties.
“In addition, we will also be using the microfiber material Dinamica as a steering wheel cover in the future,” says Bruch. “Dinamica looks and feels like suede, but is made largely from recycled polyester, such as that sourced from textiles and PET bottles.”

Testing and production readiness

Early full-scale prototypes represent an initial milestone in the development process. These are 3D-printed components where the leather is manually applied to the rim, secured with glue, and then hand-stitched like in the production models. Further development and finalization takes place on the basis of these initial samples. “A new steering wheel generation can only be properly and conclusively assessed on the road, however. Testing is carried out in preproduction vehicles via endurance tests,” explains Bruch. The test drivers include people who drive both infrequently and frequently, women and men, younger and older drivers, tall and short drivers, and people who drive both aggressively and more conservatively. Despite their differences, all of them are certified Audi experts who test and assess the vehicle from every customer-related point of view. They provide valuable input during development to ensure the steering wheel offers maximum functionality and ergonomics. How does the steering wheel feel when driving? Is the steering wheel rim too thick or too thin? Does it have any edges that are irritating to the touch? How do you rate the overall ergonomics of the steering wheel? Is it intuitive to operate? Does the hands-on detection work without any issues? All of this is tested in different traffic situations and environments – in urban areas, on rural roads, and on highways. In this process, around 600 preproduction vehicles spend about six months on the road – clocking in 700,000 hours of driving and 35 million kilometers. “This is how we can ensure that like just the rest of our vehicles, our steering wheels also meet the highest standards of quality and safety,” says Bruch.

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