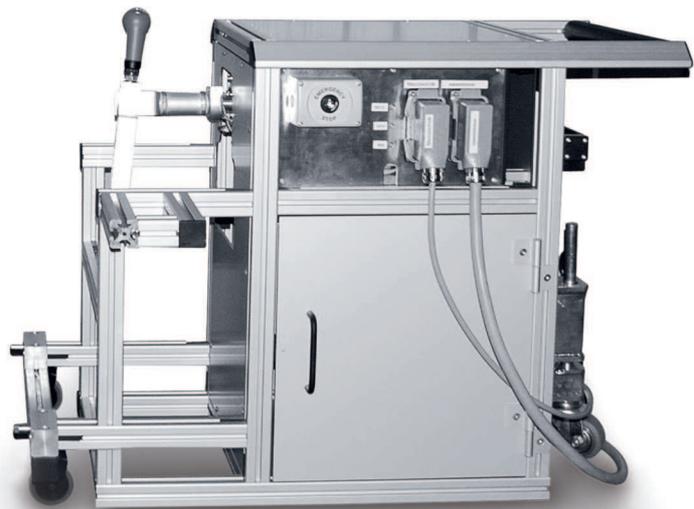


## Feel the shifting force

To ensure optimal shifting comfort and a shift response that is typical of the brand — these are the requirements that Porsche Engineering have always and ever held dear.



The second generation shifting force simulator developed by Porsche Engineering now offers a broader application spectrum



Since 2005 Porsche Engineering has used the first generation of its own, internally developed simulator both for its in-house and customer developments. The simulator makes the shifting force of any gear tangible right from the very early concept phase, making it possible to save on valuable development time and costs.

Up until a few years ago, the definition of new vehicle shifting patterns in the early development stages relied almost exclusively on the experience of a handful of engineers, while pure simulations were

only used in isolated cases. Since the completion of the first shifting force simulator at Porsche, it has been possible to marry the experience gained in testing with the variable options offered by simulation. Even before the availability of the first real prototypes, the shifting characteristics can be perceived, evaluated subjectively and initial optimizations can be defined.

The simulator is combined with a one-to-one scaled driver seat, with which the relevant driver environment can be reproduced vehicle-specifically. The test

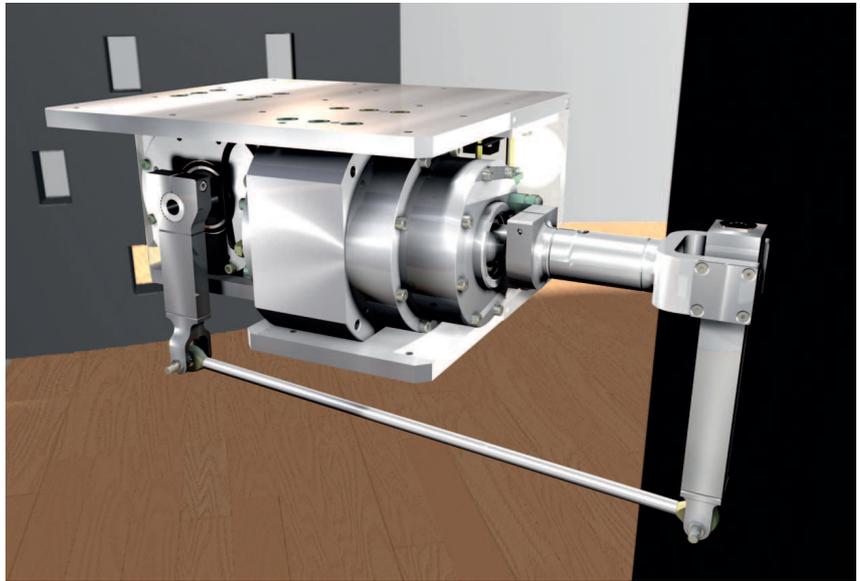
person thus takes up his actual position as if being in the vehicle. The realistic seat position means that the simulator also takes ergonomic influences on the shifting process into consideration.

Real-time simulation software maps the gear shifting. In addition to shifting-specific parameters, the influences of the vehicle on the transmission are also taken into consideration here, for example through the transmission mounting or the side shafts. The shifting forces are calculated in real-time and made tangible on the gearshift lever by means

of special electric motors. The impact of the smallest changes to the computer-assisted parameters is immediately perceptible on the gearshift lever. If what is felt is not what is desired, the shifting forces, paths and geometries can be redefined and optimized in real time at the click of a mouse.

The system developed by Porsche Engineering assists automotive engineers already in the concept phase to define the desired power transmission characteristics. Thus the shifting comfort can be evaluated objectively and reproducibly at an early stage in the project. Furthermore, it is possible in every development phase and under the same framework conditions to check whether the desired shifting characteristics can still be maintained without having to use a prototype transmission.

Based on the the experience gained from a multitude of customer development projects and in-house Porsche applications, this year sees the completion of the second generation of the Porsche shifting force simulator, which has been completed and already been successfully used in sports car development. Thanks to the significantly greater computing power of the new simulator, combined with a newly developed procedure to optimize computing time, it is now possible to run the same models in the classic shifting simulation (offline/ PC) and on the shifting force simulator (real-time hardware). Consequently, high-precision blocking synchronizer models can be used, which were previously only possible in the offline simulation. The effort involved in creating real-time models is also significantly reduced by the act of standardizing the models.



Second generation actuators

However, it was not only the computing power of the real-time unit that was improved. While the actuators of the first generation were designed for comfort shifting, the second generation of the simulator is also capable of generating forces that would only occur with very sporty shifting.

To this end, special rotatory electric motors were used, which were exclusively developed for Porsche Engineering. In the shifting direction, two of these motors are run in parallel in order to be able to supply maximum forces while maintaining a consistently high level of dynamism. In the selection direction, one motor outputs the calculated forces.

All in all, the completely new second generation of the shifting force simulator offers a significantly expanded range of applications. In addition to the adjustment of the engagement force in the shifting direction and the evaluation

of shifting impulses, malfunctions can also be represented with greater accuracy, regardless of whether they involve doubled pressure points or gear clash at low temperatures or are due to vibrations in the drivetrain. In addition to the shifting direction, combined investigations with the selection direction are also possible, for example a study of the influence of various gear selection characteristics and gate contours on the transverse shifting ability. Safety-lock forces can also be felt and adjusted at the touch of a button.

The shifting force simulator offers an advantage in that it is not just finished components that are “brought to life”. In the simulation process it is possible to evaluate ideas and designs, for which only preliminary specification is available at the time. With the simulation system, it is possible to quickly identify promising designs and then focus on the detail design engineering and on the implementation of the technology.