“Steering system tuning on the test bench is firmly integrated in our development process”

At the Hyundai Motor Europe Technical Center (HMETC) in Rüsselsheim, a steering system test bench is utilized in combination with CarMaker to enable the efficient development, pre-application and validation of steering components. We talked to Axel Honisch, Timo Schöning and Alessandro Contini about their experiences with the test bench and virtual test driving.

How can the conflicting priorities between the various markets be described? Are there any differences in terms of steering characteristics?

Honisch: In our company, we know that every market makes different demands on our vehicles. Steering precision is a key prerequisite for the European market. Handling should be agile and offer a good compromise with ride comfort. In the United States – as I see it – it’s necessary for the car to have good straight-line stability and that the steering forces are lower. Straight-line stability must be intuitively retainable without drivers noticing that they have to make any corrections. For Asia, the situation is different again.

What role does the topic of the steering system test bench play in your corporation?

Honisch: In vehicle development, we work together with our Korean development center that controls global development as well. Here in Rüsselsheim, we’re responsible for tuning the systems to suit the European market demands. With our steering system test bench we aim to shorten the development cycles and thus increase the development capacities for the applications of our steering systems.

Is there any interest at the parent corporation in adapting and expanding this technique?

Honisch: We’re pursuing a standardization of our development methods in the corporation, which means that the processes as we develop them in Namyang are transferred to other markets as well. Conversely, techniques developed here may also be used in the operations of the parent corporation.

Schöning: To ensure this, we’re engaged in regular exchange with our colleagues. The team in Korea is already working with a steering system test bench as well in order to be able to fully take advantage of the benefits of virtual testing.

However, the focus of your Korean colleagues in the test bench application varies to some extent from the one here. Can you describe the differences?

Schöning: In Korea, there’s a stronger focus on functional assurance and integration with other electronic systems, so that’s a larger HIL integration test bench there involving more ECUs. Our focus is on the tuning of steering performance in order to optimize the steering feel for the European driver.

Honisch: Even so, there’s a shared further development of these processes in order to satisfy the needs of the diverse markets in the development of performance and the utilization of HIL. This is a continuous element of our workshops that we regularly conduct with our Korean as well as with our American colleagues.

How do you perceive the transformation in the field of vehicle development and what are the implications of topics such as autonomous driving for the corporation and for your own way of working?

Honisch: The technological aspects and the complexity are a great challenge to us. This is a good reason for continuing to expand virtual development and virtual testing in order to be able to take all possible variants into account. The topic of digitization that is moving into all areas is increasingly gaining importance in vehicle development.

What impact does automated driving have on steering?

Honisch: I think that steering performance will be important for autonomous driving as well. Ensuring the interaction of the systems for instance in emergency situations such as evasive maneuvers requires direct steering performance with agile responsiveness. So the development of systems is not made any easier for us, but the emphasis is shifted to other areas to some extent.

Do you personally enjoy driving? Which assistance system is your favorite one?

Honisch: Yes, of course I enjoy driving. That’s why I chose this professional field in which I’ve been working for many years, and developing and driving vehicles is still fun. I welcome all electronic systems that help the customer. I feel that when reflecting about advanced driver assistance systems now this should be done with a view toward the chassis control systems such as ESC or ABS as well. Today, nobody talks about ABS anymore because it’s now taken for granted, but it was one of the first ever assistance systems.

Schöning: Driving has been a passion of mine for as long as I can remember. It was always my goal to work in the automotive industry. I have a strong personal interest particularly in the areas of chassis and steering. The total package of a vehicle simply has to fit and, naturally, all the new systems play a part in this. There are vehicles or driving situations where these systems are helpful and very convenient.

You initially mentioned that it was possible to shorten the development cycles. How did you achieve this?

Schöning: We developed the process together with IPG Automotive and Munich University of Applied Sciences. The idea was to shift software tuning into the virtual world – to the extent that this is possible. We’re able to prepare parameter sets on the test bench and in the simulation in automated mode so that the application engineer subsequently has more time to spend on fine-tuning the real vehicle. In this respect, we’re able to massively enhance the efficiency of the tuning process.

How has the testing of a vehicle changed compared to the past?

Schöning: Subjective tuning and testing still play a decisive role. As long as we have steering feel, it will always play a key role – it ultimately has to support the vehicle’s character and please the driver. However, the fact that the evolution of technology today has almost completely moved away from hydraulic toward electric steering is opening up all-new opportunities. For

one, steering feel can be changed in much faster and simpler ways. For the other, this poses a challenge as well because we still need to keep an eye on natural steering feel and must be careful not to lose track of things in view of the great diversity of variants. Here the test bench and simulation particularly help us achieve this goal.

How do the numerous additional functions in the area of electric power steering (EPS) affect the diversity of variants?

Schöning: Unlike past technology, the steering system today no longer provides the driver strictly with the possibility to set the direction of travel. It is influenced by other systems, such as comfort systems, as well. Keeping a handle on these interactions is a major challenge. This is an area where virtual testing methods are able to assist very efficiently and in the future will become increasingly important to ensuring that all systems smoothly function in concert.

To what extent are real-world prototypes available in the development process and how has availability developed over time?

Honisch: Every company tries to minimize the number of real-world prototypes because this is a major cost item. Virtual testing can support this. The prototypes we need are available to us. Maybe we will no longer need any real-world prototypes anymore in the future but I think that for a solid validation, a real-world vehicle will continue to be required.

So how many variants are there that you test on the steering HIL? Can this be quantified?

Contini: We're able to execute nearly 500 driving maneuvers for diverse vehicle variants and parameter sets per day on the HIL.

In real-world road testing that would be quite a large number, so that means a Design of Experiments (DOE) tool is efficiently utilized?

Schöning: Exactly, the utilization of DOE has many advantages. After all, it's not just a simple automation of all kinds of tests, but a pre-selection of the tests that are necessary in the first place.

Can you estimate how the tests would be accomplished if you didn't use any DOE?

Contini: The driving maneuvers could also be performed manually. In that case, the optimization of objectives would be iterative based on the experience and know-how of the tuner. With DOE this knowledge is documented in a database. This can be accessed again and an optimum compromise between parameters can be found.

Honisch: Subjective tuners use their experience to run the various tests and to optimize the configuration of the system. And the DOE acts in a similar way in pre-selecting meaningful tests before optimizing the system effectively in the desired direction. From this the subjective tuners then receive their hints regarding the parameters that have to be modified. They can subsequently be tested and validated in the real world in order to achieve the desired result.

Now subjective tuners might fear that a method has been developed that will shift some of their work to a machine. Does this technique find favor with them?

Honisch: Yes, it does. After all, the subjective tuners' work is not taken away from them but facilitated.

Contini: I feel that this statement is completely valid. Obviously, you're initially working against some doubts as well – but they're necessary in order to truly confirm the system. We've ultimately reached the point where steering system tuning on the test bench has become firmly integrated in the development process. The subjective tuners recognize the advantages this has and welcome the assistance for instance in being able to reliably cover the diversity of variants. Fine-tuning and evaluation continue to be performed on the real-world vehicle. At the end of the day, the application engineers are responsible for the vehicle characteristics as well. What personally impresses me again and again is how effectively you can subjectively feel what objectively exists.

How exactly are tests run on your test bench?

Schöning: The first question we asked ourselves was: How can we objectify subjective steering feel? Because this is the most important and decisive step in order to even be able to work in the virtual world at all. From this initial investigation we subsequently drew many conclusions and worked out standardized maneuvers that we now test across the entire vehicle speed range. We primarily focus on the range that accounts for 80 to 90% of a normal customer's vehicle use – the range of low lateral accelerations and steering frequencies. Of course we additionally cover high lateral accelerations and fast steering frequencies too.

What speed range are we talking about here?

Schöning: From driving at walking speed all the way to the vehicle's top speed. This is another great advantage of simulation because high speeds cannot always be simply driven as desired in the real world. On the test bench, however, this is possible at any time.

Can you quantify how many additional kilometers or scenarios you achieve due to the utilization of virtual test driving?

Schöning: It's difficult to state a specific number. We're able to run our standard tests even in simple real time about ten times faster on the test bench than on a real-world test track. The reason is that the vehicle doesn't have to be taken to a test area, that it can start immediately and that there's no traffic. In addition, we're not dependent on vehicle availability, weather conditions and proving grounds, so we're able to test a lot of things in advance on the test bench.

You not only apply one vehicle variant but the entire model range. This necessitates building a virtual prototype. How do you accomplish that?

Contini: At the moment, it takes us about two weeks to build a virtual prototype because we need to gather all the requisite data and talk to various departments. I think this process will become more efficient over time. Following the parameterization, the prototype is validated once against dynamic measurements to ensure high simulation quality.

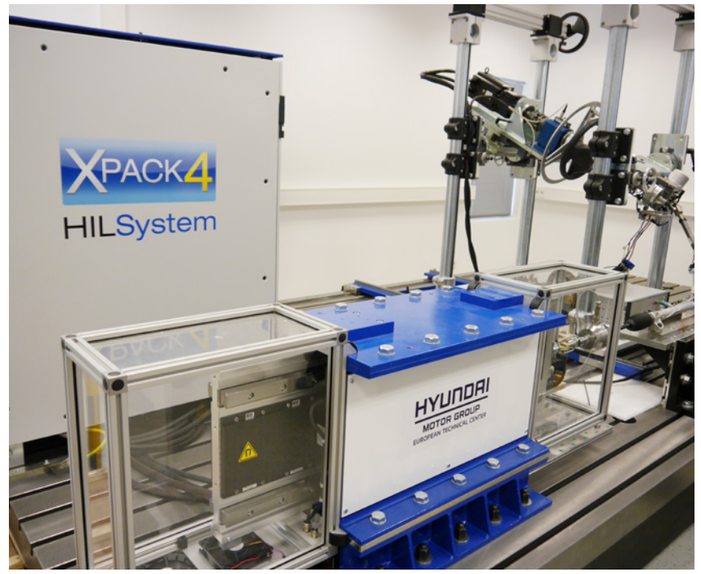
Is there a process in which vehicles are driven in specific maneuvers using respective measuring technology in order to use the data for the subsequent vehicle validation of the virtual prototype?

Schöning: We have already included this in our process. We know exactly that if we want to carry out virtual steering tuning we need to run specific tests at a pre-defined point in time. And they naturally include the KnC tests with dynamic measurements that we perform in-house. The short channels and effective communication between the teams and the team members are very beneficial. In this way, we're able to plan as efficiently as possible. However, such a fast pace is also necessity in this dynamic environment.

The entire steering system has been installed on your test bench. Are the original measuring technology and the parameterization methods and tools utilized as well?

Contini: On the test bench, we use the same tools as in real-world road testing. This is a basic prerequisite for the success of the method because in this way the parameter sets can be transferred directly between the test bench and the vehicle. As a result, the tuning of the steering system technically works exactly as it does in the car except that on the test bench objective goals are directly pursued.

Is the validation performed for all vehicle variants or do you use a basic variant and for instance an additional mass to validate other engines?



Schöning: We build upon the model variant we previously measured. If other weight variants are to be virtually tested we adapt these conditions in the simulation model in advance. If we had to run full tests of all variants this would not be feasible in time. The fact that we're able to very quickly implement these real-world variants with a virtual prototype is another great advantage of CarMaker: that you can simply say this is now the heavier diesel engine with the automatic transmission or this is now the smaller gasoline engine with the manual transmission.

What features of CarMaker have been able to most effectively assist you here?

Contini: The high simulation accuracy ensures high reliability. The reproducibility and front-loading plus the integration of other systems are major benefits as well. We're able to modify the models in the simulation and set up any desired number of variants. This works pretty well. You just have a very large number of options with CarMaker.

How is the exchange with suppliers and other departments?

Schöning: For our work, our steering system supplier was extremely important. The supplier was integrated in the process from the beginning. The exchange is smooth and fast. Obviously, a clear definition of the interfaces is important in this respect as well.

Talking about the benefits of automation: Does it allow you to go to lunch and have a dataset of a vehicle variant automatically pre-applied when you return?

Contini: Exactly. Being able to simply let the simulation run on its own is a great thing. The idea is to have all the variants available. Assuming you've prepared four or five vehicle versions as virtual prototypes, you can vary them so that you'll obtain the required parameter setting for each vehicle and each vehicle variant. For an entire vehicle series, I plan about one day on the test bench until the pre-application of the steering system is good enough for fine-tuning in the real-world road test.

Thank you very much for the interview and for taking the time to talk to us.

Honisch: Thank you, too.