Interview with Eshwar Sondhi
Volvo Cars

“The driving simulator is an integral component of our development process”

Volvo Cars in Gothenburg relies on a driving simulator to test new software and hardware components. Since it allows engineers to subjectively evaluate components’ functionality, the simulator has become an indispensable part of development there. We sat down with Eshwar Sondhi, an analysis engineer in the virtual test environment team, to talk about the role of the driving simulator at Volvo Cars as well as their development process as a whole.

More and more, people expect a certain degree of safety, environmental friendliness and comfort from a car. How do you meet these needs?

Safety is at the center of all of our development activities here at Volvo Cars. Over the past years, we have been working on numerous active safety systems in order to mitigate risks. We also conduct comprehensive testing on the bodyshell of the car to guarantee that it offers the necessary safety. Moreover, we have put strong emphasis on environmental friendliness and sustainability in recent years. These efforts have not been limited to the electrification of the vehicles themselves, but have focused on the entire production cycle. We already use many sustainable materials in our vehicles today, and we have also launched our Recharge line of plug-in hybrid and electric vehicles. Our goal is to become carbon neutral — it may not happen today or tomorrow, but it’s a realistic goal for the near future. We are also constantly working to develop new and improved functions that make our vehicles as user friendly and comfortable as possible.

Has setting up a virtual release process with your suppliers come with any additional benefits in this context?

Yes. Instead of needing to send suppliers real-life prototypes or vehicles in the early project phases, we provide them with virtual prototypes for functionality testing. For us, this means the CarMaker environments. It is cost efficient and aids with error correction and quality improvement. Of course, it’s no secret that not everything works as planned right from the start, but simulation makes it possible to try out different combinations of components, which in turn makes the development process much more flexible.

What challenges did you encounter in setting up this process?

Since we are among the first to establish such a process between the OEM and the supplier, we initially didn’t know exactly what to expect. It was critical that the requirements be clearly defined. Then we had to determine which environment and model types should be used and how complex the models needed to be. Simple models provide few results, but when models are too complex this affects the stability of the environment.

The impact on environment performance and validation was also taken into consideration. What happens, for instance, if you have a non-validated virtual environment and someone asks if they can use it instead of the actual vehicle. You need to have a response to that. Once these aspects were cleared up, we were able to focus on refining the process and making it more stable.

Using simulation makes front-loading possible. In which phase is this the most useful for Volvo Cars?

It is particularly useful for error detection in the early phases. Imagine a graph where time is represented on the x-axis and the number of errors on the y-axis. When simulations are run in earlier stages of development, many errors become apparent early on. Over time, the graph depicts a downward slope, which is exactly how it should be. The ultimate goal is to have a finished vehicle of the highest quality. Without this simulation process, the trajectory of errors would be exactly the opposite.

If we take a look at the V model, it is possible to run a simulation for a different purpose in each stage of development. At the unit test level, HIL tests can be conducted to find out if the subcomponents are working properly. How these interact with other subcomponents can be checked at the next level. And one level higher at the verification/validation level, when the vehicle typically already exists, simulations can serve to complement real-world testing and also help you do more and more in the virtual world. So, simulation is crucial for us at every stage.

What are the greatest challenges of modern HIL testing?

There are many challenges with regard to HIL. For instance, the software is becoming increasingly complex, as are the electrical architecture and the system quality. The HIL setup is based on how complex and user-friendly the system is meant to be as well as its intended purpose. The challenge then lies in finding a balance between the system’s complexity and usability. Stability and user-friendliness are also important aspects.

The fact that the system can be combined with various configurations is very beneficial. HIL is also especially important for safety-critical issues where reaction times are tested, for instance in conjunction with a driver-in-the-loop system that is intended to enable virtual functionality development and testing.

Is the ability to customize a prerequisite for developing a test system?

Our philosophy is that we want the best tool for the particular application, be it a real-time system or a bus simulation system. We believe the suppliers are the experts in this area, since they are the ones developing the products. In terms of our HIL system, customization means that we don’t have a turnkey solution; the supplier provides us with the products that meet our requirements. Open APIs allow us to connect to the system and customize it. We then receive the necessary support from the suppliers for implementing their models in our system.

What must be taken into consideration when creating an open HIL platform?

The most important aspect is the collection of tools. Each element of the setup must be selected carefully. How well the components interact with each other and how easily the HIL platform can be set up are of crucial importance.

Volvo Cars presented a driving simulator for exploratory HIL tests at Apply & Innovate 2018. What developments have occurred in this area since?’

In 2018, we presented exploratory HIL tests with the static (stationary platform) driving simulator. It was an interesting study to see how the strengths of two independent systems could be leveraged for improving, broadening and refining the test scope in order to have a better final product.

Since then, this proved to be quite successful. The logical next step was to have a dynamic (motion platform with nine degrees of freedom) driving

simulator connected as well. This in turn resulted in the use of the 'HIL + Simulator' combination for tests requiring both, dynamics of the car and associated control systems. We are constantly improving the solution and believe this can be a powerful virtual test driving platform encompassing a broader scope.

What role does the driving simulator play in your vehicle development process today?

The driving simulator is an integral component of our development process right from the start. We can use either the static or the dynamic simulator depending on the test purpose. For example, in the concept phases where a car is not yet available for testing, we use the driving simulator to test different designs. You can start with a base concept and then adjust it to test how it would feel in the real world.

We also use the driving simulator to develop control systems so that we can investigate active functions early on and predict how the driver would experience certain changes.

So you don't just use the driving simulator in combination with an HIL?

Most of the time, the HIL system and the simulator are used independently of one another. However, when they are connected you have both a passive chassis as well as the active components built into it. An independent simulator can then be used without HIL for configuring the passive chassis. If both elements are combined, you can also work on the software end of function development and testing. This makes it a very flexible system.

To what extent has using the driving simulator in development simplified your work?

Well personally, my work hasn't gotten any easier (laughs). But for those who actually use the simulator for testing, it helps immensely. Because we create the environment first and then invite the testing team to use it. This gives them an idea of what the functions will be like early on in the concept phase so that they don't need to start from scratch when they sit down in the vehicle. Although it is a driver-in-the-loop system — which still includes the non-linear element of the driver — the environment always remains constant, which isn't the case in poor weather conditions such as when it rains. You usually can't do much then, so the simulator offers a great advantage there.

What are the major advantages of integrating real-world electronic control units into simulated tests?

With in-the-loop integration of the actual ECU, essentially all of the hardware as well as the respective software is available. This makes it possible to feel how a system would react in a real car. This is very helpful for function development, where the driver's subjective experience still plays an important role.

I don't think it's enough to simply show developers a graphical representation of how everything works. It's important to experience how a system works and to know the effect it has on the vehicle level when parameters are adjusted. Even if this could be defined objectively, an important piece would be missing without the subjective aspect, and that is where the driving simulator comes into play. Perhaps not everything can be perfectly represented as it is in the real world, but the driving simulator enables us to identify a certain range instead of an absolute value.

You have taken a multi-tool approach and integrated everything yourselves. In your opinion, what advantages and disadvantages does this entail?

I find that the greatest advantage of a modular platform lies in the potential to integrate different components into the system and to experiment with the combinations. Modules can be removed, added and integrated into the surrounding systems. It is often assumed that integrating components and getting everything up and running at the same time is complicated. But for us, it was pretty simple to start up the system in a timely manner. Even though we set up the system using different parts from different suppliers, we had very few issues.

What impact did the driving simulator have on processes and technology at Volvo Cars?

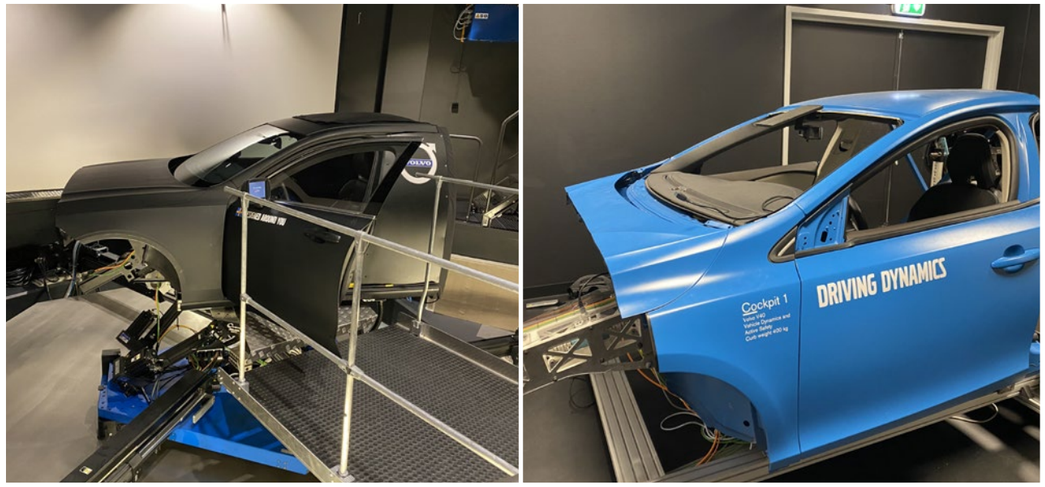
More than anything it helped us save time in development. Being able to gain a subjective feel for a product or design long before it is taken to the roads is also beneficial. Not only does this allow us to work faster, but the quality has also improved. Now that the active systems have been set up in the testing environment, they can undergo testing in much earlier project phases, which offers a great competitive advantage in terms of quality. Another advantage of our simulation-based approach is that it makes it easier to include additional functions. When the environment is available for testing these functions, we can save time, offer a greater range of functions and guarantee a high-quality product.

Have other departments followed in your footsteps and integrated simulation into their workflow to a greater extent, or do they plan to do so?

Yes, definitely. In fact, I don't think we were even the first to have introduced simulation into our workflow. However, we were the ones who introduced CarMaker (laughs). Simulation has played a critical role here at Volvo Cars for quite some time now and has been used extensively at all levels. Now, with CarMaker, virtual test driving is also being conducted with much greater frequency.

Will driving simulators become even more important in multi-domain vehicle development, for example for advanced driver assistance systems and electrification?

Without a doubt — this is just the beginning. The steady increase in ADAS and AD functions makes it more important than ever to be able to recreate a driver's experience behind the wheel. Let's say, for instance, that you've been driving for 20 minutes when we suddenly place an obstacle directly in front of your vehicle. We want to see how you react and how you feel in that moment — and we can do that with a driving simulator. So it's not just about autonomous driving and electrification.



The dynamic driving simulator (black) and the static driving simulator (blue) at Volvo Cars in Gothenburg.

The driving simulator is also useful for testing how subjects react to various HMI design elements. Simulation offers an endless number of possibilities.

Can you give us some insight into the work your department will be conducting in the future and what Volvo Cars has in store in the way of virtual vehicle development?

These kinds of questions tend to get me into trouble (laughs). We are trying to expand on the basis for the simulation. CarMaker's closed-loop environment is hugely beneficial to us. Even without the simulator element — that is, with only a virtual driver — you still have the crucial advantage of virtual test driving, which will only become more important in the coming years. Especially if it is not possible to conduct the test in the actual car in question.In the case of autonomous vehicle prototypes, it could be that legal restrictions prevent field tests from taking place. That's where virtual test driving can really come in useful.

CarMaker is essential for us and is an integral part of our environment — in CAE, HIL and SIL. We will definitely also advocate more strongly for the use of our simulation platform at various levels in order to ensure a flawless end product.

Thank you for this insightful interview. We wish you much success down the road.

My pleasure. It was a privilege to discuss this with you. I look forward to continued positive collaboration going forward and am excited to see what the future holds.