“Cutting-edge simulation technology is the foundation for development and validation across all development phases”

Steffen Schmidt, IPG Automotive GmbH

Vehicle development is becoming ever more complex, particularly due to the growing proportion of software in vehicles. This presents the industry with a variety of challenges. Virtual test driving becomes more crucial and is now regarded as a vital tool for development and testing. Against the background of the company‘s 40th anniversary, President & CEO Steffen Schmidt discusses how IPG Automotive’s industry expertise gained over decades is addressing these challenges and shares his vision for the future of virtual test driving.

Hello Steffen, congratulations on the 40th company anniversary! How would you describe the key qualities that define IPG Automotive as a company?

Steffen: As an owner-managed company, it is in our nature to think and act strategically and long-term. Since our establishment in 1984, we have been synonymous with virtual test driving and virtual vehicle development. As a spin-off of the Karlsruhe Institute of Technology (KIT), we have been deeply committed to research and driven by a strong sense of innovation for decades. That’s one of the reasons why we are still passionate about this, with our Formula CarMaker program being a case in point.

Over the past 40 years, our company has experienced considerable growth and has become established globally. Today, we are in the fortunate position of having various branch offices and subsidiaries around the globe – customer proximity being one of our top priorities.

Here’s what distinguishes us from other companies: We offer bespoke solutions for vehicle development anywhere in the world. If required, our local staff support our customers’ processes, from the initial concept to over-the-air (OTA) updates for vehicles beyond the SOP.

IPG Automotive has repeatedly been recognized for its innovative strength. What does that mean to you?

Steffen: Being voted one of the most innovative medium-sized companies in Germany for the third consecutive time fills me with pride and reaffirms that our philosophy is leading us in the right direction. I want to emphasize that this is a joint effort by the whole team and each team member’s contribution over the years. That’s what has made IPG Automotive so successful.

Where do you see the biggest challenges facing the automotive industry today?

Steffen: The amount of software in vehicles has been skyrocketing – modern vehicles now contain approximately 100 million lines of code. This increases complexity, as the individual systems in software-defined vehicles interact with one another rather than functioning in isolation. We have to be able to control the resulting complexity and networking within the vehicle.

In addition, there has been a growing trend towards OTA updates in recent years. Developing and validating OTA updates at short notice requires extremely agile development processes. Traditional development methods must be adapted.

Where do you see the greatest difficulty?

Steffen: Testing is becoming an almost overwhelming task in the real world. Every day, new functions are developed and existing functions are optimized. Even bug fixes can have undesirable side effects. And last but not least, there is always the risk that parts of the code have not been tested at all. Avoiding bugs completely is practically impossible.

The crucial aspect here is to apply the principles of systems engineering, ensuring that the entire system is considered holistically from the very beginning. If a real-life vehicle is not available, this needs to be done using a virtual full vehicle, which, ideally, can be continuously adapted as we move through the development process. A significant advantage is that test cases and assessment criteria can be reused consistently throughout the entire process.

Software also plays a role in both highly automated and autonomous driving functions. What is the particular challenge here?

Steffen: To ensure the functional safety of software stacks, they must be tested and validated across an extensive range of traffic scenarios and over millions of kilometers, taking into consideration endless factors, down to the weather conditions. Take a camera-based assistance system: the slightest change in the angle of incidence of sunlight can determine whether an obstacle is detected or not.

What’s more, there are many traffic situations that are simply extremely rare in real life, or too dangerous to test on the road. Nevertheless, the system must be able to react properly. These are known as corner cases. It is almost impossible to validate such functions in real-world test driving.

Most software stacks today are built on neural networks, which can be considered a form of artificial intelligence. They are trained using large data sets – either collected from real test drives or generated through environment simulation models. For the training to achieve the desired results, the relevant situations must be statistically well represented in the data set. Software is mostly tested in the laboratory. Parts of the software as well as the system

behavior in the full vehicle are validated using a combination of open-loop and closed-loop tests.

How can simulation and virtual prototypes contribute to this process?

Steffen: Cutting-edge simulation technology is the foundation for development and validation across all development phases. We offer support by providing scalable solutions, such as through cloud computing. This allows users to complete millions of test kilometers automatically and overnight – with full reproducibility. This makes for massive savings and considerably shorter development times.

Another important service we offer is the proof of functional safety. This requires carrying out tests that would be high risk in a real-life scenario. Many tests are so complex, that reproducing them in the real world is difficult. This also applies to NCAP tests, which have become very important for OEMs. As we move towards Euro NCAP 2026, the number of required test variations will increase exponentially, while the rules for passing these tests are becoming more and more extensive. Virtual test driving minimizes risks associated with testing and offers substantial savings potential.

Using simulation has made developers less dependent on the availability of real prototypes; virtual prototypes are used instead. This also promotes sustainability by reducing the need for resources required to produce physical prototypes.

In the context of virtual test driving, the term "vehicle-in-the-loop" is often used. What does that mean?

Steffen: The vehicle-in-the-loop (VIL) test is usually the last step before the real-life vehicle test. A real vehicle is integrated into a virtual environment, complete with road infrastructure and moving traffic, and is then driven on a real test track. During the test drive, human drivers can perceive both the virtual and the real environments, allowing them to simultaneously assess the functions of the test vehicle. This allows for an immersive experience of the simulation, meaning that the VIL method thus provides a link between simulation and real test driving, combining the advantages of both approaches.

To introduce our customers to this concept, we have equipped a demonstration vehicle that allows us to demonstrate the VIL technology on-site. Participants can even take the wheel themselves and experience this method firsthand, often resulting in a genuine "aha" moment for many.

In your opinion, what might an efficient and modern development process look like to address the aforementioned challenges?

Steffen: There is a clear trend towards front-loading, which means that an increasing number of software-in-the-loop (SIL) tests is being conducted early on in the development process. This offers significant advantages, primarily in terms of scalability and substantially reduced costs. Especially when you consider the OTA updates that I mentioned earlier, it is obvious that there is no way around such a test strategy. Otherwise, too much time would elapse between updates, which are typically released to customers within one to three months.

Again, the focus is on the consistent use of system engineering. However, this approach produces a very high number of simulations, especially when it comes to implementing a test strategy that is strongly SIL-based. If there aren't enough experts in simulation available, scalability can quickly suffer. And without scalability, the frontloading test strategy will ultimately fail.

A new product was recently launched to address this issue and facilitate an optimal development process. What was the idea behind this?

Steffen: Before I talk about the product, I would like to give you a bit of an introduction. Right from the start, our goal was clear: Everyone involved in vehicle development needs intuitive and easy access to the simulation environment. In an ideal world, they would use the simulation without even realizing it – for example when tests run automatically in the background.

The product which allows this is our Virtual Vehicle Development Tool Suite, or VIRTO for short. We are very proud to have developed a comprehensive solution from the ground up that ensures the traceability throughout the development and testing processes, and makes simulation accessible to everyone involved – including those without simulation expertise. This significantly reduces silo thinking, improves the organization, optimizes collaboration and ultimately, of course, boosts efficiency. Being able to test new software

Steffen Schmidt in discussion with Henning Kemper (Specialist Editor, IPG Automotive)

code in the full vehicle enables the aforementioned systems engineering right from the outset. And the tests are scalable, both within your own company and beyond.

Put simply, VIRTO covers three basic areas of test driving. The first area is the creation and management of virtual vehicle fleets and test scenarios to enable their testing in test drives. In the second area, the actual simulation of the component under test occurs within in the full vehicle and across selected scenarios. The third area is the automation of the process chain and the subsequent automated results analysis.

Does that mean that VIRTO is a kind of superordinate simulation level?

Steffen: Exactly. VIRTO comprises various apps that facilitate the management, revision and clear presentation of the large volumes of data generated. You don't have to use all of the apps at the same time – quite the opposite. The basic idea is to offer modular apps that optimally complete the customer's existing development process, allowing them to continue using their current solutions while enhancing their capabilities.

What else does IPG Automotive do to assist customers and provide them with ongoing support?

Steffen: Our market is extremely dynamic. That is why we continuously adapt to our customers' needs by working on new solutions with them, drawing on our many years of experience.

To effectively respond to new requirements, we organize an Advisory Board annually following our Open House Germany industry meeting. It provides an opportunity to discuss current needs with customers and partners and explore how we can optimize our products to address them. Customers and partners also have the chance to showcase their latest projects at our international technology conference, Apply & Innovate.

Hearing about the development challenges that our products and solutions can help overcome is always a remarkable experience. We greatly appreciate this exchange.

Let's look into the future: What will vehicle development look like and what can IPG Automotive contribute?

Steffen: The global market is undergoing massive changes with many previously unknown players emerging. To support our customers worldwide, IPG Automotive is also becoming more and more global. Our latest addition is a subsidiary in India.

Certain trends are also emerging, such as the current focus on avoiding recalls and product liability cases, which are often linked to significant and unpredictable costs. It is also essential to continuously track development and test processes, which our Virtual Vehicle Development Tool Suite VIRTO facilitates effectively. Using OTA updates can help reduce recalls, especially in the future. But also today, recalls should be minimized. IPG Automotive can be a reliable partner for this important task.

We aim to further enhance our role as a solution provider and our innovative capabilities to ensure that we can continue offering reliable simulation technology from a single source in the future. To achieve this, we will keep supporting our customers and partners, helping them tackle all forthcoming challenges with our solutions.

Many thanks for these interesting insights and all the best for the next 40 years of IPG Automotive, Steffen!