“Those who combine rider, motorcycle, sensor technology and powertrain early on in the virtual world can validate functions faster.”

Prof. Dr. Jannis Kress, IPG Automotive GmbH

As Product Manager for the two-wheeler sector at IPG Automotive, Prof. Dr. Jannis Kress knows the requirements of the motorcycle industry from practical experience. In this interview, he talks about the specifics of motorcycle simulation in one of the world’s largest two-wheeler markets as well as the growing cost pressure. Furthermore, he explains how MotorcycleMaker supports OEMs and Tier 1 suppliers in validating advanced driver assistance systems, electric powertrains and new vehicle concepts more quickly and reliably.

This interview was conducted by Henning Kemper, Senior Specialist Editor, IPG Automotive GmbH

Could you introduce yourself and your field of work?

Kress: My name is Jannis Kress and I work in Product Management at IPG Automotive. I am responsible for vehicle segments outside of the traditional passenger car sector, ranging from two-wheelers to heavy-duty vehicles and trucks to applications in agriculture and defense.

My area of responsibility also includes the further development of MotorcycleMaker and the support of costumer projects in the two-wheeler industry.

What does vehicle development in the motorcycle industry currently look like?

Kress: There is an extremely wide range here because the industry is evolving in very different ways from a methodological standpoint. In Europe, software-in-the-loop, hardware-in-the-loop and virtual test driving are already firmly established in many areas. In other markets, such as India, the focus still lies on more traditional development methods with physical prototypes, test benches and test tracks.

At the same time, the share of virtual development methods is growing rapidly. They enable an earlier evaluation of functions and variants and making development decisions on a larger data basis.

In your opinion, what is the biggest methodological difference between traditional and virtual development in the motorcycle industry?

Kress: The timing and reliability of decisions. In traditional development processes, many findings only become apparent on the prototype, test bench or test track. Virtual development shifts these discoveries to much earlier stages. Functions, variants and critical driving situations can be tested before hardware is available.

This is particularly valuable in the motorcycle sector because vehicle dynamics, sensor technology and rider interact closely. Roll and pitch motions significantly alter the field of view of camera and radar systems for example. For virtual results to enable reliable development decisions, these boundary conditions need to be modeled realistically.

Why can established test methods from the passenger car sector not simply be applied to motorcycles?

Kress: Because motorcycles and passenger cars are fundamentally different in terms of vehicle dynamics. This may seem obvious at first, but it quickly becomes more tangible in the methodology: Although the sensor technology used in advanced driver assistance systems is similar to that in passenger cars, a camera mounted on a motorcycle moves along with the bike when cornering. This changes the perspective, distances and sensor data. A passenger car setup does not include these effects.

When developing and validating advanced driver assistance systems, also referred to as ARAS (advanced rider assistance systems) in the two-wheeler sector, it is therefore crucial to consider vehicle and sensor motion specifically for motorcycles. Only then can distance and angle detection function reliably. This is not a small detail but a fundamental prerequisite for robust results. That is why MotorcycleMaker is so relevant for advanced driver assistance systems: The simulation platform models these movements realistically.

Which use cases does MotorcycleMaker cover, and which requirements does this imply for the simulation model?

Kress: MotorcycleMaker covers three key areas: vehicle dynamics, powertrain and driver assistance. A robust full-vehicle model is essential here. The basis is a detailed vehicle dynamics model that enables a realistic representation of the motorcycle’s longitudinal and lateral motion. However, the required model quality greatly depends on the use case: A stability test has other requirements than an initial functional test of an advanced driver assistance system.

Sensor models, realistic scenarios, a motorcycle-specific rider model and precise reproduction of the tire also need to be considered. Especially the contact surface and the shift in the center of gravity depending on the lean angle have a strong impact on vehicle handling.

India is one of the largest two-wheeler markets in the world. What does that mean for virtual development and testing?

Kress: India is indeed a key market for two-wheelers, not least because of the enormous production quantity. At the same time, manufacturers and

suppliers on site are increasingly looking into virtualization, control units and model-based development. For us as a solutions provider, this means we must model relevant vehicle types and use cases while also facilitating access to virtual processes. Usability, consulting and confidence in simulation results are therefore as important as the product features.

What do the enormous production quantities mean for development?

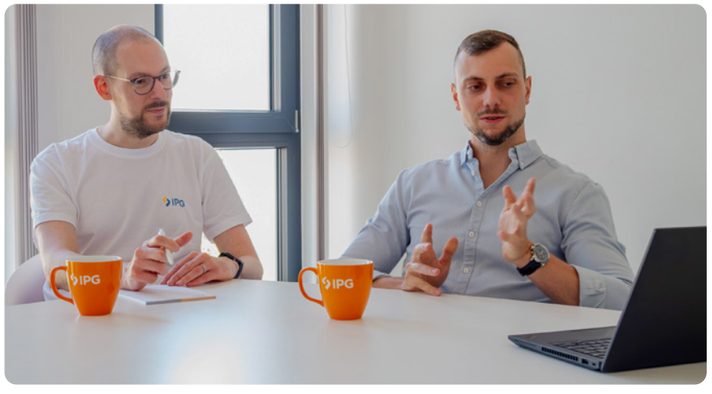
Kress: This is an interesting aspect: The market is extremely price-sensitive. Production quantities are high, but at the same time, the development budgets are usually much smaller than in the passenger car sector and the supplier structures are highly fragmented. As a result, development tools are under considerable pressure: They need to be cost-efficient, scalable and easily accessible. This is where virtualization comes in. Validated models can be reused, variants evaluated faster and the number of expensive prototypes reduced.

Furthermore, this trend is being driven by new regulations, for example the mandatory introduction of ABS in the Indian market, as well as by increasing diversification and electrification. This increases the need for efficient development and validation methods even further.

Where do Europe and India differ most in their development goals?

Kress: Above all, in these very regulations. ABS and controlled brake systems became mandatory much earlier in Europe. In India, such requirements are introduced later, but they have a strong impact due to the size of the market. Another important difference is electrification: In Europe, sustainability is often at the center of attention, whereas in India, the focus lies on the economic advantage of lower operational costs. Therefore, especially in this market, virtual validation of electric powertrains is becoming significantly more important.

How does MotorcycleMaker map such diverse market requirements and use cases within one coherent toolchain?



Prof. Dr. Jannis Kress (right) in conversation with Henning Kemper

Kress: MotorcycleMaker applies a continuous, scalable toolchain to consistently represent different market requirements. The basis for this are decades of expertise in virtualization, for example in the field of brake systems. Hydraulic and control-related aspects are modeled across various simulation stages, all the way up to hardware-in-the-loop.

In the area of electric powertrains, we expanded the simulation platform accordingly, to include electric powertrains, wheel hub motors and belt drives for example. In this way, very different use cases can be represented within one consistent methodology without having to set up a model from scratch for each individual case.

And how does MotorcycleMaker support the implementation of both performance-oriented and cost-optimized vehicle concepts?

Kress: Virtualization offers support on two levels: It reduces development efforts while also enabling earlier and more precise validation of vehicle concepts.

Due to the reduced need for physical prototypes, the reuse of existing models and parallel work of multiple teams significantly shortens development time. This is particularly relevant for cost-optimized concepts.

At the same time, performance-oriented concepts benefit from the early virtual integration of individual components. Suppliers can validate brakes, control units or powertrains early on and hardware-in-the-loop setups as well can be implemented efficiently for motorcycles with few control units. This reduces integration risks and speeds up calibration.

How can you make sure that simulation results enable reliable development decisions?

Kress: Reliable simulation results are created by combining plausible modeling, validation and accurate parameterization. First of all, the simulated behavior must be generally plausible, for example in visualization and measurement curves. Then it must be compared with real-world data. Braking distance, wheel speed, slip and other parameters need to match.

However, confidence is not only built with a tool, but rather with model quality, the underlying measurement data and the close methodological coordination with the customer. This is often an iterative process, but that is exactly what makes the results reliable in the end.

How can methodological knowledge be used for different vehicle variants?

Kress: An accurately parameterized model can be reused very efficiently for variants and derivatives. Not every parameter can be transferred directly, but the underlying modeling methodology remains the same.

One example is the rotational inertia of a wheel which is relevant for ABS, tire contact and acceleration behavior. Once the method for parameter identification is applied correctly, different vehicle variants can be parameterized and validated faster based on it.

Which trends will shape two-wheeler development in the upcoming years?

Kress: Two trends stand out: the increasing electrification and more individual mobility on two wheels. The importance of e-bikes, e-scooters, scooters and light motorcycles continues to grow in many markets. Small and lightweight vehicles are particularly easy to electrify. Battery improvements will amplify this trend.

At the same time, there is a growing demand for safety systems such as radar, warning functions, emergency braking assistance, cornering ABS and, in future, active steering functions.

Does this also include systems that actively engage in vehicle dynamics?

Kress: In terms of longitudinal dynamics, systems such as emergency brake assist (EBA) and adaptive cruise control (ACC) are already standard on high-end motorcycles. Research is furthermore working on electric steering assist systems that actively engage in lateral dynamics. This is especially challenging for motorcycles because the rider is an integral part of the control loop. An unexpected evasive maneuver can quickly become critical.

This is why such functions must be evaluated and validated in controlled virtual scenarios before real-world tests are reasonable and safe.

How can such an evasive steering assist system be designed safely for a motorcycle?

Kress: An evasive steering assist system is much more complex in motorcycles than in passenger cars. The system must detect the environment and, at the same time, consider the current state of the rider, since seating position, weight distribution and reaction impact vehicle dynamics directly.

For this reason, the early warning of the rider before an intervention occurs plays a major role. Emergency braking and evasive steering functions always require an interaction between rider, vehicle and assistance system. Simulation helps to evaluate and validate this interaction early on.

In the end, what does this mean for the virtual development of two-wheelers?

Kress: The development of two-wheelers is becoming more complex, safety-critical and software-driven. This is precisely why simulation is evolving from a supporting tool into a crucial element of the development process. Those who combine rider, motorcycle, sensor technology and powertrain early on in the virtual world can validate functions faster, identify risks sooner and develop variants more profitably.

This is particularly relevant for markets such as India. In addition to the technical performance, scalability, cost-effectiveness and confidence in the method are decisive here.

Thank you very much for the interesting insights!