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The Predictive Chassis: ZF Vehicle Motion Control and Sensor Systems create a smooth ride into the future

- **ZF is combining active damping, braking, and steering systems to create the Flying Carpet 2.0**
- **Predictive chassis with a comprehensive range of sensors and smart control algorithms**
- **ZF is enhancing ride comfort and safety – decisive factors for automated driving**

Friedrichshafen/Klettwitz (Germany). ZF is combining its comprehensive Vehicle Motion Control portfolio to create an innovative chassis concept. The predictive chassis brings the well-being of the occupants center stage: The Flying Carpet 2.0 helps liberate them from unpleasant vehicle movements and predictively helps to smooth out bends, bumps in the road, and potholes. This integrated system links advanced sensors, a smart control unit, and intelligent actuators that lay essential groundwork for the automated vehicles of the future.

Concentrating on work, reading, or watching a film in the car may have been technically possible, but still inconceivable to many people. Unwanted car body movements caused by potholes, bumps or bends: If people are not paying attention to road and traffic conditions, every chassis movement is potentially a disruptive factor in comfort. One of the decisive benefits of fully autonomous vehicles is that people can use the time they spend in them productively on their laptop, or to relax. “When developing concepts for fully automated and autonomous driving, the chassis has a key role to play”, explains Dr. Christoph Elbers, Vice President Car Chassis Technology Development at ZF. “With our Flying Carpet 2.0, we have devised a chassis concept that is capable of controlling virtually all longitudinal, transverse and vertical movements of the vehicle.” True to its name, the Flying Carpet 2.0 helps



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reduce the sensation from potholes, bumps in the road, tight bends, or abrupt braking maneuvers.

Full control over all vehicle movements

The technical basis for this is the intelligent combination of various active and semi-active systems that predictively iron out adverse movements of the vehicle body. At the heart of this is the sMOTION fully active damping system that uses four actuators to adapt the suspension movements of each individual wheel according to the driving situation and road surface features.

Unlike conventional dampers, the sMOTION actuators respond to incoming stimuli by doing more than just controlling hydraulic resistance levels. Instead, they have a very compact, external electric motor and pump unit with integrated electronics that works as a bi-directional actuator. These units can elevate wheels upward together or push them downwards, individually and actively. When cornering, for example, the two inner wheels can be retracted and the outer ones extended so that the passenger car remains virtually horizontal. sMOTION helps counteract the pitching, rolling, and lifting movements that can occur when accelerating, braking, steering, or when driving over bumps in the road.

To maximize ride comfort for the occupants, the Flying Carpet 2.0 concept also includes the AKC active rear axle steering system (Active Kinematics Control) to enhance safety, dynamics, and maneuverability. At low vehicle speeds, this makes it easier to maneuver by steering the rear axle in the opposing direction to the front wheels. If the vehicle is moving faster, the system steers the front and rear wheels in the same direction to provide greater directional stability. For example, when used in conjunction with sMOTION, AKC prevents back end power slides on tight bends. Supplemented by ZF's steer-by-wire power steering system and active brake system IBC (Integrated Brake Control), the combination of these four integral chassis components makes it possible to optimize nearly every driving situation.



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Smart control unit links sensors and actuators

The cubiX control system is the central network for this smart chassis technology: The feedback control algorithm links and coordinates the active and semi-active actuators. This scalable system is based on a modular design that enables it to be adapted to suit the requirements of virtually every automotive manufacturer. "We supply all chassis components from a single source: active damping, front and rear axle steering, and the brakes. That places us in the unique position of being able to match the control of these components by algorithm in an ideal manner, combining them to form a predictive and responsive system. The system integration and smart, connected mechatronic systems make the vehicle fit for the autonomous urban traffic of the future", explains Dr. Elbers. Optimum networking of the individual actuators results in new functions that increase not only comfort but also the dynamics and safety of the vehicle.

The control unit receives the data from a set of sensors on each wheel. This set is comprised of an accelerometer on the axle above the actuator and a height sensor. In conjunction with camera systems, a vehicle equipped with Flying Carpet 2.0 can detect irregularities in advance and can also detect obstacles and objects like road traffic signs. Accordingly, the actuators can also prepare for forthcoming movements. And when leaving residential areas, the car automatically switches to sports performance or comfort mode depending on the driver's preferences.

Caption

Relaxed on the road: With the concept of Flying Carpet 2.0, ZF has devised a chassis concept that is capable of controlling virtually all longitudinal, transverse and vertical movements of the vehicle.

Image: ZF



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#MobilityLifeBalance

For most of us, mobility originally meant personal, self-determined freedom. More recently, due to congestion, emissions, accidents, and a lack of availability, it can now be an ever more present cause of stress. It is becoming more and more challenging to determine the best solution for each individual among the range of mobility solutions currently available. ZF is highlighting this challenge with its **#MobilityLifeBalance** campaign and featuring its range of solutions that contribute to a better and more sustainable mobility offering. The objective is to enable clean, safe mobility that is automated, comfortable, and affordable. For virtually everyone, everywhere.

Find out more about the topic through the **#MobilityLifeBalance** hashtag in social media, or online at <http://www.mobilitylifebalance.com>.

ZF Friedrichshafen AG

ZF is a global technology company and supplies systems for passenger cars, commercial vehicles and industrial technology, enabling the next generation of mobility. With its comprehensive technology portfolio, the company offers integrated solutions for established vehicle manufacturers, mobility providers and start-up companies in the fields of transportation and mobility. ZF continually enhances its systems in the areas of digital connectivity and automation in order to allow vehicles to see, think and act.

In 2018, ZF achieved sales of €36.9 billion. The company has a global workforce of 149,000 with approximately 230 locations in 40 countries. ZF invests over six percent of its sales in research and development annually.

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