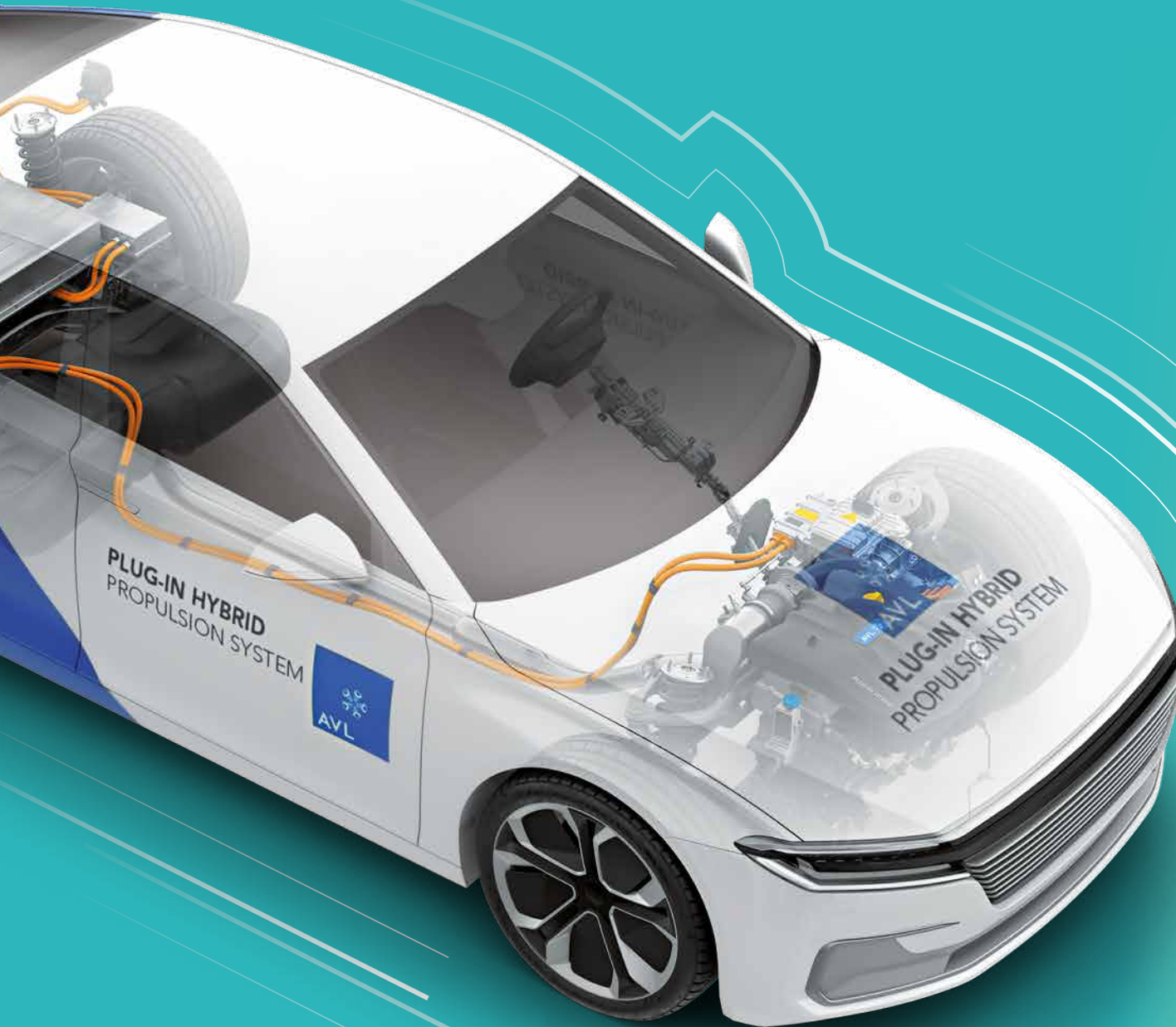




## AVL Vehicle

# Engineering for Next Generation Vehicles







## AVL AS YOUR PARTNER FOR FUTURE VEHICLE SOLUTIONS

The automotive industry is facing several challenges, including decarbonization, new energy carriers, enhanced driving comfort, automated driving and digitalization. But AVL is helping the entire automotive industry as it moves into a new era of mobility. Whether it's passenger cars or commercial and agriculture vehicles, by balancing existing and new technologies with customer and consumer expectations in mind, AVL is your preferred partner. AVL offers a broad set of solutions for the entire

development process, from portfolio and product definition to the ideation phase and serial production. Our services cover future vehicle architectures as well as platform solutions. We also develop and integrate new powertrains and energy carriers, electric / electronics, chassis, and thermal and advanced driver assistance systems.

To successfully position vehicles in a targeted market segment and meet customers' demands during vehicle

development, we rely on approved engineering competences, functional development and attribute engineering. We balance and optimize overall goals at vehicle level. This includes advanced virtual development methodologies and tools along with next-level testbed and measurement devices. We include connectivity solutions for automated vehicles as well.

Our methodologies and tools enable short time to market while meeting cost and quality targets at a low development risk.

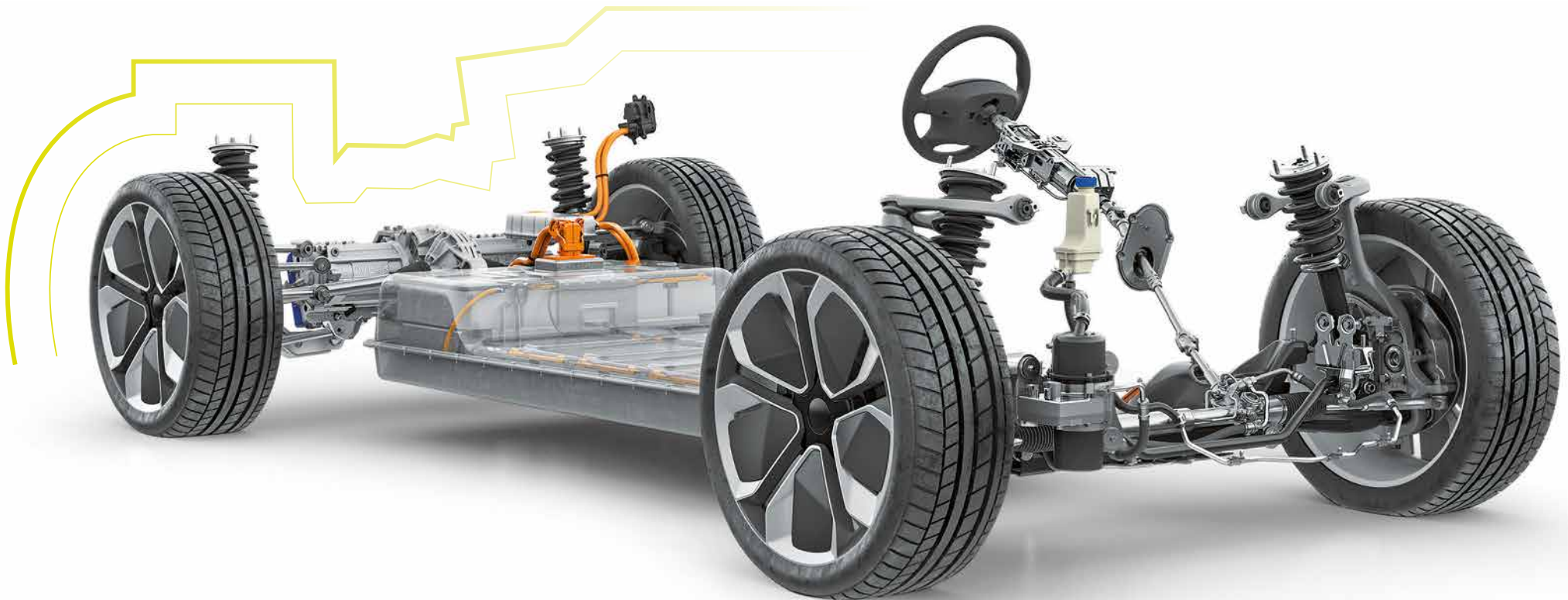
At the leading edge of innovation, our R&D activities identify the solutions to tomorrow's challenges for sustainable mobility solutions. The results of R&D projects are qualified and used to develop future-proof vehicles according to our customers' requests.

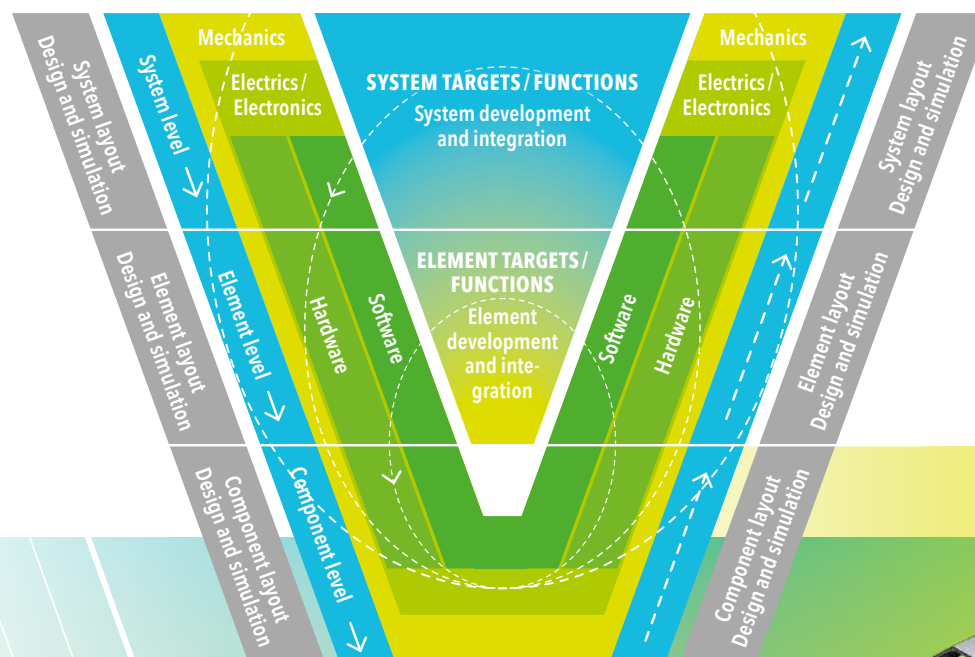
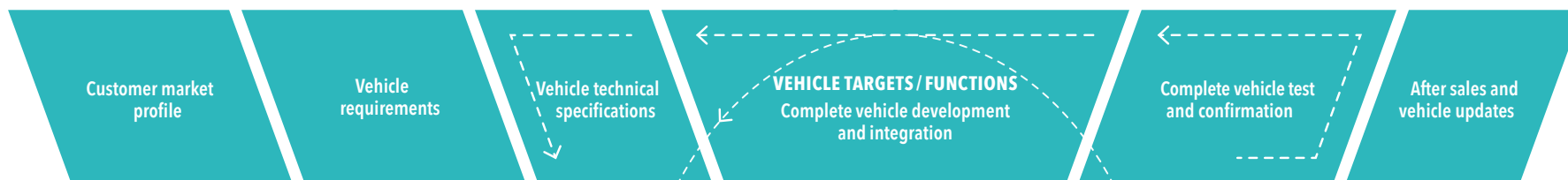
# Advanced Vehicle and Platform Development

On point function-based vehicle development that meets quality, time and cost targets

## A COMPREHENSIVE SERVICE OFFERING

Together with engineering partners, AVL offers SOP development from initial target definition to final assembly. This includes supplier selection and qualification, supply chain definition and monitoring as well as production engineering.





Right from the start, our engineering services and products address our customers' needs. The development process is tailored to our customers' milestones, which lets us reduce costs and save valuable time while constructing high quality vehicle architectures.



# Vehicle System Development

Innovative solutions across all vehicle systems





The technical complexity of a complete vehicle and its subsystems is rapidly increasing. All subsystems now interact with each other, including powertrain, electrics and electronics, thermal systems, chassis, body and driving assistance systems, infotainment and HMI. AVL's tailored development process is designed to handle this growing complexity.

AVL solutions meet engineering, manufacturing, assembly, quality and cost targets and are sustainable for two or more life cycles. Complete vehicle functions define both vehicle systems' and subsystems' specifications, meaning we take interactions into account.

### OUR OFFERING

Together with engineering partners, we offer a wide range of services within the vehicle area.

- Module and platform strategies
- Connectivity solutions
- Ergonomics and roominess optimization
- Vehicle, system and subsystem cost engineering and product cost optimization
- Manufacturing and assembly engineering
- Supplier qualification and supply chain management
- Quality assessment, optimization and monitoring for vehicle product quality, in-service quality, development quality and supplier quality
- Perceived quality optimization
- Production process optimization
- Assembly process optimization

We offer these services for the fields of electrics/electronics, chassis, powertrain, body, advanced driver assistance systems and thermal management and HVAC for passenger cars, trucks, busses and agriculture vehicles.

### INVESTING IN INNOVATION

For us, investing in R&D is essential for creating new innovative solutions. Low risk in series vehicle development is based on our commitment to solving problems. Our product development process is customized to your requirements and milestones and aligns with your specific time schedules.

### WHY AVL?

- Global service and development partner with full on-site support
- Functional oriented development
- Approved engineering competence
- Maximum customer focus with aligned competences and processes
- Virtual development that fulfills functional goals
- Broad partnering network

# Vehicle Function Development and Functional Integration

From target definition to the complete vehicle level



Vehicle



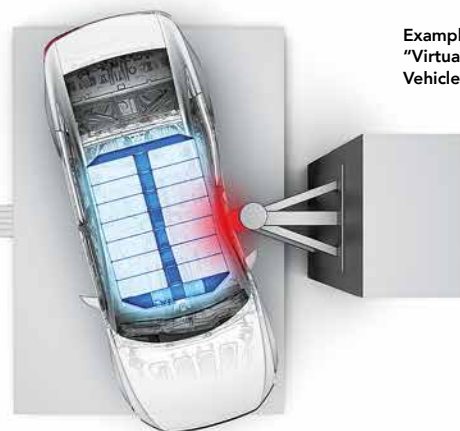
Battery



Module



Cell



Example of functional development:  
"Virtual Safety Assessment from  
Vehicle to Cell Level"

Developing vehicle functions with a focus on individual components and systems is no longer an efficient approach to meet actual automotive requirements. Functions are more and more linked across systems inside and outside of the vehicle, which means a holistic development approach is required. At AVL, our functional development approach is geared towards eliminating these issues from the very start of the process.

Our goal is to ensure high product maturity at the earliest possible development stage. That's why we developed models of subsystems that are not purely focused on components, such as Human Machine Interface HMI, ergonomics and comfort, or cab climatization and HVAC. We recognize that fuel consumption is not only linked to the efficiency of the powertrain, which is why we take all vehicle influences – including driver requests and behavior – into account.

We develop new vehicles with a focus on functionality, from target definition to evaluation. By using an approach where we look at the complete vehicle, we are able to ensure perfect vehicle functionality to fully optimize individual components.

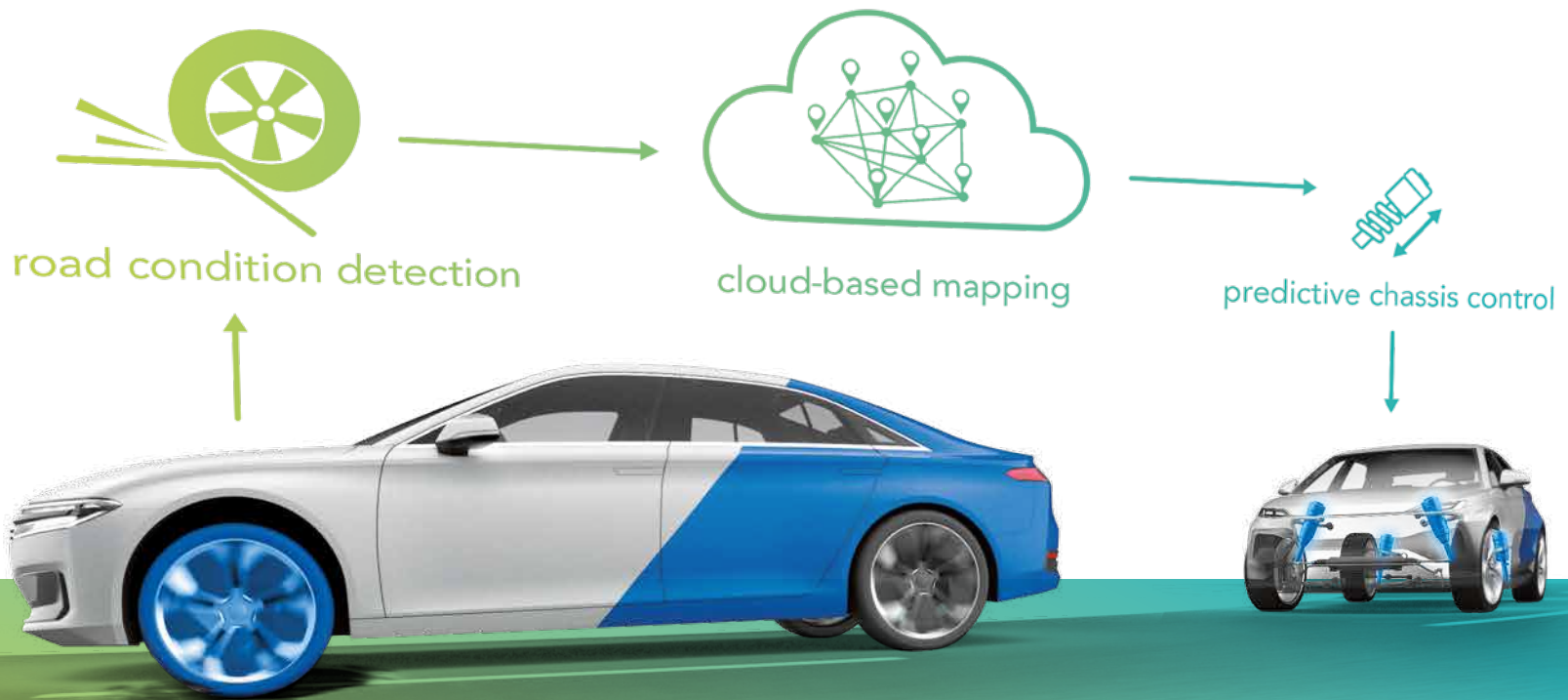
## HIGHER FUNCTIONALITY

The increased complexity in vehicle systems has challenged us to move away from a purely component and system approach. Today, development tasks focus on fulfilling all vehicle function requirements. Therefore, we focus on a systems engineering, multi-disciplinary functional development approach. By including functionality early in the process and understanding the vehicle functionalities as a whole, we bring solutions to life that would not have been possible before. Questions like:

How does the dashboard color influence the roominess? How to link a driver's perception of vehicle acceleration to NVH while shifting gears? This cross-functional approach lets us design dimensions for sub-systems and components in the most efficient way in a high quality manner. This lets us reduce costs in purchasing, manufacturing and vehicle production.

Early in the product development process, our knowledge of functional interactions and their relations to vehicle attributes saves you from unpleasant surprises shortly before SOP.





Example of functional development:  
"Predictive Chassis Control"

# Vehicle Targets and Attributes

Enhance customer experience with targeted system design

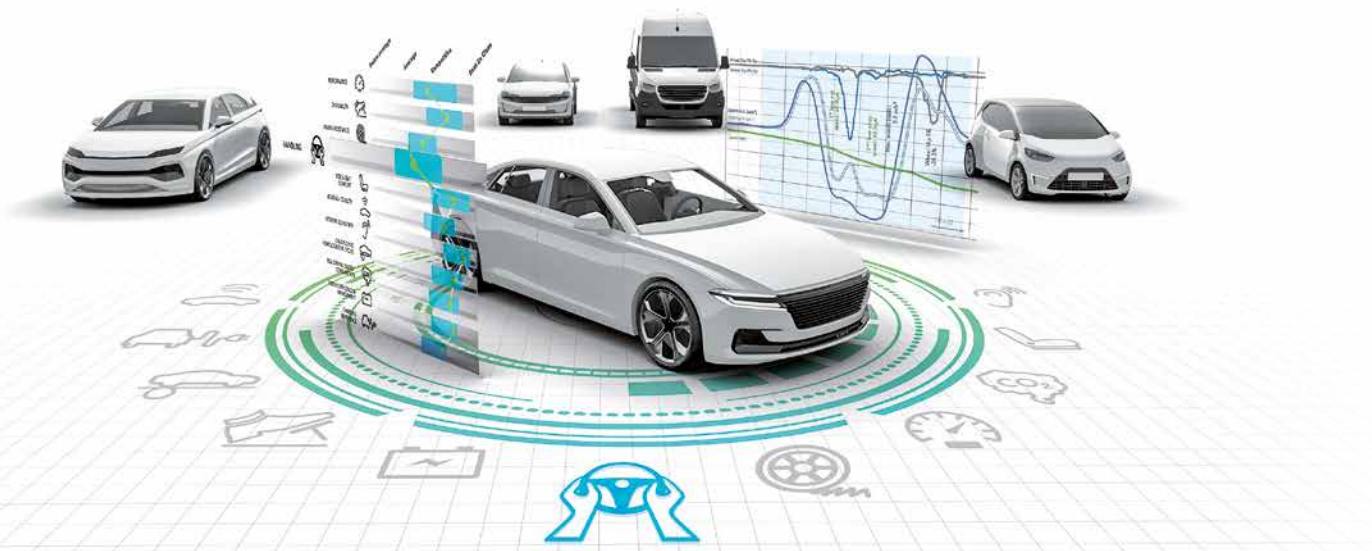
Stricter regulations as well as consumer demands for more options have become more prevalent – meaning that, among other things, powertrains now come in an array of configurations with varying vehicle architectures, each created with the goal of reaching zero impact emissions. To address the increased complexity that comes along with this, we design and optimize vehicle architectures, systems and subsystems to be the solid basis for optimized vehicles.

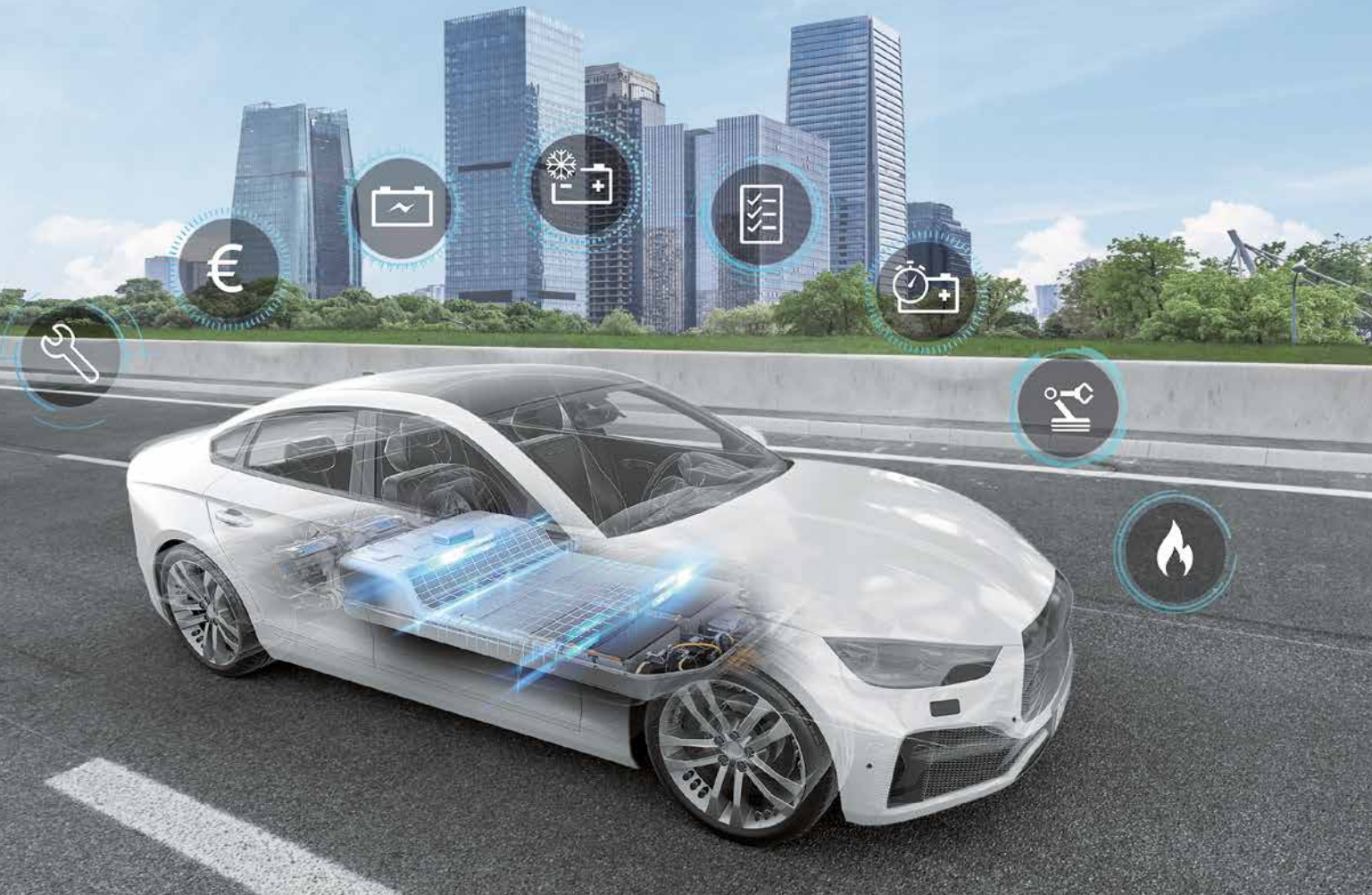
## ATTRIBUTE ENGINEERING

We use the AVL Attribute Engineering Process to balance the desired specifications of the vehicle. This incorporates characteristics such as performance, driveability, ride and handling, interior sound, ergonomics, thermal management, thermal comfort, energy management, range, safety and connectivity. We also consider geometric and operation relevant characteristics such as Human

Machine Interface HMI, ergonomics, space and operation. We use mathematical models of the subsystems to balance functions for an optimized driver experience. AVL Attribute Engineering is based on functional vehicle development to achieve best-in-class energy consumption, driving behavior, roominess and seating comfort. Connectivity is related to the functions of the interior, such as the pre-adjustment of the driver seat and mirrors. HMI plays a major role in customer acceptance, and all vehicle characteristics must meet cost and quality targets in production and assembly.

Based on the requirements, vehicle functions define components, subsystems and trade-offs of vehicle systems. Our systems engineering approach lets us look at the vehicle with a holistic point of view. We strive to achieve the optimal balance between your requested vehicle attributes while meeting cost, durability and timing targets.





### THE AVL SOLUTION FOLLOWS A HOLISTIC APPROACH

The AVL Design and Validation Plan (DVP) documents all specific vehicle tests. This DVP is continually developed through virtual and physical validation. We use our internal databases to analyze existing characteristics on the vehicle and system level and can then simulate the effects of the systems and components that have not yet been installed. This lets us objectively assess the vehicle at a very early stage. We are able to identify potential conflicts long before the actual prototype is built. This helps you make informed decisions about the necessary trade-offs between technology, cost and vehicle market positioning. With our deep know-how and state-of-the-art tools, we balance the contradicting effects of vehicle attributes and characteristics to fulfill legislative requirements and ensure that your vehicle has its own distinctive DNA.



