1.2 BASICS OF VEHICLE PERFORMANCE

What is vehicle performance?

Vehicle performance is the study of the motion of a vehicle. The motion of any vehicle depends upon all the forces and moments that act upon it. These forces and moments, for the most part are caused by interaction of the vehicle with the surrounding medium(s) such as air or water (e.g. fluid static and dynamic forces), gravitational attraction (gravity forces), Earth's surface (support, ground, or landing gear forces), and on-board energy consuming devices such as rocket, turbojet, piston engine and propellers (propulsion forces). Consequently, in order to fully understand the performance problem, it is necessary to study and, in some way, characterize these interacting forces.

Generally speaking, **the performance of a vehicle can be evaluated using following indicators**: the maximal speed that can be reached, the accelerating time from zero to a certain speed, the maximal climbing angle, the mileage in a certain condition and the hydrogen consumption in a specific cycle.

The attributes of vehicle performance engineering

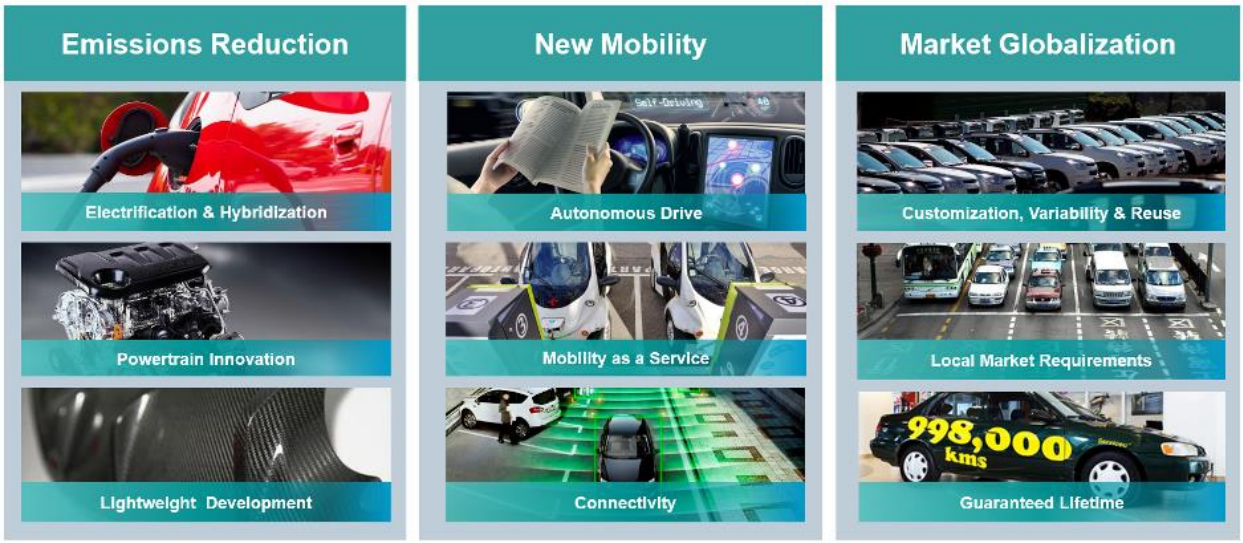
Some of the domains to be tested and analysed as part of the vehicle performance attributes include:

- Fuel economy & emissions
- Thermal and energy management
- NVH and acoustics, pass-by-noise regulation
- Durability
- Drivability

- Driving dynamics
- Integrated safety
- Aerodynamic performance
- Water management

All these attributes must intersect with the evolution of manufacturing by aligning with Industry 4.0. To achieve this, you must focus on frontloading design decisions using digitalization for faster turnaround time.

Let's start out by looking at some key trends in ground transportation which make product innovation critical to remain competitive.



First, the recent Paris agreement was signed by over 190 countries committing to reversing GHG emissions. About quarter of the emissions come from the transport industry, and without changes in transportation, this reverse trend will not occur. Stricter regulations are planned well into the future, making it challenge for new competitive vehicle designs.

Conventional combustion engines alone will not be able to achieve the future emission levels. By optimizing performance of the current combustion engines, we may be able to achieve target goals for the next generation vehicles. But to go beyond those limits, new innovate ideas need to be implemented to achieve future regulations.

One key, disruptive technology that will help meet those goals is vehicle electrification. In the near future, this will be growth in Hybrid electric vehicles, but by 2025 there will be regions shifting to purely electric vehicles. This new technology brings new complexity into the design process, further challenging engineers.

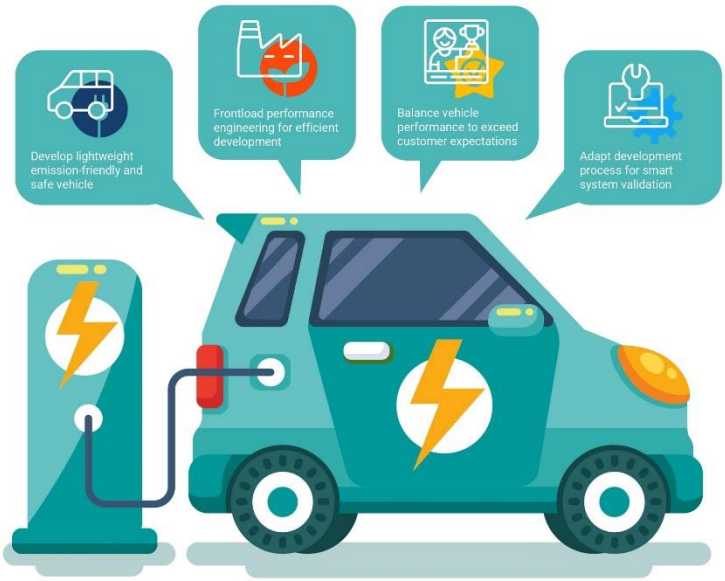
Simultaneously as we need to incorporate new, innovative ideas, engineers need to bring these concepts to the market quickly, while still reducing the cost to be competitive.

It is a challenging market today in the automotive industry.

Performance engineering departments in the automotive industry are confronted with many different challenges:

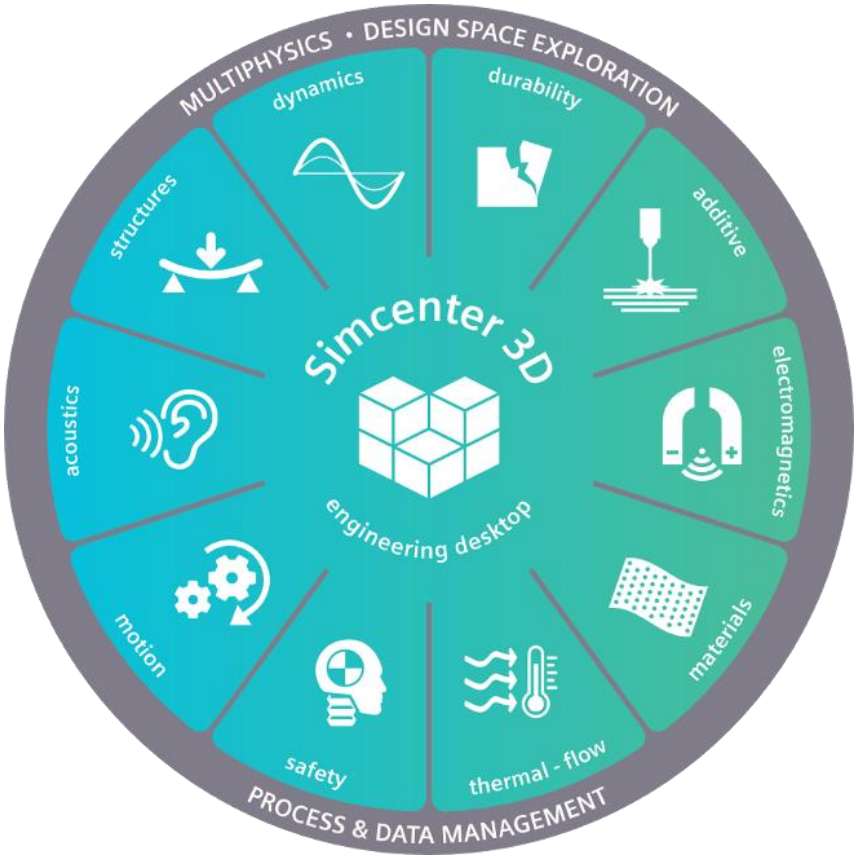
- There is the program pressure on emission friendly, lightweight and safe vehicles – with the strong trend of electrification and autonomous development
- Frontloading performance engineering remains essential to support more efficient development for the many vehicle & architecture variants coming to market

- At the same time, all of the different performances need to be balanced in order to meet requirements for customer brand experience
- On top – the growing amount of ECU, controls, systems and sensors (AV/EV context) challenge the industry for more system driven development.



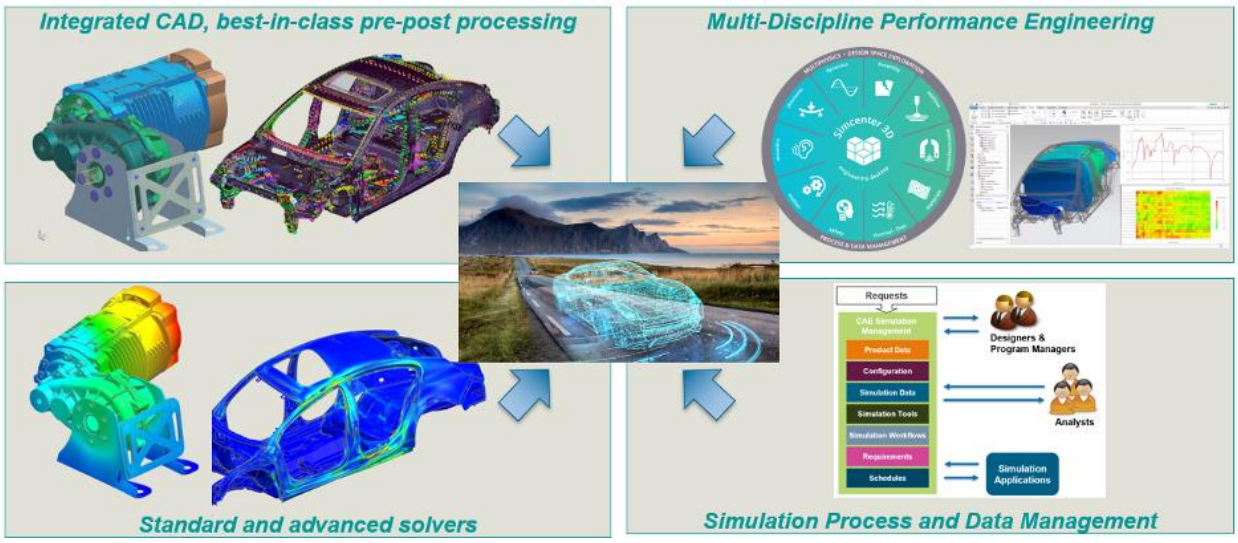
Technologies like simulation, 3D printing and digital twin are recognizable innovations in manufacturing. Moreover, the automotive industry is no exception to implementing these technologies into their vehicle performance engineering.

Simcenter 3D - The most comprehensive, fully-integrated 3D CAE solution

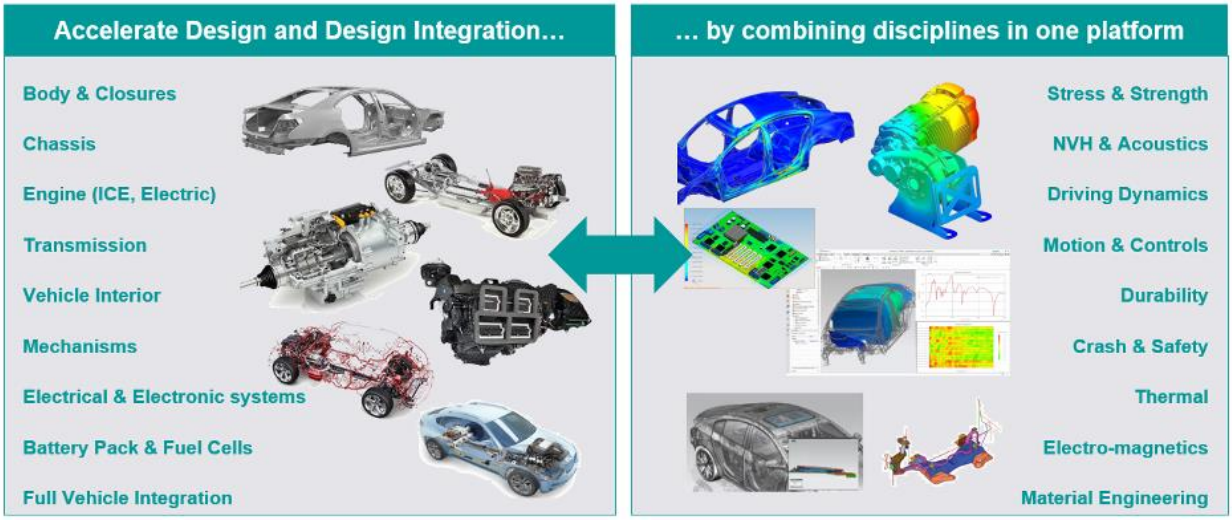


Advantages of using Simcenter 3D

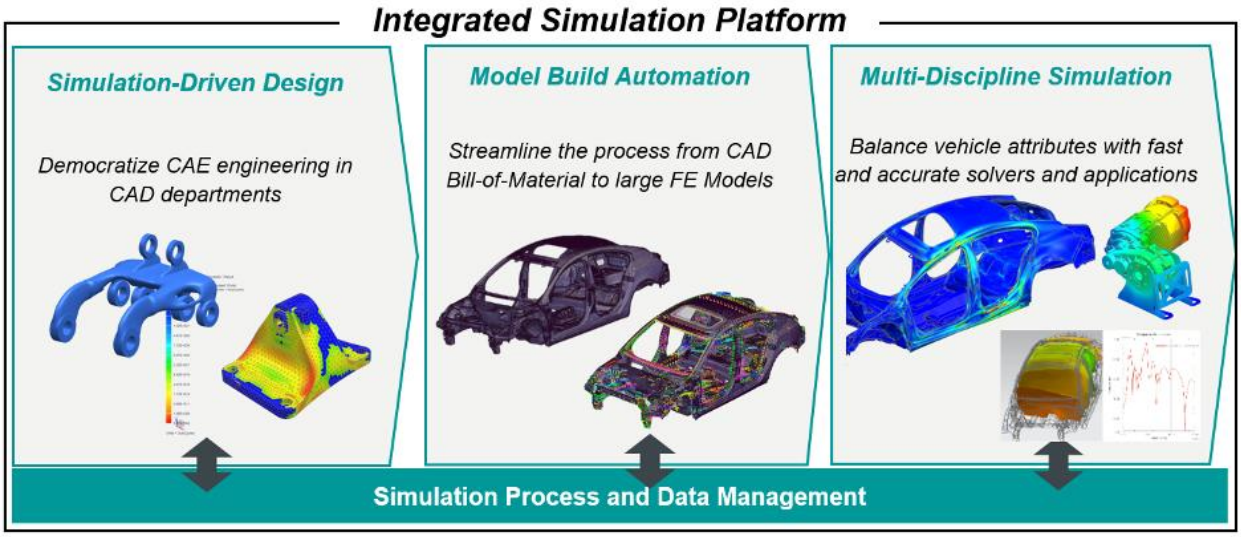
Leveraging expertise in design, simulation and data management



Achieve Excellence in cross-domain engineering



Deliver Insights Earlier



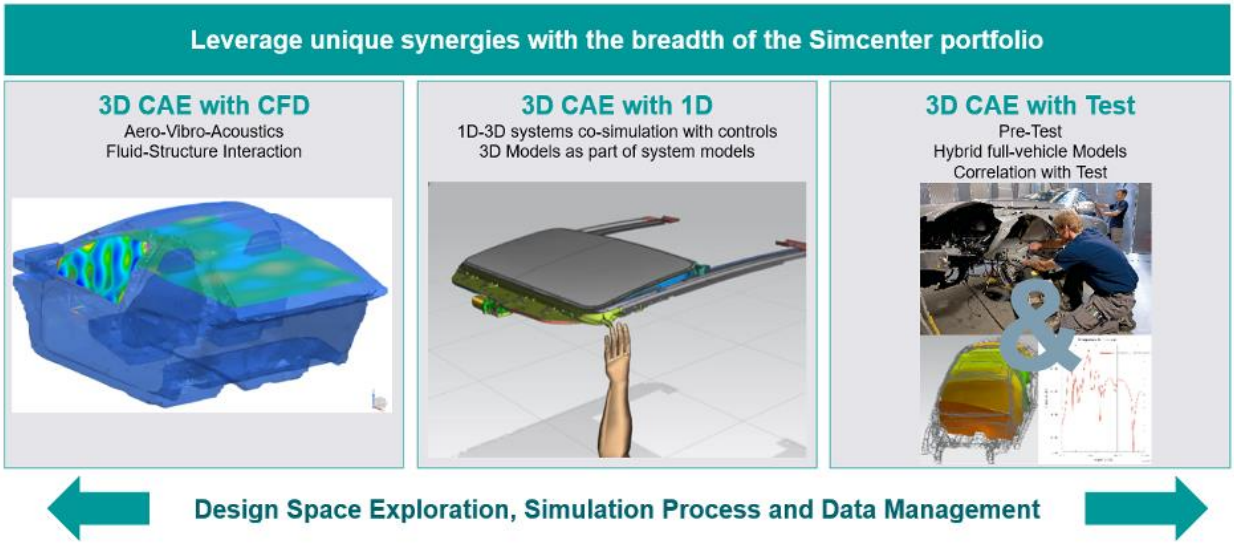
First stage of this end-to-end solution is Simulation Driven Design: The idea behind this is that Simulation must drive design. At this very early stage of the CAE process, components of complex assemblies must already be optimal. These optimal configurations can be obtained with simulation, even if CAD experts are not CAE experts.

Second stage is Model Build Automation: Select components defined in Design, generate application-specific mesh, build models, build connections, in an automated way.

Last stage is Multi-Discipline Simulation. CAE analysts must be able to evaluate, optimize and update designs when needed.

As different engineers, departments, or sometimes companies, are typically involved in these 3 steps, Simulation Process and Data Management is the way to increase the efficiency of communication between design engineers, CAE generalists, CAE experts, such that everyone remains up to date with components designs, CAE process, results, material data, configurations, tests results, requirements and so on… For example, if a CAE specialist detects a design issue, the proposed update and feedback can be efficiently sent back to the complete organization.

Going beyond 3D CAE



This solution is proposed in one integrated simulation platform, which makes a clear difference in process efficiency.

Some of the factors that influence the design for vehicle performance:

- The use of the automobile: some cars are required only for local driving; these cars may be capable of achieving good fuel economy on short trips, but they may be less comfortable to drive at high speeds. A sports car, built for speed, will have enhanced steering and handling abilities, but requires a stronger engine, more fuel, and a more sophisticated suspension system. Yet, an automobile must also be flexible enough to perform in every situation and use.
- The requirements for pollution-control components
- Safety features: affecting everything from the braking and steering systems to the materials used to construct the body. The design of the body must incorporate standards of safety, size and weight, aerodynamics or ways to reduce the friction of airflow, and appearance.

Successfully handling today's vehicle design challenges, such as balancing fuel economy and energy efficiency with performance, requires innovative designs that are explored digitally and confirmed physically.

Emissions reduction, new mobility as well as market globalization have changed the way manufacturers design, engineer and produce vehicles. The race to develop driverless cars is on, and automakers must also focus on developing low-emission vehicles that deliver competitive performance to ensure their brand image in the global marketplace. Vehicle performance engineering departments have to support the vehicle program and vehicle platform managers with simulation and test-based verification and validation in various stages of the vehicle development, from early

program to prototype and pre-production sign-off for vehicle driving experience performances.

Siemens Digital Industries Software supports these engineering departments with a model-based development approach fully capable of handling a mechatronic system’s complexity. Our multi-attribute solutions allow engineers to explore digitally and confirm physically a vehicle that balances all of these performance considerations.

By offering a wide range of simulation and testing solutions, as well as engineering services, ETS Solutions together with Siemens Digital Industries Software helps you solve difficult design decisions. The combined leverage of test and simulation to support performance engineering and mechatronic system validation brings on the concept of the digital twin - best of class modeling, best of class testing or combination there-off - which is a key enabler to delivering solutions to frontload performance engineering and design right the first time.