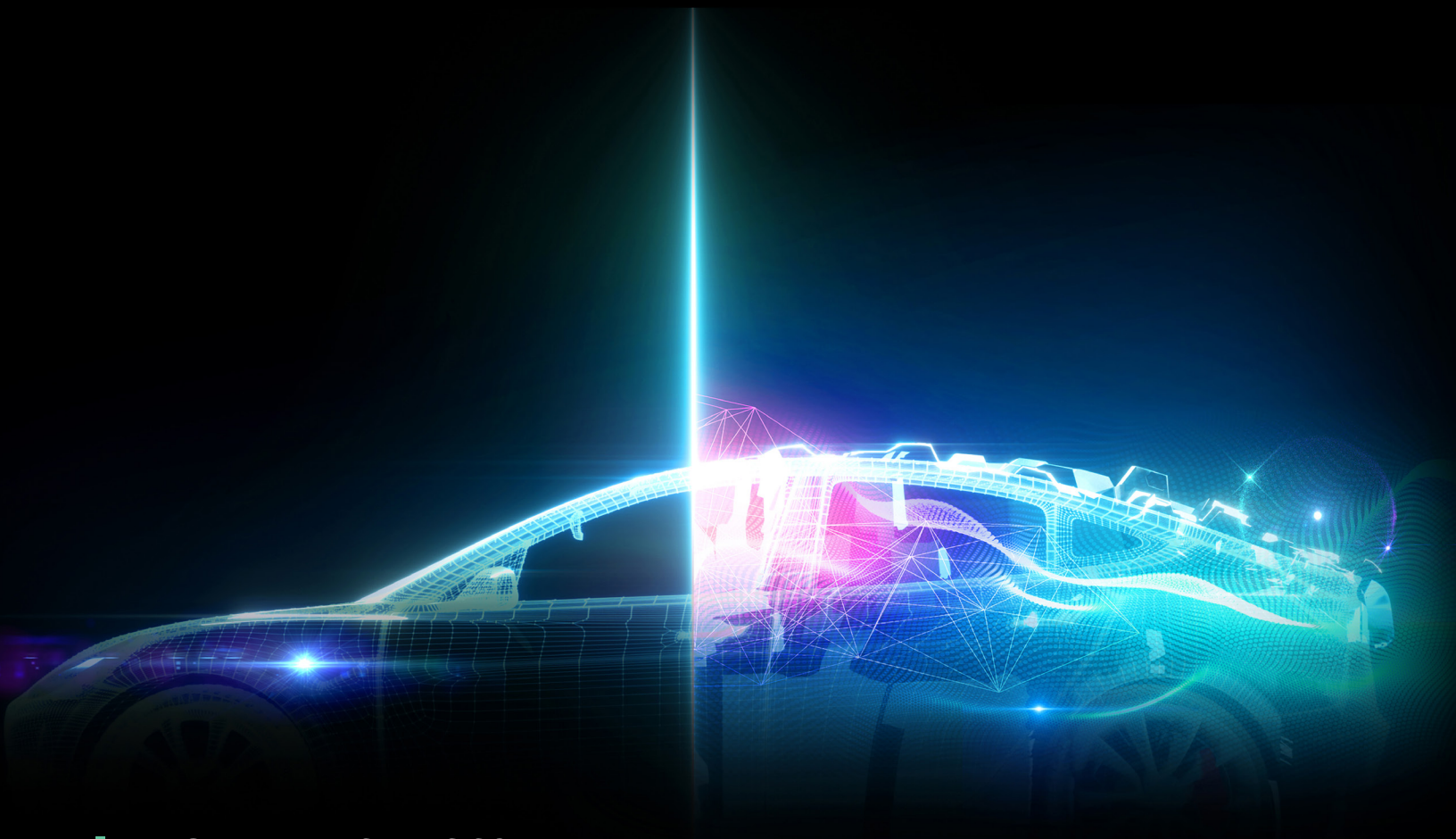
SIEMENS



DIGITAL INDUSTRIES SOFTWARE

Vehicle performance engineering

The role of collaboration and integration in improving the vehicle of the future

siemens.com/software

Modern **vehicle demands**

Modern vehicle demands, both electric and traditional, force manufacturers to accelerate their development processes.

Now, instead of producing two or three models each year, many are looking to double this rate or more. Keeping up with an increased production schedule while maintaining profitability is a serious challenge. Costs of components, such as electric batteries, may be coming down, but companies are struggling to make profits. A recent McKinsey survey from September 2020 found only 18 percent of electric vehicle (EV) manufacturers expected a profit margin above $3,000 per vehicle. More than 50 percent expected a profit margin of less than $1,000 per vehicle. Simply cutting costs isn't enough. Manufacturers need to streamline their development processes so they can improve the performance of vehicles and reduce development times. But what exactly needs to be changed, and how can customers integrate these changes into existing business models?

Simpler vehicles, **more complex development**

The newest vehicles being produced today, especially electric ones, are simpler than ever before. They have fewer moving parts and individual components, meaning less can go wrong. This is ideal for consumers but introduces new challenges for manufacturers.

To improve the efficiency and performance of electric vehicles, the inverter, motor and gearbox are now typically all put into one container. Different performance areas such as thermal management, durability and noise, vibration and harshness (NVH) are now much more closely linked. Electronics, electromagnetic and mechanical specialists can no longer exist in separate teams with minimal interaction. With this kind of complexity and the interconnectivity of components, software engineers must be able to work much more closely together because their components can have a far greater influence on the performance of each other.

Isolated working **costs time and money**

With traditional vehicle development, different engineering specialisms only come together at certain milestones during a project. This worked well enough for a long time, but as the demand for more models in a shorter timeframe has increased, it's become clear that it is far from optimum. Working in isolation like this leads to major redesigns and delays – something that could be absorbed by manufacturers producing only one or two new models per year but is too inefficient for those needing to increase their output. The design team can avoid major redesigns by collaborating earlier and more regularly throughout a project, saving both time and money. But how can these separate disciplines work effectively together from start to finish?

Simulation enables **collaboration and integration**

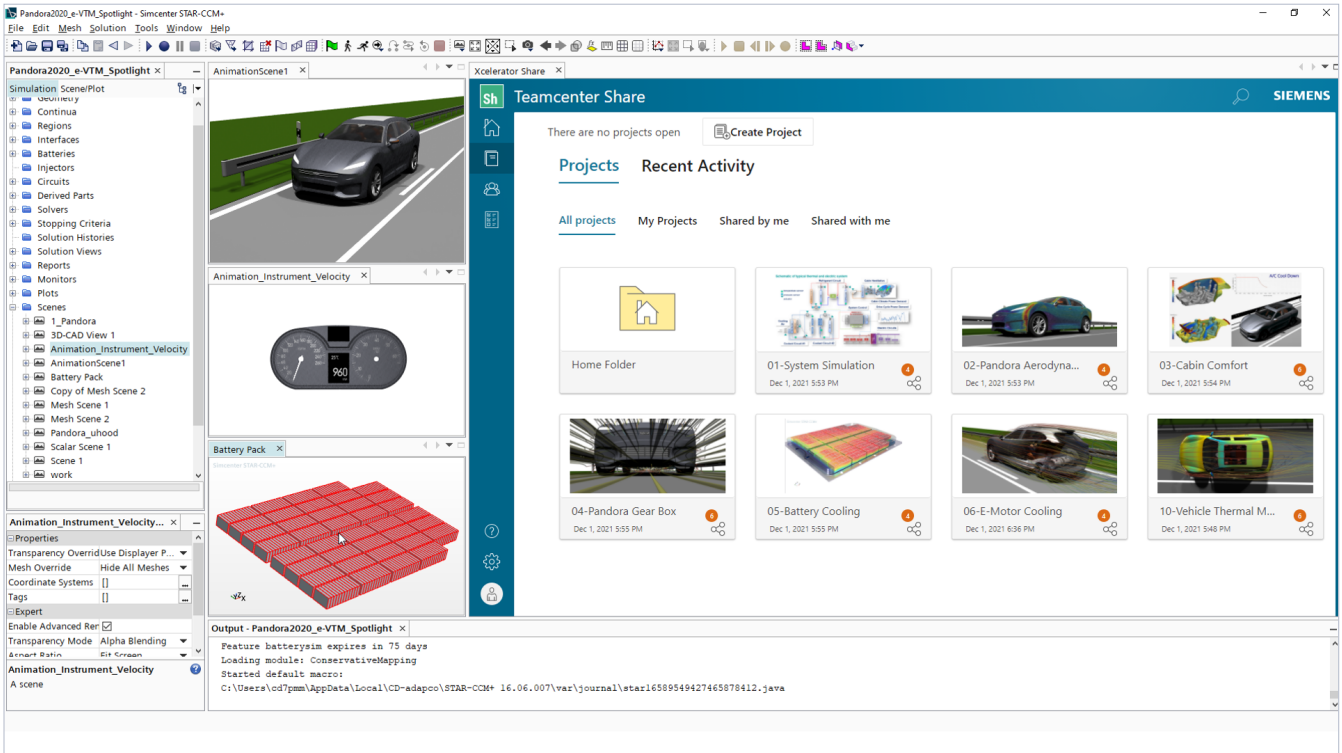
Building more physical prototypes would simply add more costs and inefficiencies to a project. With accurate simulations, teams can easily share with each other as they focus on their areas of responsibility. By producing a comprehensive digital twin, engineers can understand exactly how their components will perform whenintegrated with others to ensure that even the first prototype works as planned.

Siemens Xcelerator is our open, digital business platform that assists teams with their digital transformation. Siemens Xcelerator consists of a comprehensive and curated software portfolio including IT-enabled hardware and services; an ever-expanding ecosystem of partners; and a marketplace to explore, educate, share and purchase products, solutions and services within a community of customers, partners and developers. Siemens Xcelerator as a Service (XaaS) on AWS Cloud makes the portfolio more accessible, scalable and flexible. XaaS helps teams of all sizes collaborate securely with stakeholders, including designers, managers, test engineers, suppliers and customers with appropriate access control.

Each specialist can immediately see when another has changed the design of a component and how it will affect theirs. Instead of waiting for the next project milestone to discover what performance issues have transpired, they can immediately react and work with their colleagues to find the best design solutions for the overall optimization of the vehicle.

A key element of Siemens Xcelerator is the Simcenter™ software solutions portfolio. This is a comprehensive platform that combines simulation with testing tools and services for performance engineering. Using Simcenter helps automotive engineers model, gain insight and optimize the physical behavior of all elements of the vehicle. This includes systems development, thermal management, comfort, electromagnetics and integration and more.

The solutions integrated into the Simcenter environment help users facilitate a scalable modeling approach from component level to vehicle integration and from low-to high-fidelity representations. Using Simcenter can help engineers support all development phases from early concept, trade-off studies and detailed design to the verification phase, covering all physics and disciplines involved and fully underpinning the digital twin/digital thread paradigm.



Engineering teams from different countries work jointly to develop an electric vehicle. Project members can view and mark up designs, share simulation templates and review simulation results using any device.

It can be a real engineering challenge to find the right balance between conflicting functional performance characteristics.

Vehicle integration and **performance balancing**

Once assembled, vehicle subsystems are in constant dynamic interaction with each other. Vehicles have a host of performance requirements that can cause conflicts between subsystems. To minimize these conflicts and avoid late, costly design issues, it's important to evaluate as many vehicle attributes as possible at the earliest stage. This includes everything from driving range and fuel or energy consumption to driving dynamics, comfort and NVH performance.

To effectively integrate systems and subsystems on the full vehicle level and front-load design decisions, engineers need to integrate different methodologies. Using Simcenter allows them to integrate all relevant analysis technologies into one comprehensive solution. By using the established strengths of testing and simulation methods, customers no longer draw conclusions manually by looking at analysis results from different tools. Customers can view all the data in one place, reducing potential issues at the start of the development process and enabling the optimum design of each subsystem.

It can be a real engineering challenge to find the right balance between often conflicting functional performance characteristics. Multi-attribute balancing includes optimizing performances in an integrated approach, helping and accelerating innovation while minimizing any trouble downstream. This ensures all the other teams have instant access to this modification when somebody modifies the design or there's a new iteration.

Teams can save time and promote innovation by collaborating seamlessly on one platform, rather than being separated in silos or using different software. Working closer together can help each team simulate at a system level to ensure the assembly of a well-balanced car.

For example, employing this approach to balance NVH with vehicle ride and handling means the body design can be optimized for all attributes at the same time using innovative body stiffness simulation methodologies. There is no longer a need for a back-and-forth between teams as they make design changes in one place rather than on separate systems.

Model-based **system engineering**

Along with simulation, model-based system engineering (MBSE) is key to modern vehicle performance engineering (VPE). Although it is a relatively new concept used in the automotive industry, MBSE can be traced back to NASA and the early days of the space program when it was used to help thousands of engineers collaborate to build safe and reliable rockets to get astronauts into space and to the moon. By incorporating modular design, engineers can re-use elements rather than having to start from scratch with each new vehicle. They can combine individual design models to form the basis of any new project. New development is only needed for additional or improved functionality that wasn't previously available. Combined with the frontloading of simulations, MBSE helps the team make many design decisions as early as possible, resulting in a better product that is completed sooner at a lower cost.

Using artificial intelligence to **improve autonomous driving**

The role of artificial intelligence (AI) in simulation is growing rapidly. AI is used in the latest simulation software to train a neural network to extract data from virtual sensors in the most efficient way possible. In autonomous driving development, AI is used extensively to determine the perception and control algorithms. Engineers can create an environment via testing and simulation and use AI to validate different scenarios, significantly speeding up the process of developing the optimum systems.

Simulation and testing **in harmony**

A combination of simulation, testing, MBSE and AI is the key to the future of vehicle performance engineering.

Simulation alone won't produce the results manufacturers need. Testing still has a crucial part to play, but now in a much more efficient manner. Instead of running simulation and testing separately, they are now brought together into the same environment to perform an analysis that previously wasn't possible. Modern technology allows users to run simulations in real-time alongside physical components so engineers can better understand the overall performance of a vehicle during the development process.

This combination of simulation, testing, MBSE and AI is the key to the future of vehicle performance engineering. Together they promote close collaboration between engineering teams to make modern vehicle production efficient and profitable. Successfully integrating these into development processes will help manufacturers increase the quality and quantity of their output, ensuring they remain competitive now and in the future.

Siemens Digital Industries Software helps organizations of all sizes digitally transform using software, hardware and services from the Siemens Xcelerator business platform. Siemens' software and the comprehensive digital twin enable companies to optimize their design, engineering and manufacturing processes to turn today's ideas into the sustainable products of the future. From chips to entire systems, from product to process, across all industries, Siemens Digital Industries Software – Accelerating transformation.

Americas: 1 800 498 5351

EMEA: 00 800 70002222

Asia-Pacific: 001 800 03061910

For additional numbers, click here.

84420-D6 6/23 A