SIEMENS

Accelerate innovation

as a sustainable
Digital Enterprise

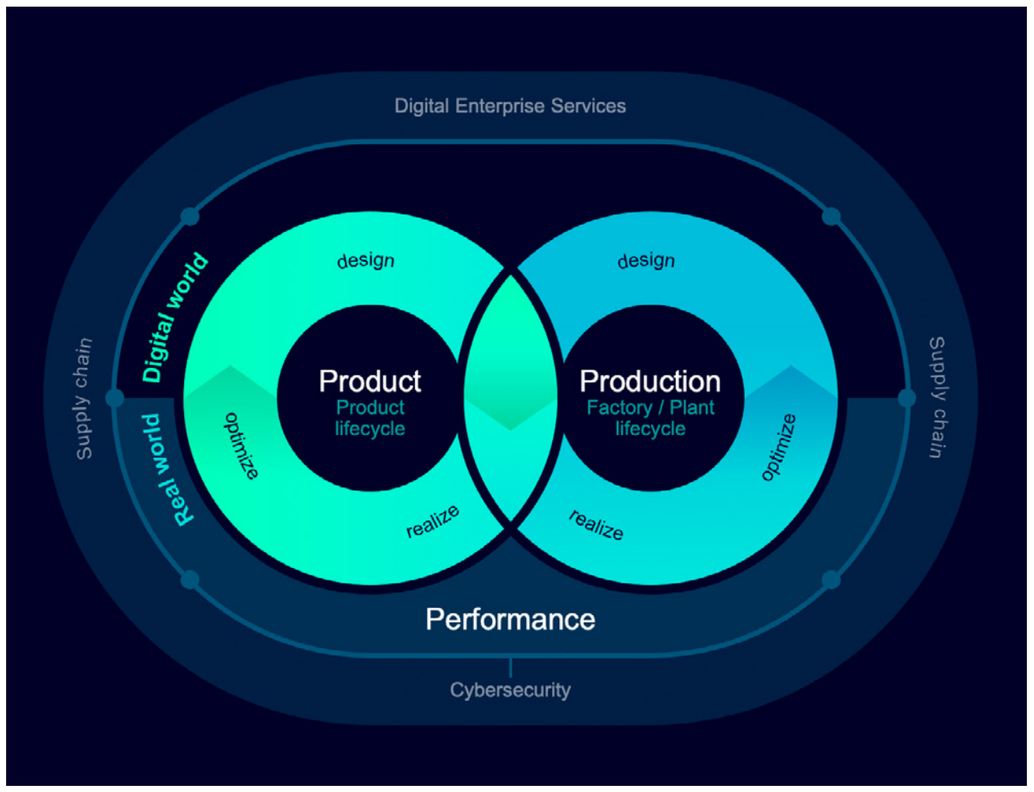
Accelerate your digital transformation in the automotive industry

Several major trends are currently reshaping the automotive industry, including electrified mobility, additional sustainability regulations, changing investor expectations, and the ongoing push for connected and autonomous vehicles. To stay competitive, companies must innovate and adapt their entire value chain – from design and production to use – as well as their supply chains.

The key to meeting today's and tomorrow's challenges is an intelligent combination of automation and digitalization. By combining the real and digital worlds, companies can transform into sustainable Digital Enterprises that can adapt to evolving market demands and regulations while maintaining competitiveness, innovation, and profitability.

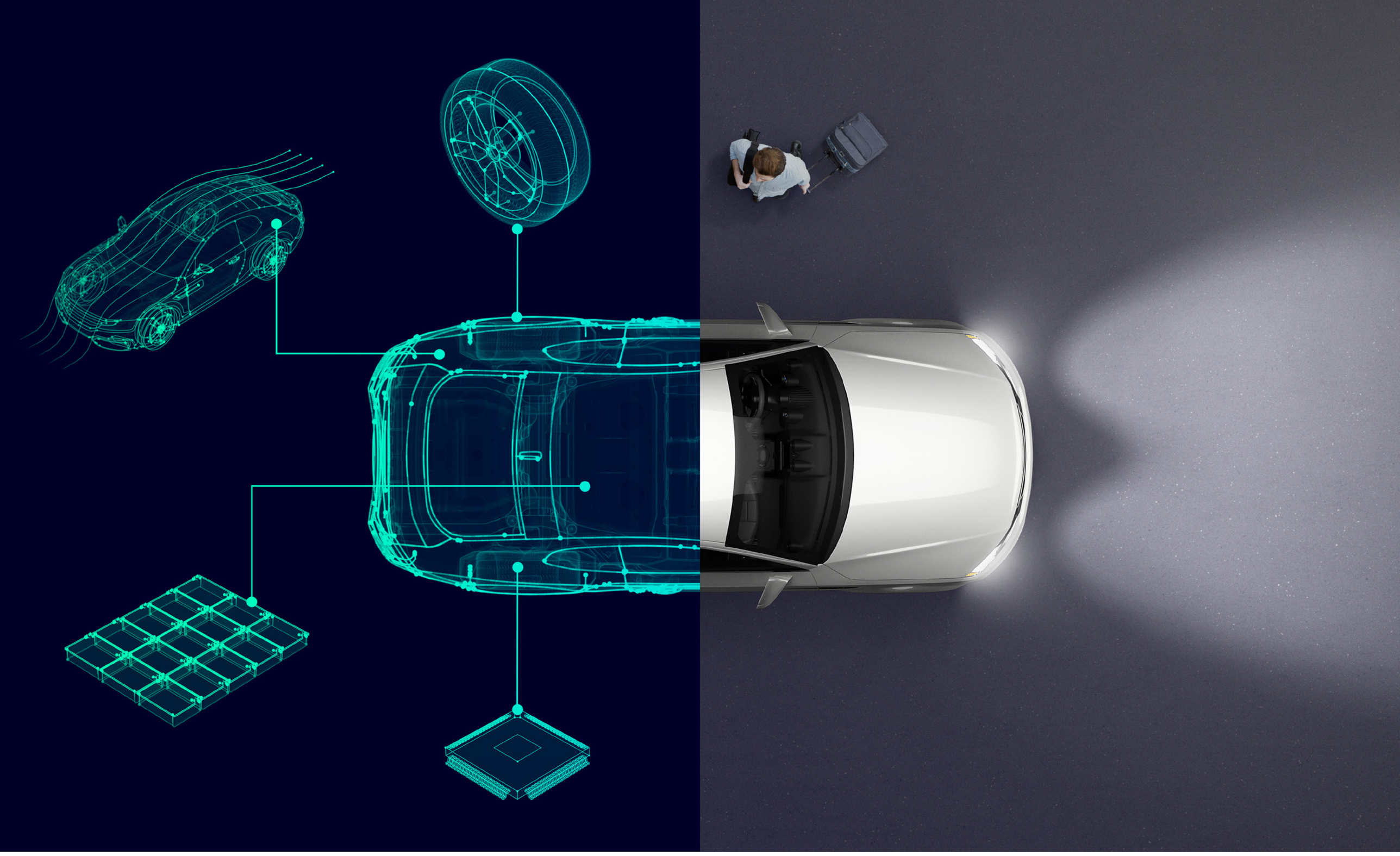
Learn more about automotive product development and automotive production.

Digital Enterprise: Siemens' unique approach of combining the real and digital worlds and integrating product and production lifecycles, including supply chains.



Become a sustainable Digital Enterprise faster

With Siemens Xcelerator, our easily accessible, flexible, and open digital business platform, we support our customers in managing complexity by enabling rapid progress across the product and production lifecycle and supply chain. The ability to design, manufacture and deliver products faster translates directly into competitive advantage. With this holistic and end-to-end approach to digital transformation, we help our customers realize their sustainable Digital Enterprise faster and transform their everyday business.



Accelerate the development of sustainable, software-defined vehicles

Successful automotive development starts with a change in mindset – from hardware-first to software-first. Automakers need modular architectures, powerful development platforms, and agile, software-driven workflows. Model-based systems engineering is essential, while Digital Twins and simulation reduce risk and accelerate innovation. Most importantly, an open ecosystem fosters collaboration and scalability.

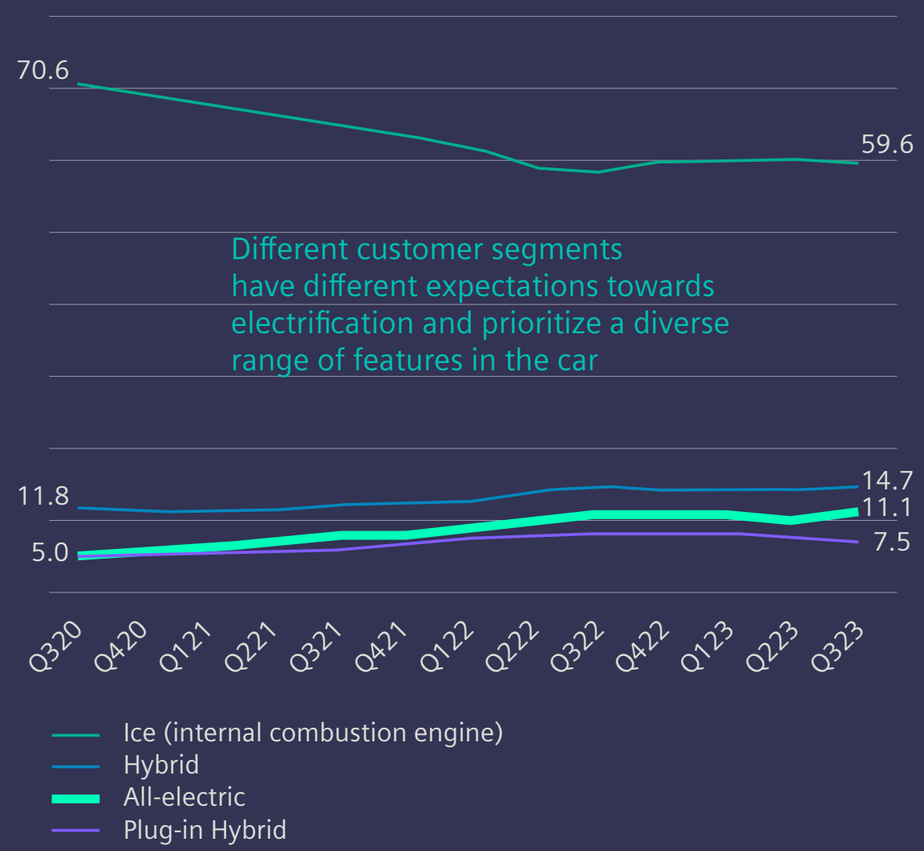
Accelerate your product development with the Digital Twin

The automotive industry has always been synonymous with innovation, but recent shifts present challenges that demand a more agile and adaptable response. A paradigm shift driven by the need for software-defined mobility, sustainability, and advanced digital technologies like AI and machine learning is driving rapid change in the automotive industry.

Companies must embrace digital transformation to stay competitive, leveraging powerful technologies, like the Digital Twin, and solutions that ensure end-to-end connectivity, efficiency, and innovation across the vehicle lifecycle.

The automotive market is becoming more and more diversified ...

Vehicle mix among 1 year intenders



Consumers continue to demand a mix of different engine types

Source: GfK AutoMobility® 2024 The future of Mobility

Top reason for 1st choice among EV intenders

Features/Tech is significantly more important to EV intenders than ICE intenders and is chosen as a reason for 1st choice more often than trust or safety

Technology features are important to consumers planning to purchase a new electric vehicle.

The graphic illustrates diverse consumer preferences. The survey of potential electric vehicle buyers reveals varying reliance on drive technologies and increasing importance of car features.

Key challenges

Car shopping today reflects a shift in priorities. Modern vehicles are evolving into advanced, interconnected systems that enhance daily life by combining performance, safety, quality, and security with seamless functionality. This is part of a movement in the automotive industry from physical to digital innovation.

Automakers are faced with multiple implications. Innovation is required across vehicle development, manufacturing, service, and internal processes to produce the advanced and sustainable vehicles customers want. Automotive companies must also foster transparency across the supply chain to understand and lessen their ecological footprint. The pressure on all players in the automotive market is only increased by a wave of nimble new entrants that, while less resourced, can focus almost exclusively on speed and technological innovation to win customers.

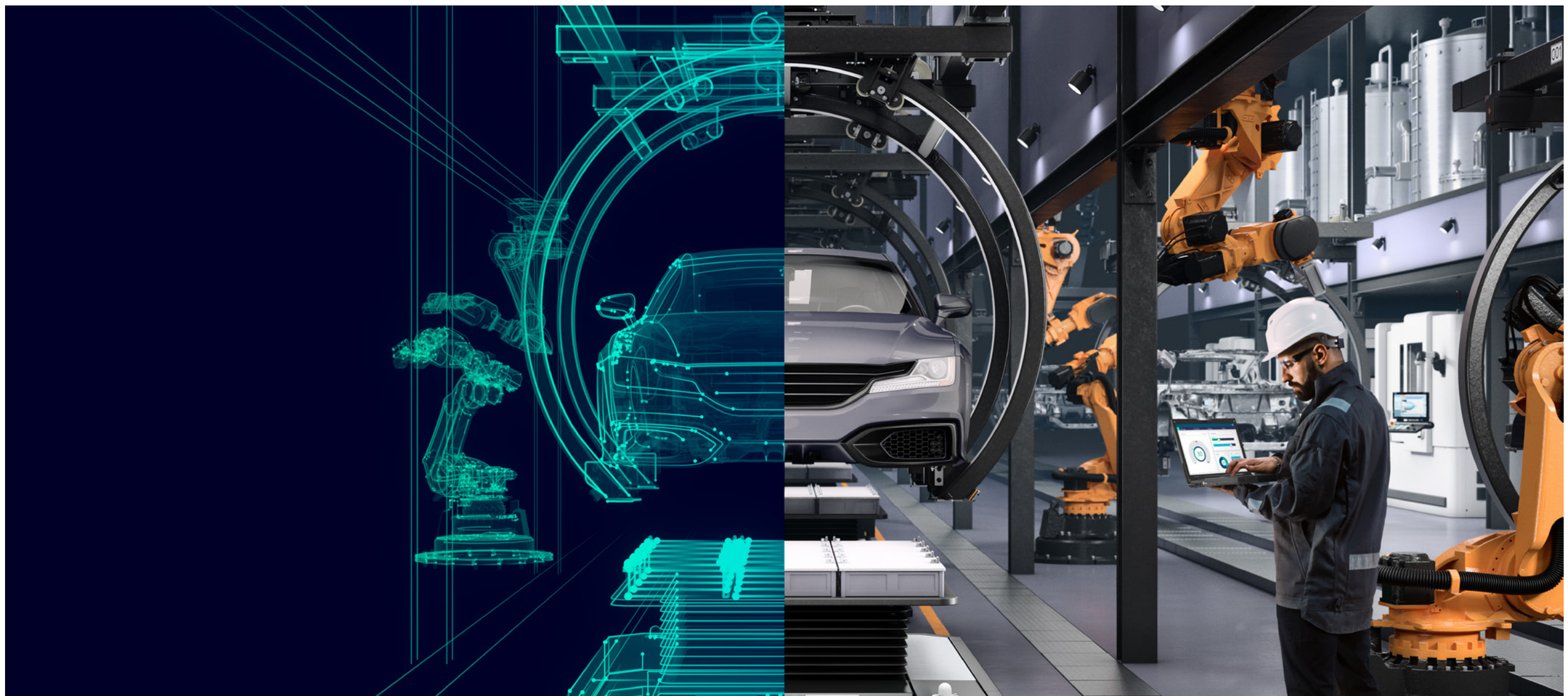
Digital transformation supports sustainable software-driven development

Automotive manufacturers must invest in digital transformation to connect processes, technologies, equipment, and personnel from engineering and design, through manufacturing planning to execution, to vehicles in the field, and back in a closed loop. Achieving widespread digital transformation will enable automakers to combine the real and digital worlds to accelerate development processes, establish traceability and auditability, and prioritize decarbonization from concept through vehicle maintenance and end-of-life processes.

Digital transformation is built on the Digital Twin. Siemens' unique comprehensive and physics-based Digital Twin approach incorporates mechanical, electronic, electrical, and software domains in product development and manufacturing, fully capturing today's smart products and processes. It comprises a set of consistent digital models, connected by Digital Threads, representing various aspects that can be used throughout the entire product and production lifecycle and the supply chain.

Meet the Digital Twin

A Digital Twin is a digital representation of a physical asset or process that evolves over the lifecycle, from a product or machine to production, plants or even the entire supply chain.
By combining the real and the digital worlds, the Digital Twin helps to define and optimize the product and production system before investing in physical assets, thus reducing the need for physical prototypes.



Software-defined vehicle development

The Digital Twin makes rapid vehicle development feasible, using AI capabilities, immersive design technologies, and powerful physics-based simulation. By embracing these technologies, automakers can increase process agility, enable data-driven and environmentally conscious design decisions, optimize cost, and incorporate limitless virtual verification to set new industry standards for sustainable vehicle development.

Integrated end-to-end collaboration

Companies must adopt Digital Thread solutions to create channels for integrated, end-to-end collaboration. These data connections ensure that requirements like performance, sustainability, and other data are constantly available, tracked, and updated consistently throughout all engineering teams. These data connections are also bi-directional, allowing engineering teams to complete designs and verification and validation processes in a traceable and auditable workflow, updating the comprehensive Digital Twin of the vehicle (via the Digital Thread) with new system designs and performance characteristics.

As a result, vehicle lead engineers and business leaders can track development progress and ensure that all performance and sustainability requirements are met.

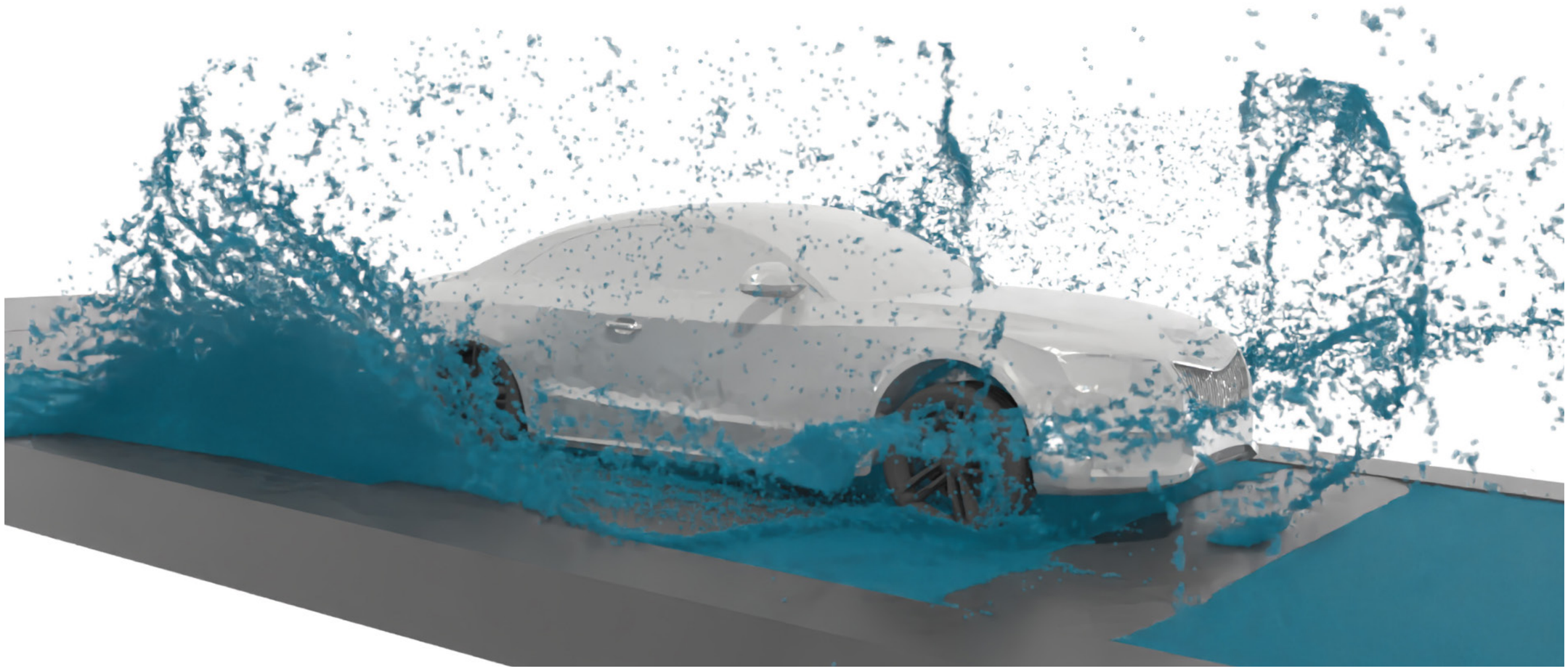
Digital Threads, explained

Digital Threads are traceable paths of digitalized business workflows in product and production lifecycles, which are interconnected and ensure an integrated flow of data. Along these paths Siemens provides extensive solutions with which automotive companies can successfully transform into a sustainable Digital Enterprise.

Automated design innovation

The Digital Twin, combined with high-fidelity exploration and AI capabilities, enables the rapid generation of thousands of design options to quickly discover the most efficient, sustainable, and cost-effective configuration. The primary objective is to dissolve barriers between teams and disciplines, fostering concurrent design that seamlessly integrates electronics, mechanical, electrical, and software engineering.

This process streamlines initial vehicle design through to final production, including design for recyclability, disassembly, and reuse. It allows engineers to experiment more freely with designs, validate them in a virtual space, and make faster and more accurate decisions with confidence, including predictive analytics for more sustainable material and component selection and optimized manufacturing processes. The combination of simulation and automation empowers engineers to push the boundaries of innovation to create sustainable vehicles rapidly.



Virtual verification and validation

Companies can leverage boundless virtual verification and validation to evaluate all aspects of designs virtually. Simulations must assess everything from structural integrity and safety to performance under various conditions, including extreme cases that would be difficult or impossible to replicate physically.

Virtual verification and validation activities also generate insights for each new design revision. This ensures that changes from across domains are accounted for and reflected in predictions for product performance, cost, and carbon footprint early and repeatedly throughout the design process. Modern solutions also blend physics-based simulation with data analytics and can integrate product requirements to enable accelerated design iteration and optimization in the virtual world. This minimizes the number of physical prototypes required before signoff, saving significant time, cost, and material consumption in the vehicle development process.

Software and systems engineering

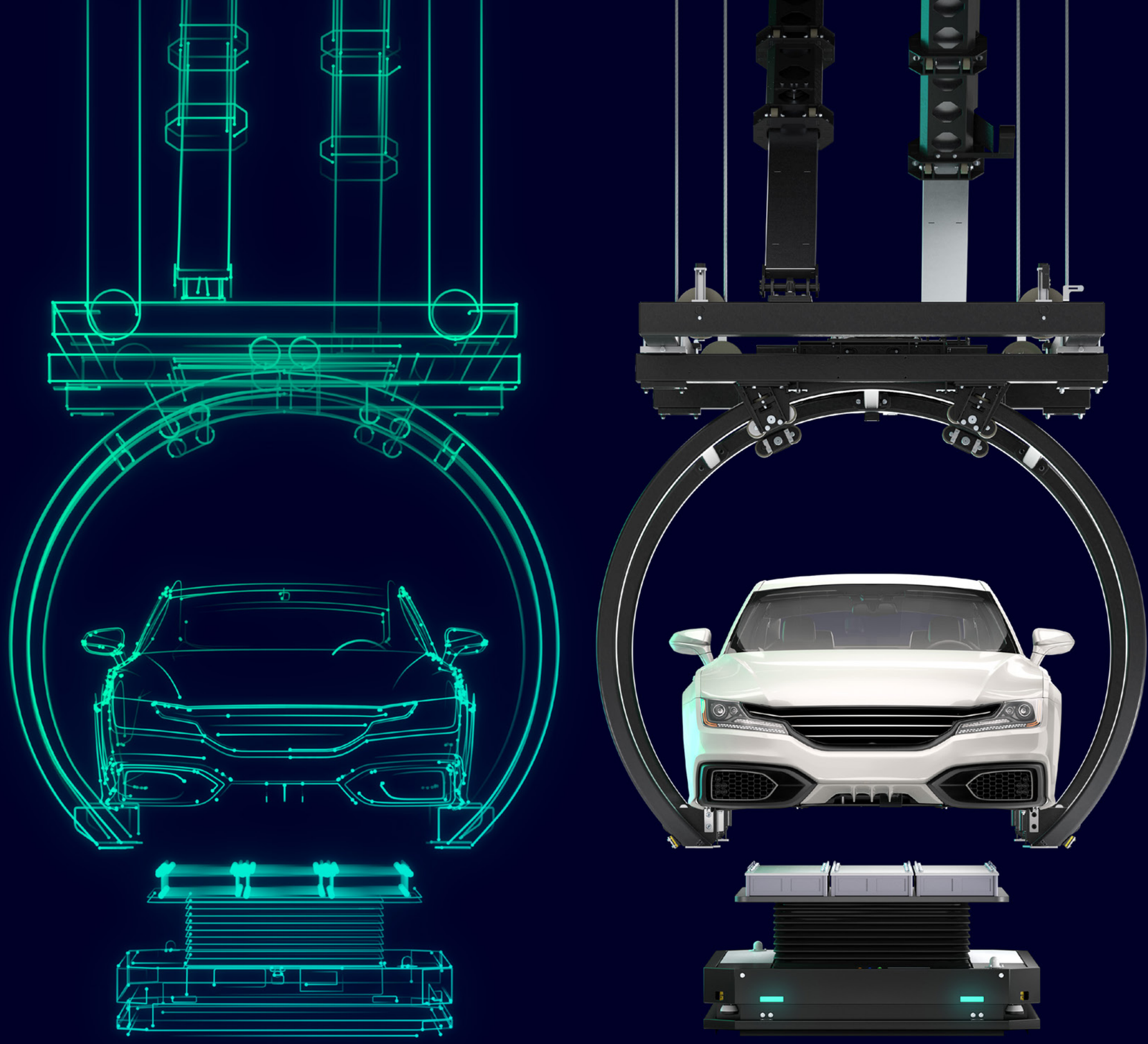
Finally, to make the most of their digitalization efforts, automakers and suppliers should align on an integrated model-based systems engineering approach that views vehicles as a system-of-systems with software as the driving force for innovation.

As customers seek a distinctive driving experience, automakers are shifting their engineering efforts to be more feature centric. By adopting a model-based systems engineering approach, automakers can complete all engineering, testing, and certification efforts in the context of developing the features defined at the beginning of vehicle development. This approach becomes even more productive as tradeoffs are shared across the development value chain, facilitating decision-making based on a complete understanding of the impact of design optimizations, including effects on production.

Building the software-driven automotive future

The software-defined vehicle paradigm brings significant opportunities for automotive companies to develop innovative vehicles and new sales and service models. However, this transition in the automotive industry coincides with significant challenges including growing vehicle complexity, shifting workforces, faster timelines, and growing pressure to account for sustainability from the very beginning of development.

The automotive industry must seek new engineering and development methodologies that support the future of software-defined vehicle platforms. Companies that pursue digitalization will build closed-loop development methods that incorporate design, verification, validation, production, and operation. With unprecedented data connectivity, these automakers will unlock their data to make intelligent and environmentally conscious decisions, enhance agility, reduce cost, and set new industry standards for sustainable vehicle development.



Accelerate the sustainable production of vehicles

Vehicle production must be fast, flexible, and future-proof. With Digital Twins, simulation, and real-time data, automakers boost efficiency, cut emissions, and reduce waste – long before the first part is built. From flexible manufacturing and additive manufacturing technologies to energy-optimized facilities and sustainable supply chains, digitalization connects everything. It’s how innovation scales – and sustainability succeeds.

Accelerate time-to-market with smart solutions for automotive production

The automotive and transportation industry must navigate unpredictable changes and rapidly evolving trends. A paradigm shift, driven by growing demand for sustainability and cutting-edge vehicle features, is ushering in the future of software-defined and electrified mobility. In this dynamic environment, traditional methods and processes for product development and manufacturing will not suffice.

The key to overcoming these challenges lies in adopting the Digital Twin and solutions that ensure end-to-end connectivity, efficiency, and innovation throughout the vehicle lifecycle. This approach will enable automakers to produce high-quality, sustainable vehicles that meet the demands of today’s discerning consumers.

Integrating design and manufacturing for sustainable vehicles

End-to-end digitalization in the automotive industry will be crucial as companies develop cutting-edge, next generation vehicles. Importantly, a sustainable vehicle design must be complemented by sustainable production methods that maximize efficiency, cut carbon emissions, and reduce waste. The combination of Digital Twin technology and virtual manufacturing engineering for production processes offers a transformative approach to achieving these intertwined objectives.

Fostering sustainability in manufacturing operations

Enhancing production efficiency with digitalization

Improvements to production efficiency begin with detailed manufacturing planning. The integration of simulations allows companies to plan and validate their production strategies in a virtual environment. This approach boosts productivity and minimizes waste. As production system designs are refined, virtual commissioning connects virtual models to real control systems, streamlining the process of implementing machine tools according to the production concept.

Flexible production methods

Digitalization also facilitates the design and implementation of flexible production methods, enabling automakers to reconfigure production facilities to enhance efficiency or respond to market changes. Modular production concepts and automated guided vehicle (AGV) systems can be created and simulated to ensure efficient operations, resolving logistics bottlenecks before any physical work begins.

Advanced production technologies

End-to-end digitalization simplifies the incorporation of advanced production technologies, such as additive manufacturing. These technologies optimize the weight and strength of vehicle components, resulting in safer, more fuel-efficient vehicles. Handling heavy battery packs requires strong, power-hungry robots with large grippers for assembly. Big robots mean big power consumption. Generative design can be used to create a new, smaller, lightweight gripper. An AI-driven configurator application uses topology optimization in NX to reduce design cost and time and improve performance.

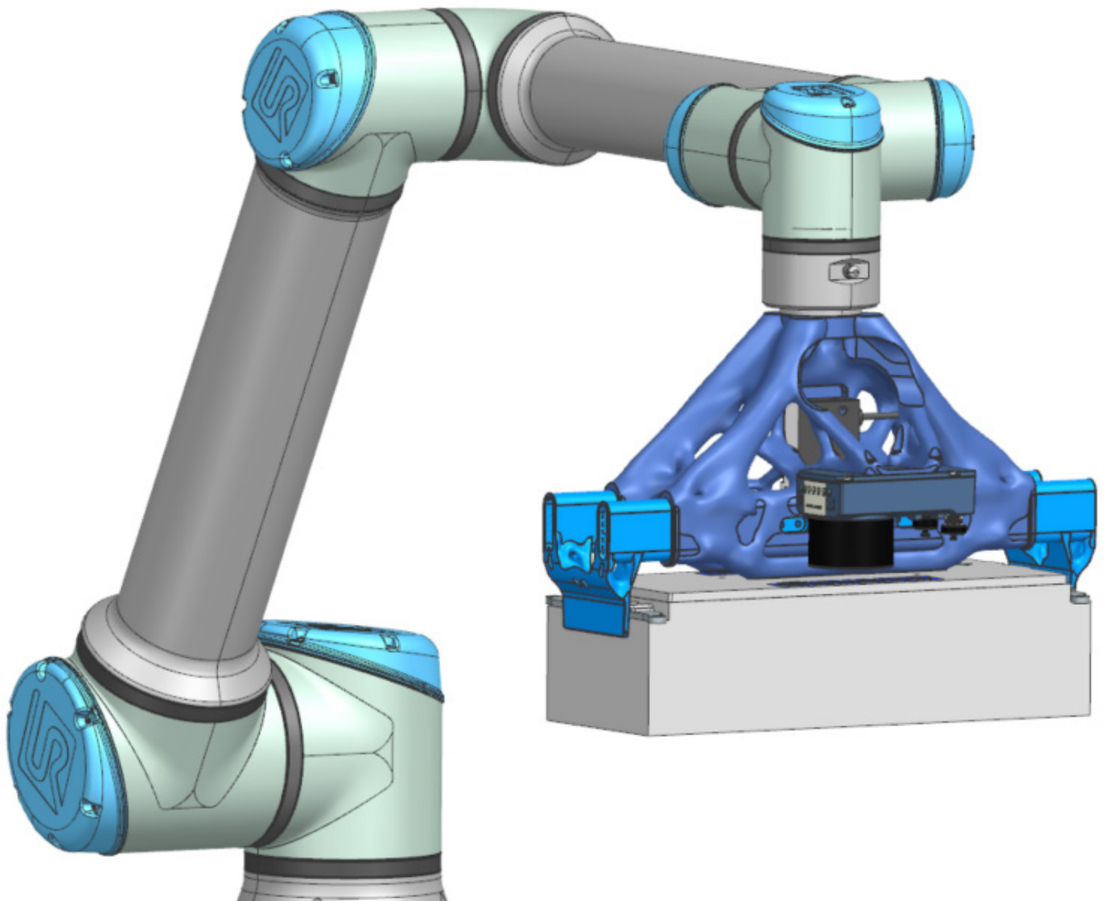
The only production method for this lightweight gripper is additive manufacturing. To ensure that the new design works as expected, it can be validated by simulating the entire manufacturing step. Using smaller robots with grippers that are more than 80% lighter saves more than 50% energy, reduces carbon emissions by more than 3 tons per year (about 90%), takes up 50% less floor space, and reduces cycle times by 20%.

Benefits of generative design for a smaller, lighter gripper

reduced carbon footprint and weight

fewer parts

energy savings

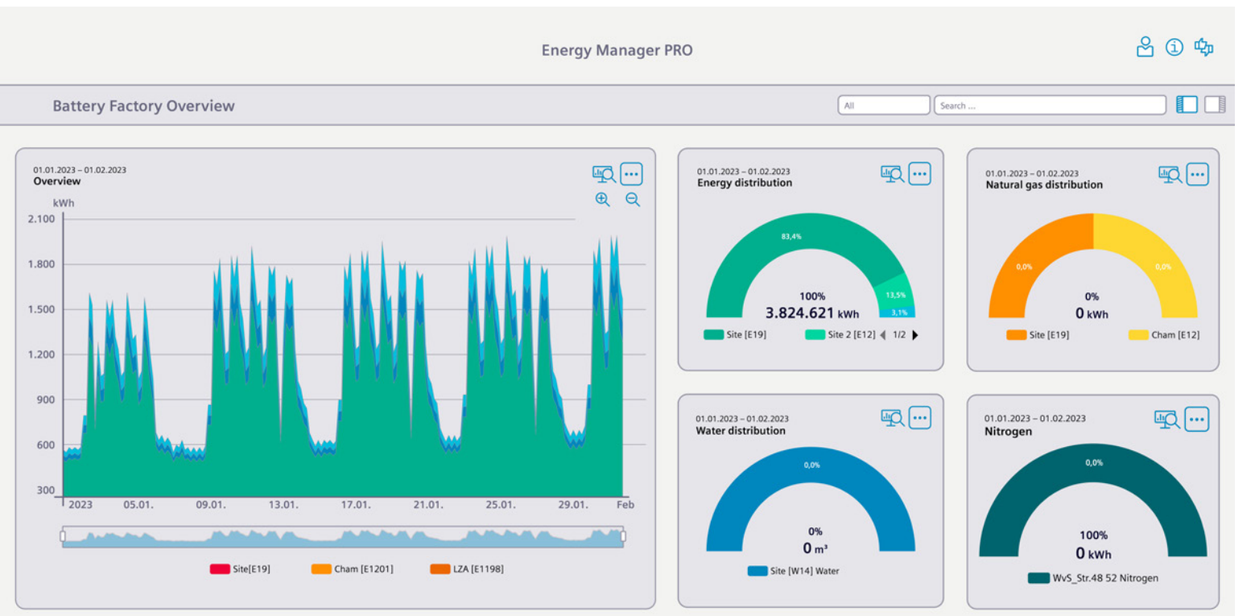


Transparency: Leveraging data to drive optimizations

Transparency is key to improving operational efficiency and the sustainability of production systems and facilities. Direct data connections to machines, sensors, and manufacturing management systems provide this transparency. Operational data gathered from the factory floor can be processed and analyzed to guide targeted improvements in production operations, reducing waste and energy consumption and supporting key business goals.

Modern simulations can use operational data to identify wasteful processes and help production engineers develop solutions to eliminate scrap or lower raw material consumption. Such measures often also reduce wear on production assets, lengthening their service lives and reducing costs and material consumption associated with maintenance and replacements.

Detailed operational data can also support the electrification of heat-intensive processes, like paint curing, to cut carbon emissions during production. A detailed understanding of the energy consumption of the existing production facility, coupled with energy simulations, enable the increased demand created by a newly electrified process to be anticipated and accounted for, ensuring minimal production interruptions.
On-site renewable energy generation is another key strategy for reducing carbon emissions from automotive production facilities. For example, Siemens and Mercedes-Benz are collaborating on a Digital Energy Twin to simplify and accelerate the transition of the automaker's production facilities to renewable energies. The Digital Energy Twin is based on behavioral models of real buildings, equipment, and energy generation, and connects inputs like weather data, load profile simulation, building asset selection and dimensioning to simulate a physical energy system. Mercedes-Benz can use the Digital Energy Twin during early planning phases to verify proposals for energy usage and develop recommendations for optimizing desired outcomes including energy efficiency, associated cost savings, and emissions reductions.

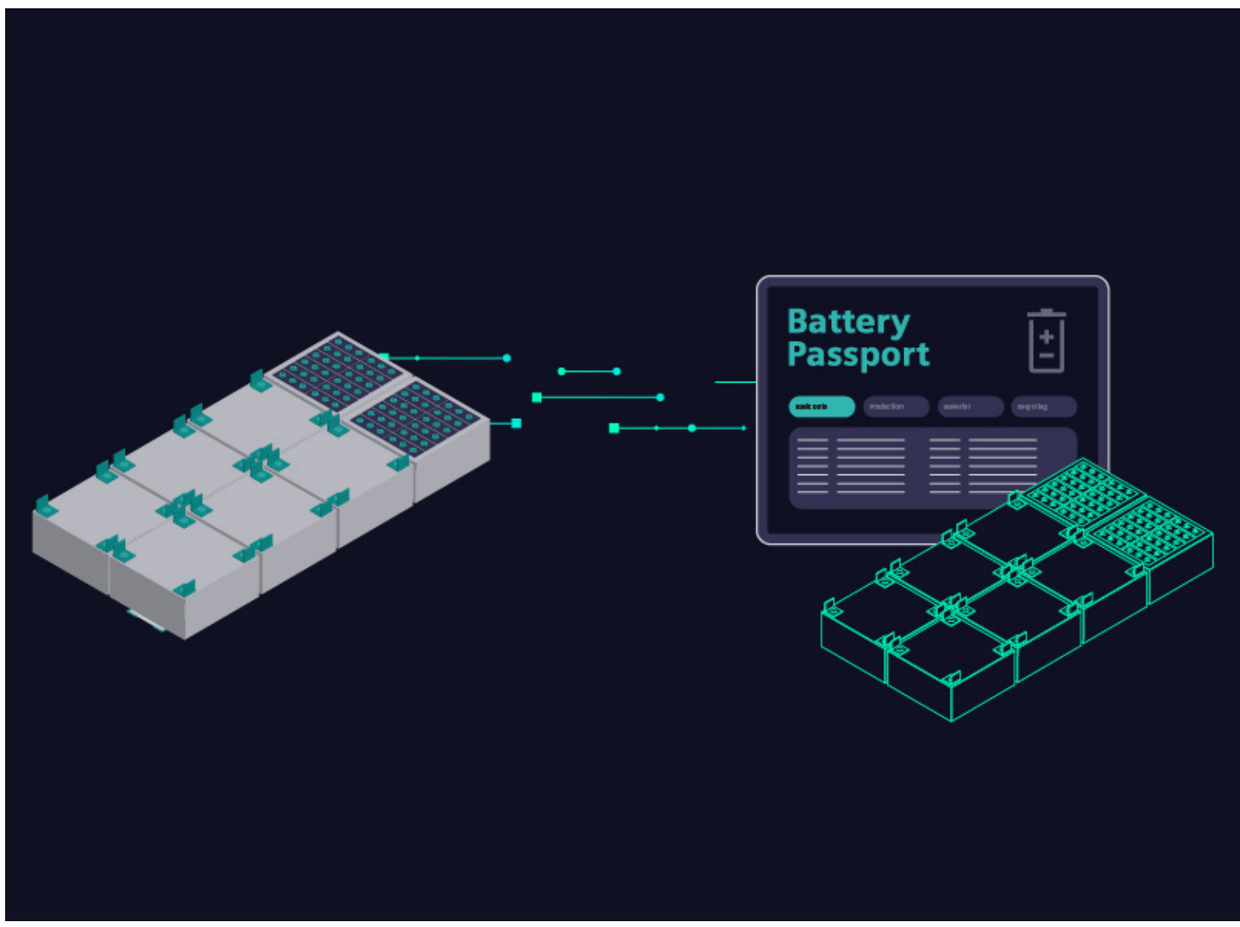


Building a sustainable supply chain

A McKinsey study found that the supply chain accounted for more than 80% of the greenhouse gas emissions and 90% of the total impact to air, land, water, and other ecological factors attributed to a company's operations[1]. This emphasizes the need for a comprehensive approach to reduce environmental impact and meet regulatory and consumer expectations. Key to this is the selection of suppliers who prioritize sustainability, ensuring that every link in the chain contributes to overall emissions reduction.

Much like with production operations, the creation of a sustainable supply chain is based on the availability of information and clear, transparent collaboration among automotive manufacturers and suppliers. It requires comprehensive data collection and sharing among all stakeholders, including suppliers, manufacturers, and logistics providers.

With a dynamic and detailed picture of supply chain sustainability, automotive manufacturers can engage their suppliers through collaborative sustainability initiatives and by setting company standards for emissions, energy usage, material efficiency, and more. Encouraging or even requiring suppliers to track and report their own emissions fosters a culture of transparency and shared responsibility for environmental impacts. Supply chain transparency and collaboration are doubly important due to their role in enabling regulatory compliance and risk reduction. Digitalization of carbon footprint tracking and sustainability certification, such as through the upcoming Battery Passport, help ensure that all sustainability targets, whether external or internal, are met and appropriately documented.

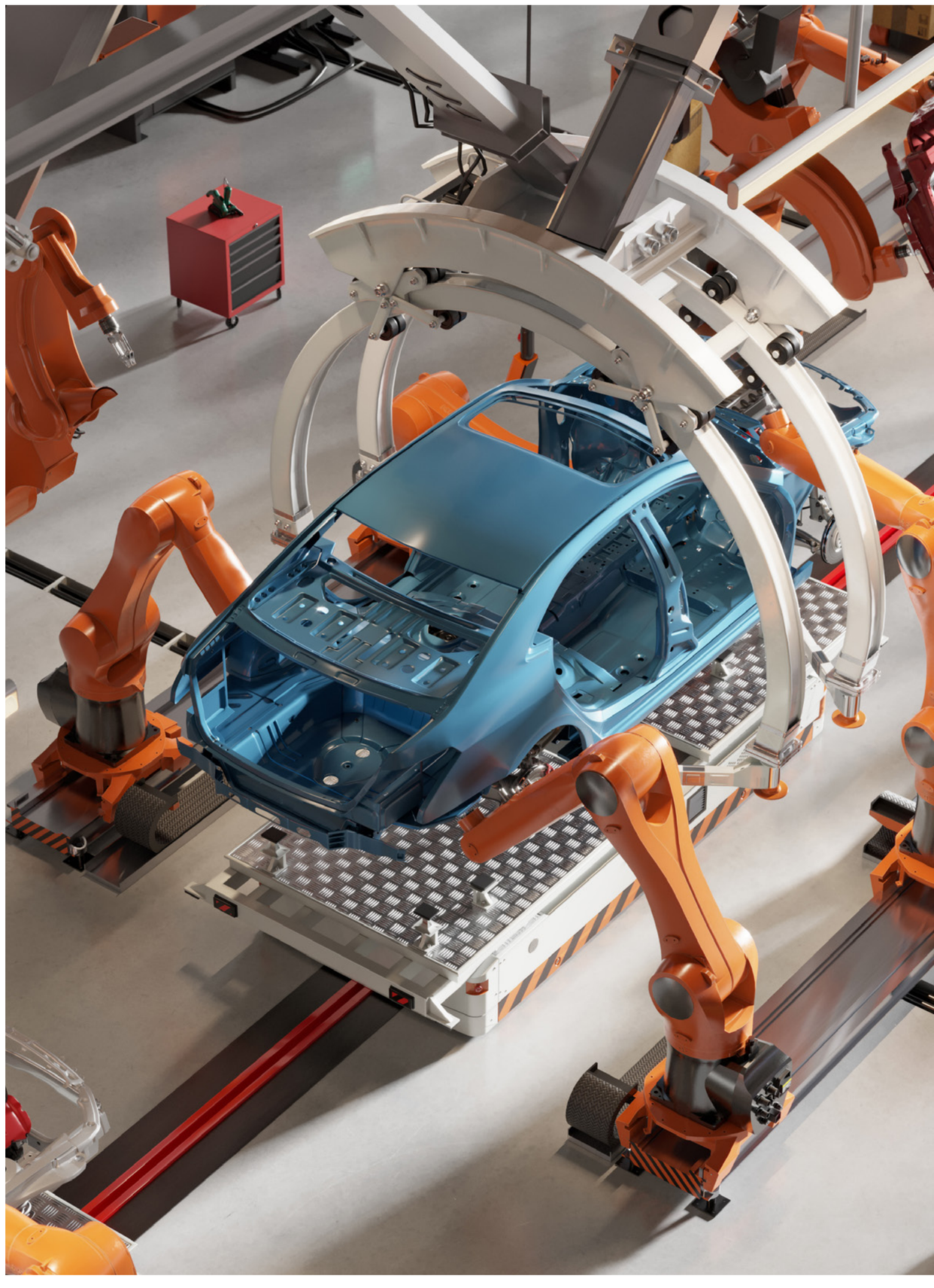


1 Bove, A. & Swartz, S. (2016). Starting at the source: Sustainability in supply chains. McKinsey & Company.

Together towards a more sustainable automotive industry

Through investment in digitalization, automotive companies can build a comprehensive Digital Twin that encompasses the vehicle development and production lifecycle from end-to-end. This digitalized approach will reduce complexity and foster innovation to meet customer and regulatory demands.

A digitalization solution for the automotive industry must span from design to validation to production to the field and back. Unlike traditional processes, this progression cannot be linear. Manufacturers must speed up innovation and production scaling to meet future demand, cost requirements, and sustainability targets. This acceleration requires leveraging models, information, production data, and materials to continuously improve designs and quality. The automotive manufacturer's success depends on a suite of digitalization solutions that include evaluations, training, cybersecurity, software, and hardware to drive end-to-end efficiency and flexibility.



Siemens offers a full suite of software solutions and factory automation that work seamlessly together to accelerate innovation, design for longevity and sustainability, and drive operational excellence. For automotive companies, Siemens Xcelerator offers the tools necessary to manage the increasing complexity of vehicle design and manufacturing, enhance efficiency, and drive sustainability. By becoming a Digital Enterprise and leveraging the products and services of Siemens Xcelerator, automotive companies can streamline their operations, reduce time-to-market, and achieve greater agility in responding to market demands.

Further information

↗ siemens.com/automotive

↗ siemens.com/digital-enterprise

↗ siemens.com/digital-twin