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Background paper

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Siemens is driving the sustainable transformation of the automotive industry

- **Software-defined vehicle (SDV) solutions enable car manufacturers to develop more sustainable vehicles with flexible, customizable, and highly automated functions**
- **Efficient green production – energy management via a virtual line to real production**
- **Hardware-independent virtual PLC (vPLC) provides more flexibility and a better convergence of IT and OT**
- **Siemens Battery Passport: Paving the way for a more transparent and sustainable battery industry**

Driven by the electrification of mobility, the automotive industry is undergoing a massive transformation. There's also an increasing demand for advanced driver assistance systems (ADAS), autonomous driving technology, and connected vehicles. This is impacting the entire value chain, from development and design to production and the use of the vehicles. But it also creates new opportunities for both new and existing players in the market. The question is: How can automotive industry players shape their development, production, and supply chain so they can stay ahead of the industry while also complying with sustainability regulations and requirements?

The answer lies in Industrial Operations X, Siemens' ever-growing, interoperable portfolio for industrial production. Industrial Operations X integrates information technology (IT) and operational technology (OT) into the world of automation to make production processes more flexible, autonomous, and worker-friendly. The combination of IT and OT on the shop floor enables precise, data-driven decision-making, and this makes automotive production more sustainable. This seamless flow of data along the entire value chain bridges the gaps between information silos and connects everything from development to production to the supply chain.

Siemens AG
Communications
Head: Lynette Jackson

Werner-von-Siemens-Straße 1
80333 Munich
Germany

Product design and development in the automotive industry

Sustainability starts at the design stage, where every decision has an impact on the entire lifecycle of the vehicle. 80 percent of a car's environmental impact is determined in the design phase. The goal of manufacturers is to find efficient, sustainable, and cost-effective configurations by generating different design options. And software-defined functions (aka software-defined vehicles) in production development make it possible to develop innovations in the areas of fuel and power consumption, recyclability, passenger safety, and optimization of service life. To achieve this, four important elements of software-defined functions in product development are crucial:

1. Through seamless end-to-end collaboration, automated design innovations, and comprehensive virtual verification and validation, it's possible to accelerate sustainable product development while keeping quality, cost, and performance at the highest level.

2. The increasing complexity of software-defined vehicles can be managed with the help of software and systems development, continuous multi-domain simulation, and accelerated model-based detail development. These solutions improve collaboration, increase efficiency, and drive innovation.

3. An advanced driver assistance system (ADAS) supports the driver while driving their vehicle. Depending on the system, it can provide more comfort, more safety, and more fuel-efficient driving. Reliable (ADAS) and autonomous vehicles require early and continuous optimization of the system. Siemens offers solutions for verifying, validating, and maximizing ADAS values.

4. Siemens offers a virtual development environment (immersive engineering), design and optimization simulations, and a production management solution. They'll enable car manufacturers to bring safer and more comfortable electric vehicles to the market with optimized range.

Holistic solutions for sustainable production of cars and batteries

One strategy for achieving sustainability goals is resource-efficient automotive production.
Automakers need to advance their digital transformation in order to meet their

sustainability and efficiency goals, and digital twins and virtual production engineering are essential tools. The TIA Portal enables intelligent automation development from planning to operation. With the Plant Simulation software, production systems and logistics processes can be designed, simulated, and analyzed to optimize material flow and resource utilization. In a PLM-supported 3D environment, Process Simulate software facilitates the planning and validation of manufacturing processes like handling, painting, bonding, and welding with robots – as well as virtual and real commissioning in mechanical and plant engineering.

Virtualization of the manufacturing environment

For holistic solutions, a smooth collaboration between the shop floor and the top floor is a prerequisite. This can be achieved by using a virtual industrial control system, among other things. One example is the Simatic S7-1500V, which is based on the Simatic S7-1500 controller for its function and operation. This virtual PLC is hardware-independent, which means that no specific hardware is required. Via Industrial Edge Management, virtual control and other applications can be centrally managed and flexibly adapted to the needs of automotive manufacturers. This data-centric and software-based automation also allows costs to be optimized and car manufacturers to react more flexibly.

PLC projects can be more easily scaled with virtual control and efficiently integrated into other IT offerings through open data interfaces. The Simatic S7-1500V is fully compatible with the TIA portfolio, which means that existing projects and data can be reused in the TIA Portal and investments can be reduced. The virtual PLC is downloaded as an edge app and integrated directly into the IT environment. This is a great way to exploit previously untapped potentials of digitalization. For example, the SIMATIC S7-1500V virtual PLC has been in productive use on the Audi e-tron GT production line since January 2024.

More sustainable production processes thanks to energy efficiency

With the digital transformation, automotive manufacturers can achieve optimal energy and resource efficiency in their production operations. This includes increasing the transparency of energy consumption and CO2 impacts and optimizing processes with an eye on sustainability goals like more flexible production and standardization of battery pack assembly. By using tools like the Energy Analyzer and Energy Manager,

car manufacturers can monitor energy consumption, determine the product carbon footprint, and make informed decisions to reduce their CO2 emissions.

Integrating manufacturing technologies like additive manufacturing and automated guided vehicles into their production is another way automotive manufacturers can achieve their sustainability goals, including more adaptable and efficient process flows. One example is the use of 3D-printed lightweight grippers in automotive manufacturing. In one case, the total mass of a gripper solution on a handling robot was reduced by 64 percent. This was possible because the design phase took advantage of additive manufacturing's design freedom. In addition, the lower weight of the gripper permitted smaller robots to be used, reducing energy consumption by 54 percent per year during operation.

Resource efficiency in battery production

One of the major trends that's impacting the automotive industry is electromobility. Environmentally friendly battery production is of great importance for sustainable electromobility.

The demand for batteries is growing rapidly in the automotive industry, and holistic solutions allow manufacturers to bring the next generation of innovative batteries to market at scale and quickly. A model-based development process is needed for manufacturing high-quality and high-performance batteries with a fast production start-up. This allows for innovative electrochemical compositions and optimized designs to reduce weight and increase range.

High scrap rates are a problem for battery manufacturers due to the expensive materials required, including rare earths. Continuous process improvements and increased productivity enable production waste and the consumption of raw materials to be reduced. Siemens relies on optimized controls and data analysis to detect defects at an early stage and reduce scrap rates. Technical guidelines enable the plug-and-play integration of battery machines, while IoT and edge solutions help machine builders continuously optimize production using digital analysis and simulation. The combination of predictive maintenance and remote services contributes to improved availability and productivity.

These advanced technologies and solutions not only increase efficiency, they also reduce carbon dioxide emissions to enable a sustainable and environmentally conscious battery production.

Intelligent battery cycle

Battery manufacturers have set themselves the goal of achieving an intelligent battery circuit with maximum material reprocessing and minimal disposal. By 2030, 95 percent of the cobalt, copper, and nickel and 70 percent of the lithium are expected to be recovered from batteries. – and virtually validated, standardized, and automated recycling processes will play a decisive role. A recent update to the Battery Directive introduces the concept of a Battery Passport in the EU, which will be mandatory for all electric vehicles, light transport, and industrial batteries (> 2 kWh) by 2027. The battery passport will serve as a digital dataset for individual batteries by documenting their entire lifecycle, from the procurement of raw materials to remanufacturing and recycling. It contains information about the composition, manufacturing, performance, and environmental impact of the battery. Siemens' IT/OT portfolio can currently provide up to two-thirds of the dataset relevant to the Siemens Battery Passport, which consists of more than 100 attributes. This also includes the product carbon footprint, which can be recorded by Sigreen, a CO2 management tool.

Decarbonizing the automotive supply chain

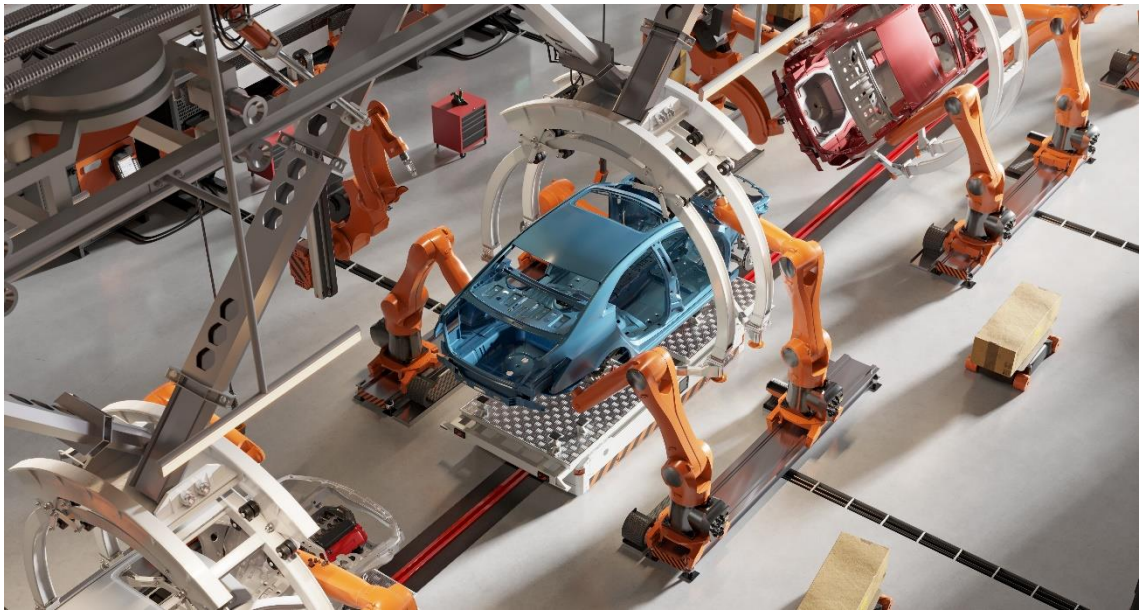
Up to 90 percent of the carbon footprint is generated in the automotive supply chain – but inconsistent data formats, lack of visibility, and complex global supply chains make this a challenge that no company can tackle alone. Comprehensive tracking and management of the carbon footprint is the key to a sustainable supply chain. Companies need to build circular ecosystems and work closely with their suppliers, partners, and customers. An exchange of data to calculate the CO2 footprint of a product along its lifecycle is made possible by Sigreen, a platform that simplifies the tracking and management of emissions at the product level across the entire supply chain.

Catena-X: Ecosystem for the automotive industry

The challenge for automotive manufacturers in terms of sustainability is to oversee the entire production value chain. It’s therefore important to include not only production or infrastructure but the entire production lifecycle, and this requires open, transparent communication between all stakeholders.

To enable a secure flow of information, co-creation, and data transparency in the automotive industry, Siemens has joined forces with some of the most important players to form the global partner network Catena-X. Catena-X – the first collaborative, open, and decentralized data ecosystem for the automotive industry –connects car manufacturers, suppliers, and service providers along the entire supply chain. This transparent data exchange of the CO2 footprint’s components enables robust sustainability decisions.

Digital twin in the automotive industry



More efficient production in the automotive industry

Siemens at SPS 2024:
siemens.com/press/sps24 and siemens.com/sps-fair

More information on Siemens' solutions for the automotive industry:
https://xcelerator.siemens.com/global/en/industries/automotive-manufacturing.html

More information on Catena-X:
https://www.siemens.com/global/en/products/automation/topic-areas/catena-x.html

More information on virtual controller Simatic S7-1500V:
https://press.siemens.com/global/en/pressrelease/first-virtual-simatic-controller-enables-more-flexible-software-based-automation

More information on the use of the virtual PLC at Audi:
https://www.siemens.com/global/en/company/stories/industry/factory-automation/virtual-plc-audi.html

Contacts for journalists

Hannah Arnal
Phone: +49 (152) 22572736
Email: hannah.arnal@siemens.com

Carla Mather
Phone: +49 (173) 5223558
Email: carla-louise.mather@siemens.com

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Siemens AG (Berlin and Munich) is a leading technology company focused on industry, infrastructure, transport, and healthcare. From more resource-efficient factories, resilient supply chains, and smarter buildings and grids, to cleaner and more comfortable transportation as well as advanced healthcare, the company creates technology with purpose adding real value for customers. By combining the real and the digital worlds, Siemens empowers its customers to transform their industries and markets, helping them to transform the everyday for billions of people. Siemens also owns a majority stake in the publicly listed company Siemens Healthineers, a globally leading medical technology provider shaping the future of healthcare.
In fiscal 2023, which ended on September 30, 2023, the Siemens Group generated revenue of €77.8 billion and net income of €8.5 billion. As of September 30, 2023, the company employed around 320,000 people worldwide. Further information is available on the Internet at www.siemens.com.