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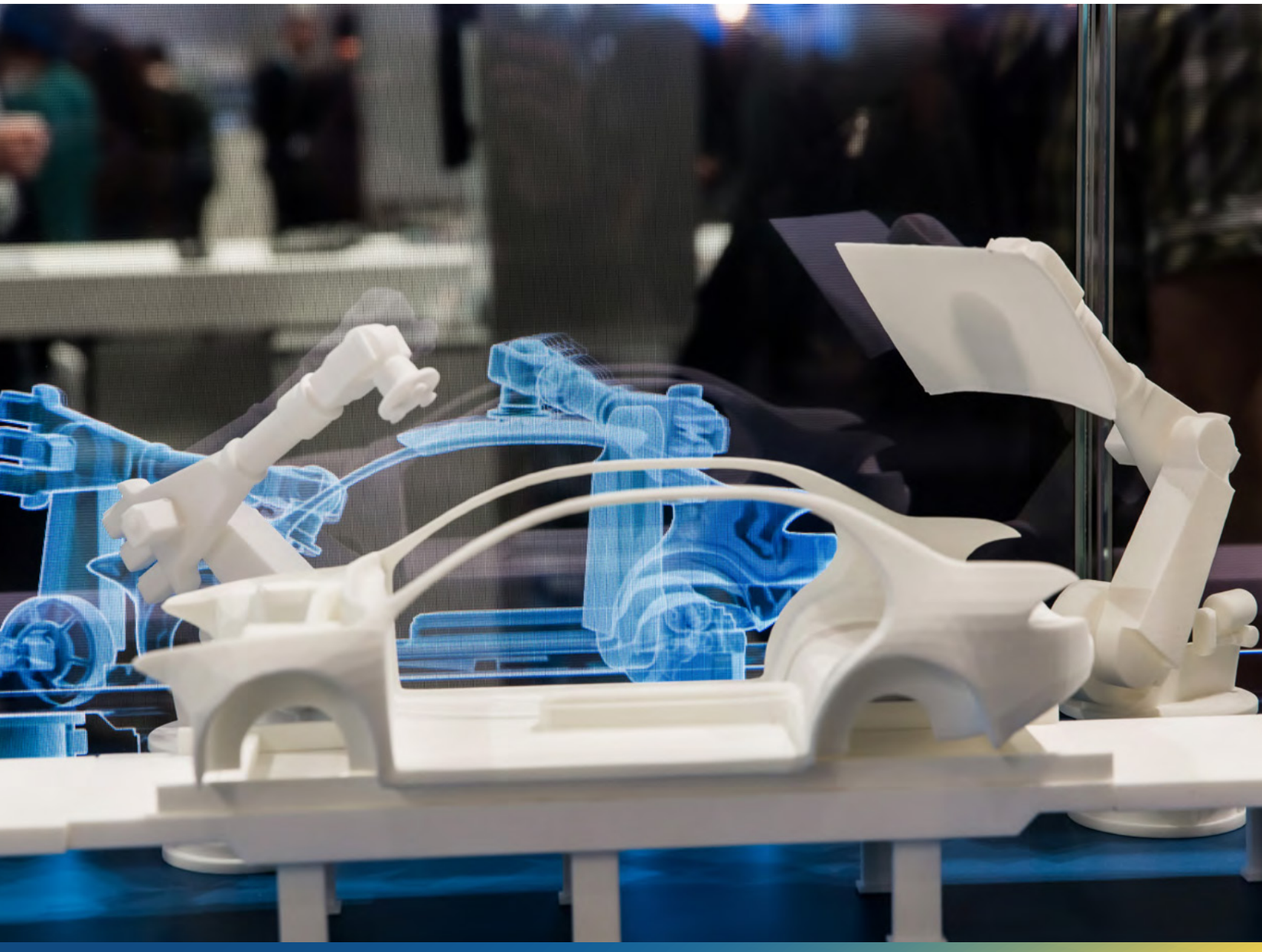

POV

Role of Digital Twin in the **Automotive Industry**

Eighteen months of the COVID-19 pandemic has left a severe impact on the globally integrated automotive industry. Despite encouraging news on the vaccination front, Forbes forecasts that sales in Europe and the US will not rebound to pre-COVID levels until 2023 at the earliest [1]. This has resulted in the "great restructuring" forcing the automotive industry to design new ways of working across the value chain. Car manufacturers need to adopt an Agile and data-driven approach to survive and thrive in these uncertain times. The answer may lie in digital twin technology which provides a virtual solution to the conundrum faced by the automobile industry.

Digital Twin

A digital twin is a dynamic digital representation of the product and helps an organization create a digital footprint throughout the complete product life cycle. It is updated from real-time data, and uses simulation, machine learning, and reasoning to drive decisions [2]. Digital Twins create an immersive and assisted experience for manufacturing clients to better analyze their comprehensive portfolio and predict future issues, thus averting failure. The technology helps drive business transformation—not just business sustenance. Digital twin technology has much-needed capabilities to boost the automobile industry by accurately understanding the present and predicting the future.

Applications of Digital Twin Technology in the Automobile Industry

The product life cycle of an automobile involves multiple stages, generating a magnitude of useful data at each stage. The Digital Twin integrates all this data, helping businesses make an unerring decision at each stage. Let us see how using a digital twin facilitates various stages in the life cycle of automotive.

Product development: Product development in the automotive industry has changed drastically in recent years. Strong competition along with the ever-growing demand has led to shorter development cycles combined with higher product variations. The smallest error of judgment at this stage can have a huge financial impact and affect a company's brand value. Using a digital twin at this stage would help avoid such mishaps.

A digital twin integrates data at numerous points in the product life cycle, working with various stakeholders to help designers finalize the vehicle concept. The product must undergo multiple simulations covering multiple scenarios to ensure a fail-safe model. A digital twin greatly improves the effectiveness of these simulations.

Product manufacturing: The success of a manufacturing plant depends on factors such as resource management, production planning, and process control. The complexity added by self-driven and electric vehicles and the shortage of skilled labor along with the focus on improving the overall equipment effectiveness (OEE) underlines the need for digital intervention.

The digital twin, collecting information from multiple sensors, helps to improve the OEE and reduce downtime. Augmented Reality (AR) is being used to train the workforce and help shop floor operators in the maintenance of critical assets. The plant manager must have real-time visibility into all his assets, including his workforce, to act swiftly in case of an emergency. The use of predictive analysis on a digital twin helps ensure plant safety, where even nanosecond changes could lead to a potentially harmful work environment. Thus, along with predicting and preventing machine breakdown, a digital twin also helps to create a safer work environment. In addition, it works with AGVs (automated guided vehicles) and helps them work autonomously. Let us take a look at industry examples.

- Jaguar Land Rover in collaboration with Dimensional Control Systems has already demonstrated the implementation of a closed-loop manufacturing process, which involves actual measurements of the assembly process as feedback to precursor CAD analysis and simulation tools [3].
- Mercedes, with its "Factory 56," aims to equip its employees with personal digital assistants (PDAs) and other digital tools, through which production processes can be visualized and optimized using virtual reality to enhance accuracy as well as improve vehicle quality and line rate speed [3].

Thus, implementing digital twin technology helps an organization get real-time on-road insights and prevent failure by predicting it, even before the customer receives the product.

Quality: Continuous monitoring of processes and statistical process control are standard tools used for quality management. They help control the quality of a process. However, with implementation of the digital twin we can have not just predictive quality control but a prescriptive one too. The digital twin can continuously collect data and model the process, and hence predict the possible areas of quality challenges. The historic data digital twin can also predict quality issues with suppliers based on seasonality or other changes in process parameters and prescribe preventive measures.

Digital twin powered new product development (NPD) process can create a visual representation of the new product, and assemblers can virtually step-through the assembly process of the new model to identify potential issues and quality challenges. The impact of using this methodology can have a significant reduction in new product introduction cycle time. Addressing the quality issues at the process design stage, improves the throughput of the line and prevents new product or product update quality issue spikes.

Supply chain: Digital twins provide a complete replica of all the assets in a factory as well as the supply chain. With this data the transactions, third-party relationships, and logistics routes can easily be simulated. This helps immensely in lowering supply chain and logistics costs and ensures the organization stays nimble by providing the ability to react to changes faster.

Logistics cost is directly proportional to the weight and the number of touch points which a part has throughout its manufacturing process and its assembly onto the prime product. Heavy equipment manufacturers can leverage insights from the digital twin system to significantly improve the in-plant logistics. Through simulations and diagnostics iteration, the digital twin can prescribe better routing, reducing the number of touch points without increasing the distance or handling time, thereby drastically bringing down the logistics cost.

Sales: AR working along with digital twin has brought about a paradigm shift in automotive sales. The sales model has been shifting toward servitization, with the customer making personalized demands where a customer may want to pay only for a specific feature they want in their car. By building a 360° view for each customer vehicle, the dealer can help activate/deactivate any feature as per user requirement to enhance customer experience. Dealers and manufacturers also get a complete picture of customer preferences and behavior which helps them cross-sell/upsell.

Renault, for its last-mile delivery vehicle, used the Dassault Systèmes platform to design improved and efficient mobility solutions for delivery in urban areas. Further, they were able to augment digital twin technology with immersive virtual reality and information intelligence to validate product aesthetics and technical requirements, as well as analyze market trends [3].

After-sales service and maintenance: Real-time data collected by the digital twin gives insights into the condition of the vehicle and helps owners track their service requirements. It can also predict and plan for breakdowns by monitoring critical components. The service history collated by the digital twin helps manufacturers in demand forecasting by producing parts in demand region-wise. It also helps them track the failure pattern based on warranty details. These proactive measures can significantly reduce costs and boost the brand image.

Tesla Motors fixes almost all the minor to major real-time problems in their vehicles by simply downloading software updates. The constant transmission of the data between the vehicles through its Vehicle Identification Number (VIN) and Tesla factory helps improve the quality of Tesla products by each passing day [4].

Predictive analytics software packages can also help with battery management in electric vehicles. These packages are capable of creating a digital twin of battery systems by utilizing time-continuous sensor data to predict, simulate, and optimize the battery's lifetime[3].

Twinning for the future

Despite the disruptive impact of COVID-19, 47% of organizations plan to increase their investments in the IoT, according to a recent Gartner survey [5]. The digital twin as an "operating model" will continue to proliferate and is expected to become a critical and mainstream part of manufacturing soon.

Industry players are exploring technology trends shaping the future of digital twin such as virtual validation, generative design, AI DevOps, and quantum computing.

Technologies such as blockchain can also be used in combination with digital twin to facilitate secure implementation with a high degree of transparency and data integrity.

As the data lake from multiple sources increases gradually, we are likely see a rise in the use cases of digital twins. We have already seen some effective applications of the digital twin—the future could unlock unimagined functionalities and value potential for OEMs and suppliers in the automotive industry value chain with the possibility of several connected digital twins.

References

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