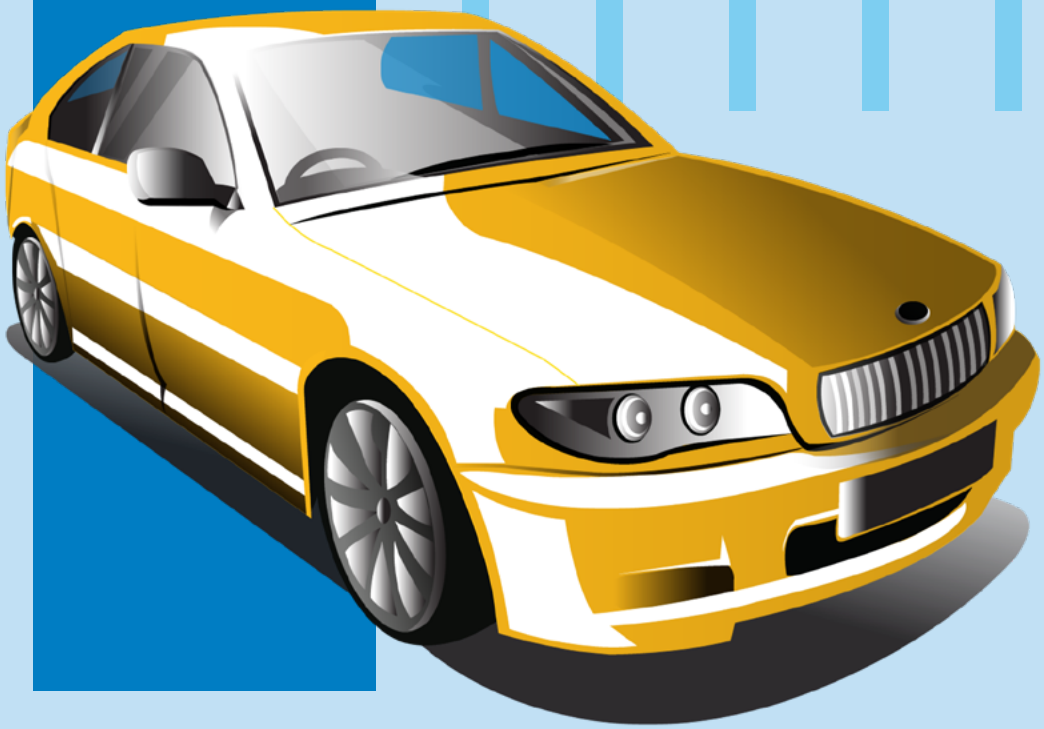
VIEW POINT

XR IN AUTOMOTIVES: PAVING THE WAY FOR NEXT-GENERATION MOBILITY



Infosys®
Navigate your next

The Evolution of XR in the Automotive Industry

The automotive industry is leading the way in technological advancements, constantly adapting to fulfill the demands of an increasingly digital world. As consumers increasingly desire immersive, interactive experiences, extended reality (XR) has become a game-changing technology. By blending the physical and digital worlds, XR is revolutionizing automotive design, redefining marketing approaches, and enhancing the vehicle experience for consumers across the value chain. This article explores the latest trends, future forecasts, and realistic implementations of XR in the automotive sector, showcasing how these advancements are reshaping the industry. From virtual display rooms to realistic hands-on training, discover the far-reaching benefits of extended reality in the automotive world.

XR Redefining the automotive industry: Current trends and use case across the value chain

As various industries increasingly adopt XR technologies, the market continues to expand. As per Markets and Markets, the global XR market was valued at approximately **40.1 billion** in 2023, driven by increasing adoption in areas like virtual prototyping, immersive customer experiences, AR-assisted manufacturing, and training, the market is expected to grow at a **CAGR of 22.7%**, potentially reaching **$111.5 billion** by 2028. The growth of the automotive XR market is being **driven** by rising demand for enhanced in-car experiences, technological advancements in XR, increasing focus on safety and convenience, expanding use of XR in automotive design and manufacturing, and the growing shift towards electric and autonomous vehicles.

Some of the major **use cases of XR across the automotive value chain** are -

Design and Development

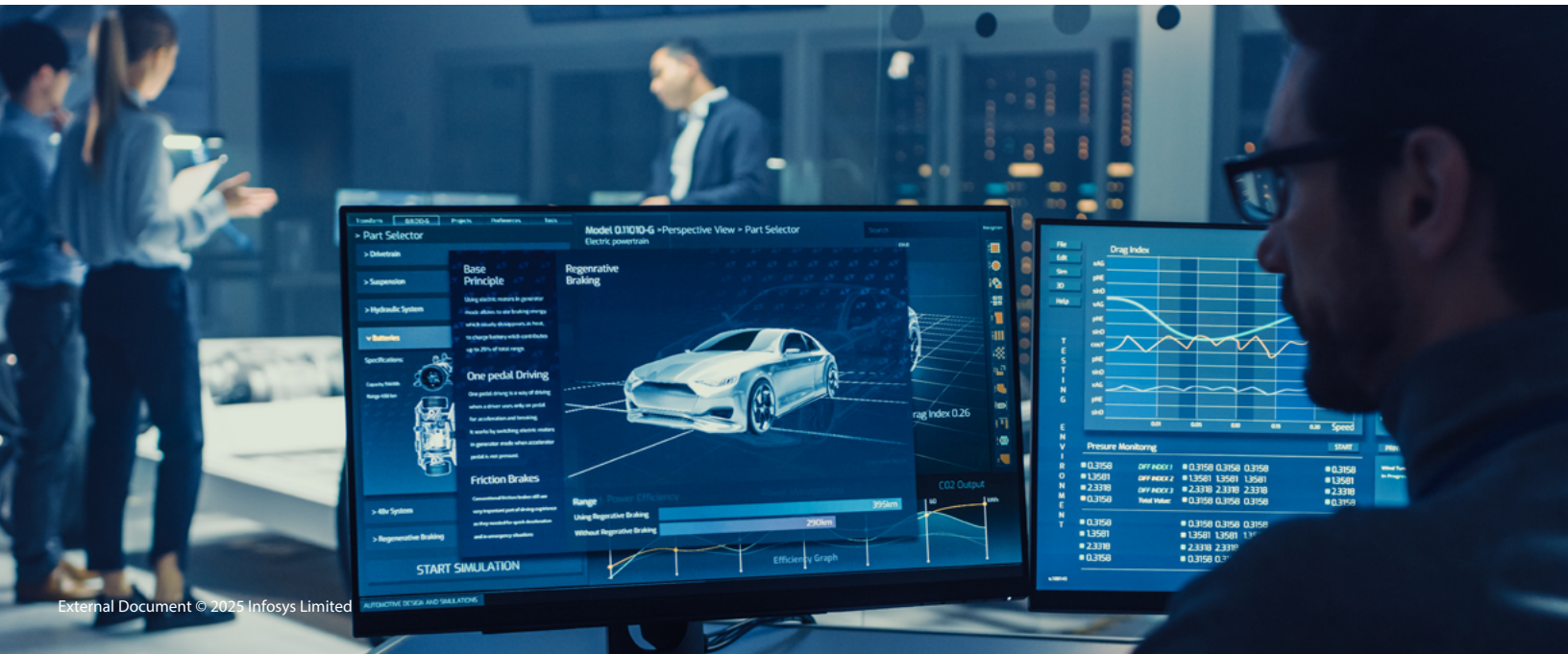
- Virtual Prototyping
- Remote assembly line assistance
- Testing and Safety Simulations
- Autonomous and connected vehicle development
- AR embedded quality control

Ops, Sales and Marketing

- Immersive product demonstration
- Interactive Marketing campaigns
- Employee Training and workshop
- AR-powered vision picking in logistics
- Warehouse and inventory management

Customer Experience and After Sales

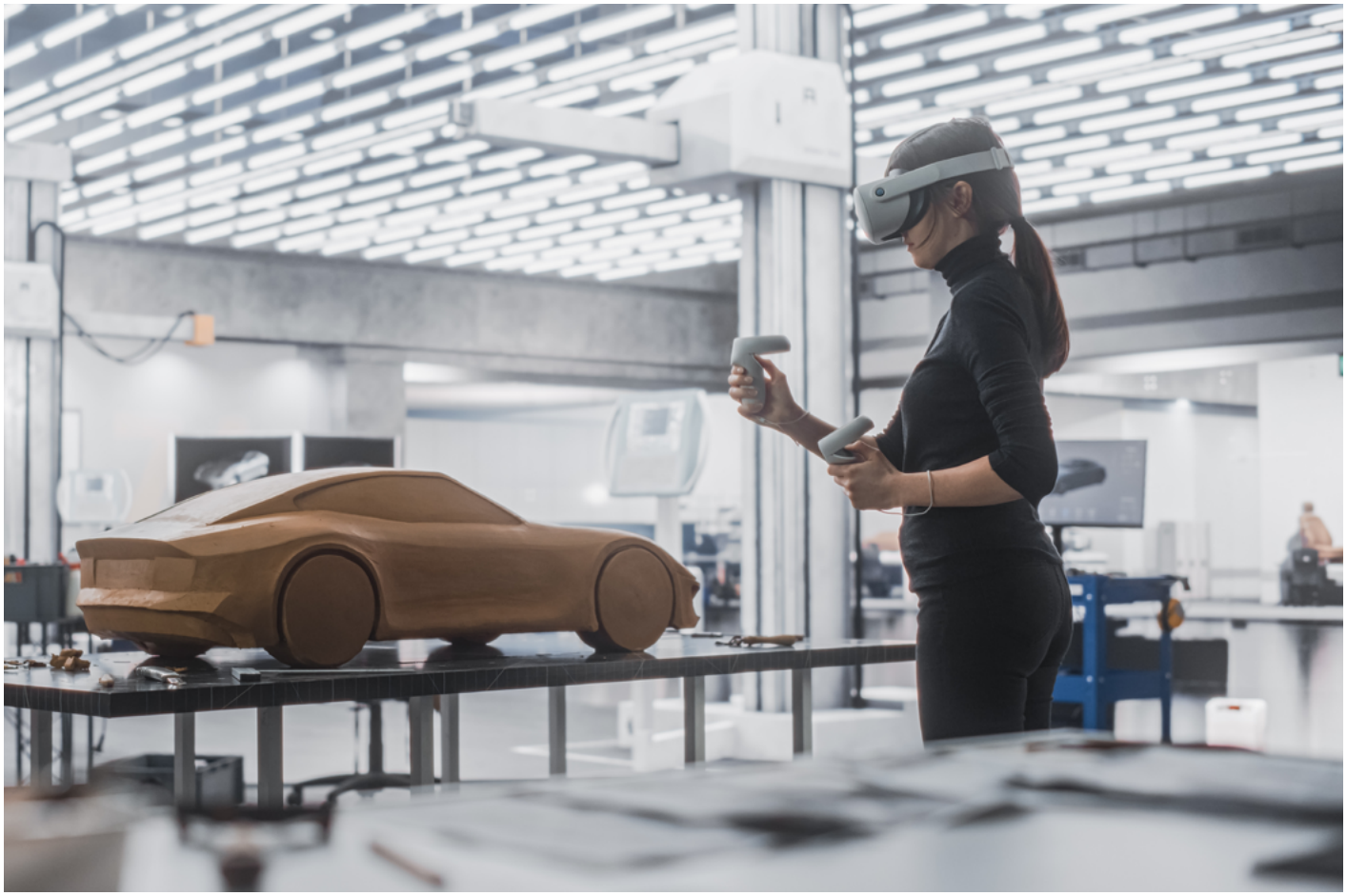
- Virtual Showroom
- VR powered self-driving car test
- AR assisted repair and maintenance
- AR vehicle customization
- In-Car Virtual Reality Entertainment



Design and Development

Virtual Prototyping

Creating physical vehicle prototypes is costly and time-consuming. Extended reality (XR) solves this by enabling digital twins for virtual design. XR-powered prototyping reduces costs and speeds up design iterations. In automotive, VR-based models let engineers simulate vehicle dimensions, detect design flaws early, and make real-time corrections. This approach boosts development speed, enhances productivity, reduces costs, and delivers a higher-quality final product. One such **example** is **Ford**, which has leveraged VR technology for car design, allowing automotive engineers to work together and visualize concepts in a common virtual space. Instead of relying on costly physical models, Ford now actively uses VR headsets to design cars and refine prototypes. **Toyota** has leveraged **Unreal Engine** and **VR** to accelerate design validation while significantly reducing costs. By utilizing the engine's open architecture, Toyota integrates cutting-edge software and technology, streamlining workflows that enhance **vehicle ergonomics**. This approach also enables the company to explore proof-of-concept testing for future autonomous vehicles.



Remote assembly line assistance

AR offers real-time guidance to assembly workers by projecting instructions directly into their line of sight, enhancing efficiency and reducing errors. Workers can see step-by-step procedures through AR devices like smart glasses, which enhance productivity on the production floor. On the other hand, VR allows remote development teams to collaborate on design projects from different locations, interacting with full-scale vehicle models. Virtual twins, digital replicas of physical assets, simulate real-world conditions, enabling the continuous optimization of the vehicle design and assembly processes, reducing downtime, and improving precision. For example, **Porsche** has integrated AR into its assembly line processes to enhance precision and efficiency. Using AR smart glasses, technicians receive real-time visual guidance and overlay instructions during the assembly of complex parts.

Testing and Safety Simulations

XR enables highly realistic testing and safety simulations in virtual environments. Instead of relying on physical prototypes for crash testing, vehicles can be subjected to various simulated crash scenarios using VR to test structural integrity and safety systems. These simulations can also recreate different environmental conditions such as wet roads, extreme weather, and varying terrains. Engineers can evaluate and fine-tune vehicle performance, safety features, and behavior under diverse conditions, helping improve both safety and reliability while reducing costs and development time. For example, **Volvo** implemented virtual reality technology for safety analysis and accident simulations, providing workers with a controlled virtual environment to evaluate and enhance vehicle safety features.

Autonomous and connected Vehicle development

Autonomous and connected vehicles rely heavily on data processing, sensors, and complex algorithms, all of which can be tested and validated using XR platforms. With XR, developers can create sophisticated driving environments that simulate real-world conditions such as city traffic, highway driving, or adverse weather. This immersive testing environment allows for comprehensive evaluation of autonomous systems like object detection, navigation, and decision-making. XR also helps fine-tune connected vehicle technologies, ensuring seamless communication between cars, infrastructure, and external systems. In **Hyundai's** case, AR is used on the factory floor to provide real-time diagnostics and monitoring, enabling engineers to test connected features, like vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) connectivity. This combined VR and AR solution shortens development cycles, improves system accuracy, and enhances overall vehicle safety and functionality in autonomous and connected applications.

AR-embedded quality control

AR is transforming the quality control process in automotive manufacturing by enabling workers to inspect components with enhanced accuracy. AR tools overlay digital models onto the physical parts being produced, allowing instant comparison between the design specifications and the actual product. This ensures any deviations are quickly identified and corrected before moving further down the production line. AR can also display real-time data and analytics, empowering quality control teams to take corrective actions immediately, reducing errors, improving product quality, and ensuring consistent manufacturing standards. For example, **Volvo** partnered with PTC to implement a digital thread using Vuforia AR and ThingWorx IIoT, enabling real-time data synchronization across systems. This integration allows QA technicians to capture defects instantly, creating a feedback loop that enhances engineering and manufacturing processes. The bi-directional data sharing significantly improves product quality and throughput.

Operations, Sales and Marketing

Immersive product demonstration

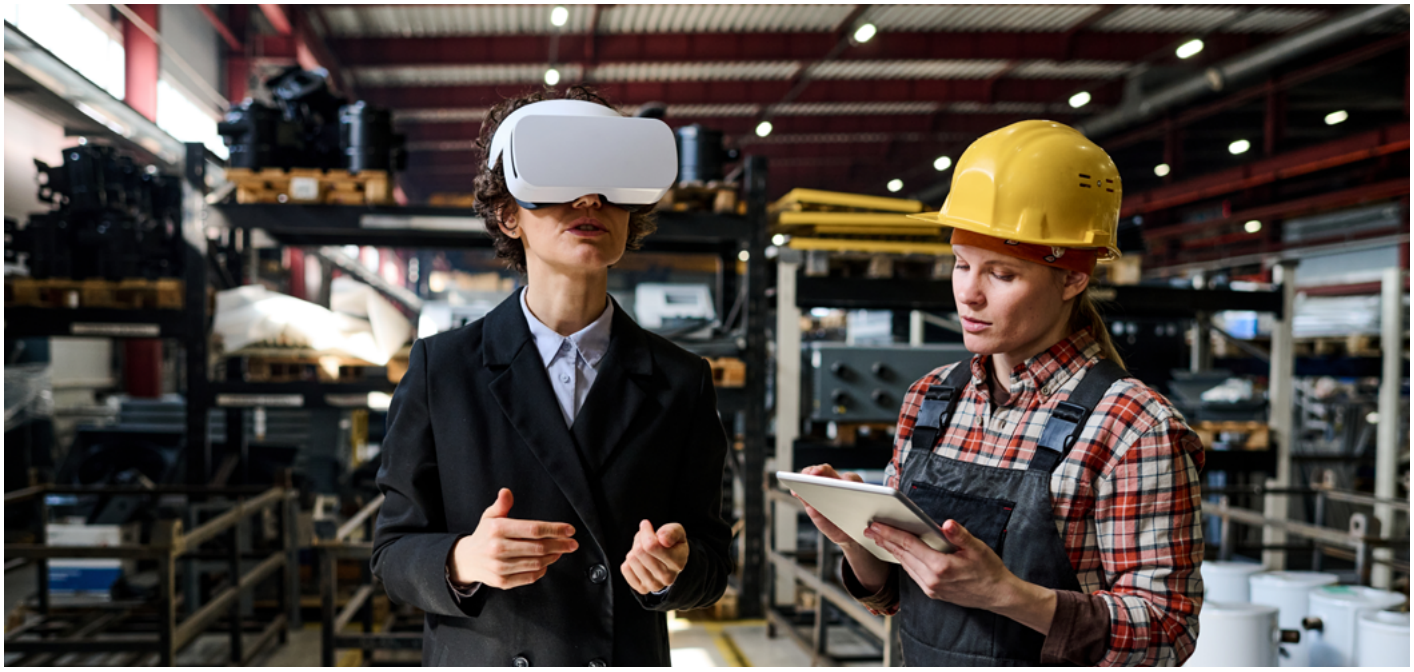
XR technology allows customers to experience immersive product demonstrations without needing to visit a dealership. Using VR or AR, customers can interact with virtual models of vehicles, exploring features such as interior design, functionality, and performance. This immersive experience provides a 360-degree view, allowing potential buyers to visualize the vehicle in different environments or customize it with various color schemes and accessories, enhancing customer engagement and decision-making processes. For example, **Porsche** launched an AR application that enables customers to customize their preferred car model within their own environment. This immersive experience enhances the buying journey by allowing for personalized interaction and detailed exploration of the vehicles, making the selection process more engaging and tailored to individual preferences.

Interactive Marketing campaigns

XR enables automotive brands to launch interactive marketing campaigns that deeply engage consumers. AR-based applications allow users to project virtual vehicles into their surroundings, where they can visualize how the car would look in their own driveway. VR experiences, offered at events or through apps, let customers virtually drive the car or experience unique brand narratives. These interactive elements create memorable marketing experiences that boost brand awareness and drive engagement, leading to higher conversion rates. For example, **BMW** has utilized AR in its promotional campaigns, allowing consumers to virtually view and engage with three-dimensional vehicle models within their own surroundings.

Employee Training and workshop

XR is revolutionizing employee training in the automotive industry by creating realistic simulations for technical training, safety workshops, and hands-on experience. VR can be used to simulate complex repairs or assembly procedures, allowing technicians to practice without needing physical components. AR devices, such as smart glasses, offer real-time, on-the-job guidance, improving learning outcomes. These immersive training sessions help employees understand intricate vehicle systems, new technologies, and assembly procedures more effectively while reducing training costs and risks. Some significant example are **BMW** which has long utilized a virtual assembly line as part of its training program, allowing participants to practice their tasks effectively. Similarly, data from **Ford's** virtual reality training highlights significant improvements in their manufacturing process, resulting in a **70% reduction** in assembly line injuries.



AR-powered vision picking in logistics

In logistics operations, AR-powered vision picking streamlines the process of selecting parts and components. Workers equipped with AR devices receive visual guidance, allowing them to quickly locate items in the warehouse. These AR systems reduce errors, improve accuracy, and increase efficiency in logistics operations. Workers no longer need to rely on paper-based systems or handheld devices, as AR projects the necessary information directly into their line of sight, optimizing the picking process. For example, **Mercedes-Benz** Trucks launched 'Truckopolis,' an immersive VR experience where users can explore the eActros 600 and its associated services in interactive virtual environments. Accessible through VR headsets and web browsers, this experience showcased the brand's innovation in sustainable logistics and strengthened its B2B engagement efforts.

Warehouse and inventory management

XR enhances warehouse and inventory management by providing real-time data visualization and operational insights. AR tools help workers navigate large warehouses efficiently, overlaying information about inventory locations, stock levels, and order-picking routes. Virtual twins can be employed to monitor and simulate warehouse operations, optimize workflows, and identify areas for improvement. This application of XR leads to greater accuracy in stock management, faster order fulfillment, and reduced operational costs, helping automotive companies manage their supply chain more effectively.

Customer Experience and After-sales

Virtual Showroom

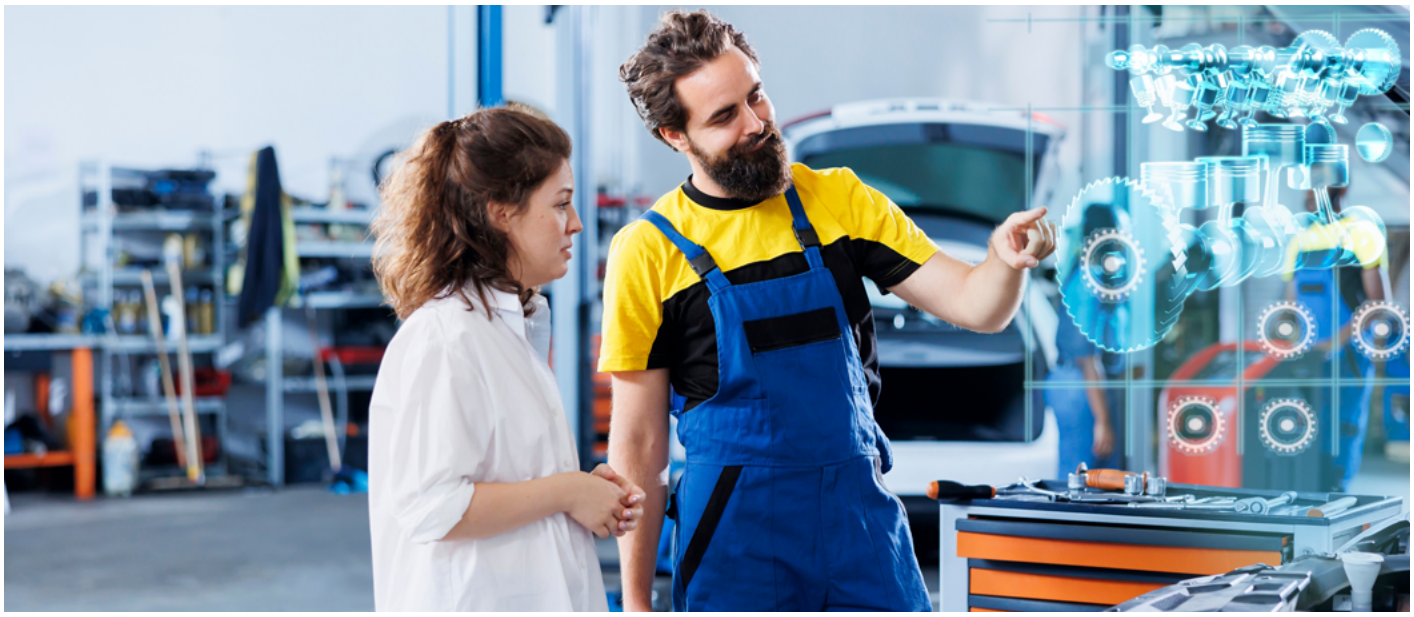
XR has revolutionized the automotive industry with virtual showrooms, allowing customers to explore cars in detail from home. XR provides an immersive experience that surpasses traditional showrooms, allowing customers to explore vehicle features, customize options, and even simulate driving. Virtual showrooms offer dealers a more engaging, maintenance-free sales process, while customers benefit from a personalized experience - interacting with the car's features, such as seat adjustments and audio controls, for a more dynamic and informative exploration than a static brochure or video. A notable **example** in the automotive industry is **KIA**, the South Korean multinational automaker, which launched a **VR showroom** to showcase new vehicle models, providing customers with a more immersive experience. Similarly, **Renault** introduced the **Renault Virtual Studio**, a virtual showroom that allows customers to remotely explore vehicles online. Through a 360° view, users can see every detail of the vehicle and customize its features and accessories, offering a highly interactive and engaging experience.

VR-powered self-driving car test

Current self-driving car testing requires a human driver to ensure the safety of others in case of emergencies or system errors. However, integrating VR with testing software eliminates the need for a driver in the seat. VR-based autonomous vehicle testing significantly reduces costs related to fuel, maintenance, and human oversight. Additionally, virtual traffic simulations offer a completely safe environment for testing, ensuring no risk to other vehicles or pedestrians while still providing thorough and realistic assessments of self-driving technology.

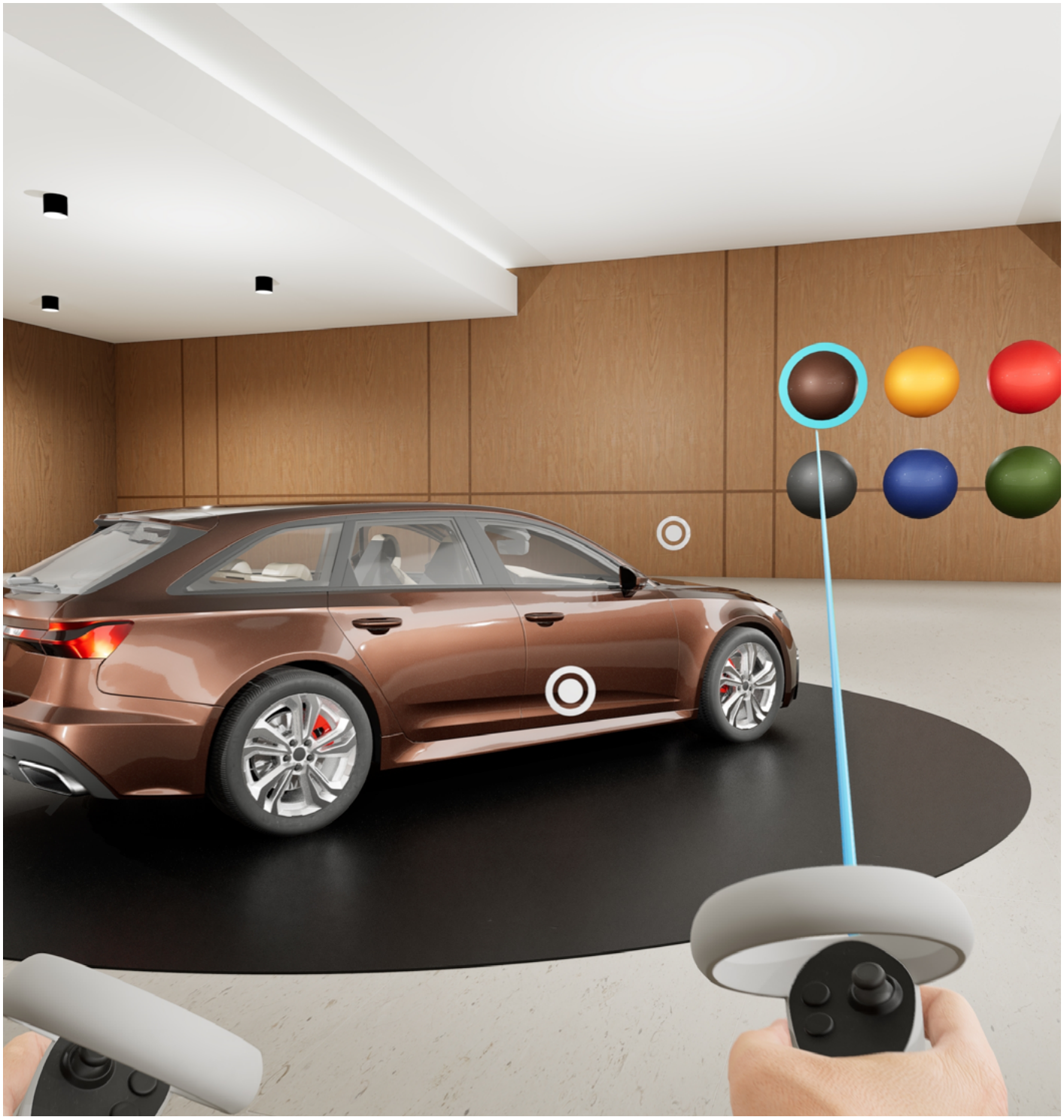
AR-assisted repair and maintenance

AR is transforming maintenance and repair in automotive manufacturing by providing technicians with real-time access to detailed equipment information, such as manuals, schematics, and troubleshooting guides through AR overlays. This enhances diagnostic accuracy, speeds up repairs, and reduces unplanned downtime. Additionally, AR enables remote assistance, allowing experts to guide technicians in real-time via AR-enabled devices, eliminating the need for travel and accelerating issue resolution. By leveraging AR, manufacturers can improve equipment uptime, minimize disruptions, and boost overall operational efficiency. One such example is **Bosch**, which utilizes an AR application in its Bosch Car Service workshops, where navigation arrows guide technicians to hard-to-see automobile components. The app also provides on-screen instructions detailing the necessary actions and tools to use. As a result, Bosch reports that auto technicians now spend 15% less time on each step of maintenance, repair, and operations (MRO) activities compared to working without AR.



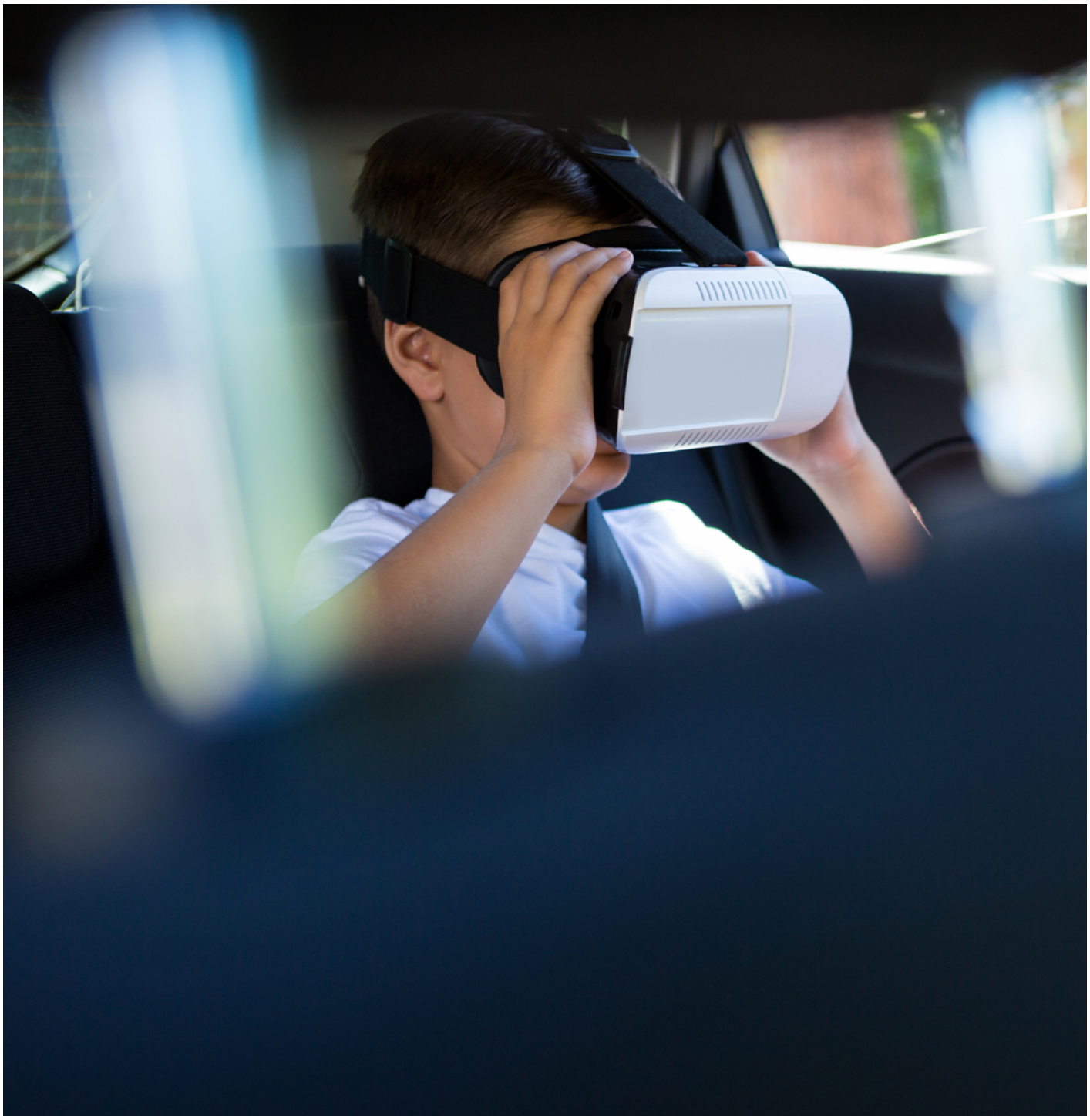
AR vehicle customization

AR enables customers to visualize modifications in real-time, helping them make informed choices and avoid costly errors. Auto body shops and customization centers are increasingly adopting AR to enhance customer interaction and satisfaction. With AR-based apps, customers can customize nearly everything, from the vehicle's color to the wheel design, offering a seamless experience for both interior and exterior upgrades. The process feels akin to designing an avatar in a virtual game, making customization easy and engaging. For example, **Audi** integrated extended reality across multiple areas, such as digital showrooms, vehicle customization, and workforce training. Their "Audi VR Experience" enables customers to have a 360-degree view of the vehicles and accordingly tailor them virtually, offering a more interactive and personalized experience.



In-Car Virtual Reality Entertainment

In-Car Virtual Reality (VR) provides substantial advantages for passenger entertainment and travel, boosting both engagement and productivity during trips. Through techniques like Vehicular Translational Gain, VR can adjust perceived motion, minimizing motion sickness and delivering immersive experiences. Portable VR head-mounted displays (HMDs) enable customers to enjoy highly immersive entertainment while on the move. With long commutes, casual gaming during public transport or car rides has become a popular activity. **Audi** is the first automaker to introduce **virtual-reality entertainment** in its vehicles through a system developed by Holoride, which creates a new realm of immersive entertainment in select Audi models. This technology enhances the travel experience by allowing passengers to engage in a virtual environment synchronized with the car's movements, making journeys more entertaining and reducing the monotony or discomfort of travel.

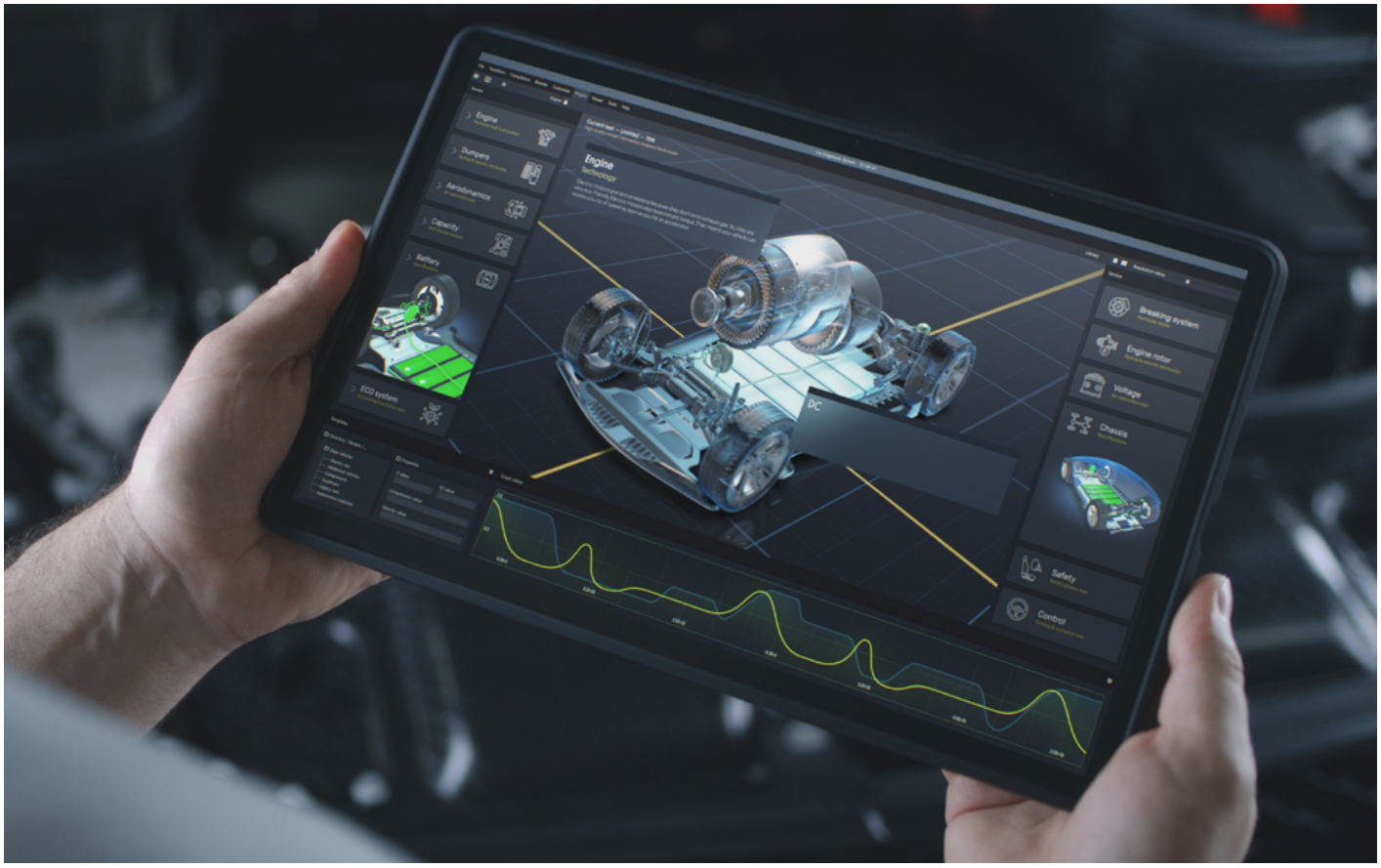


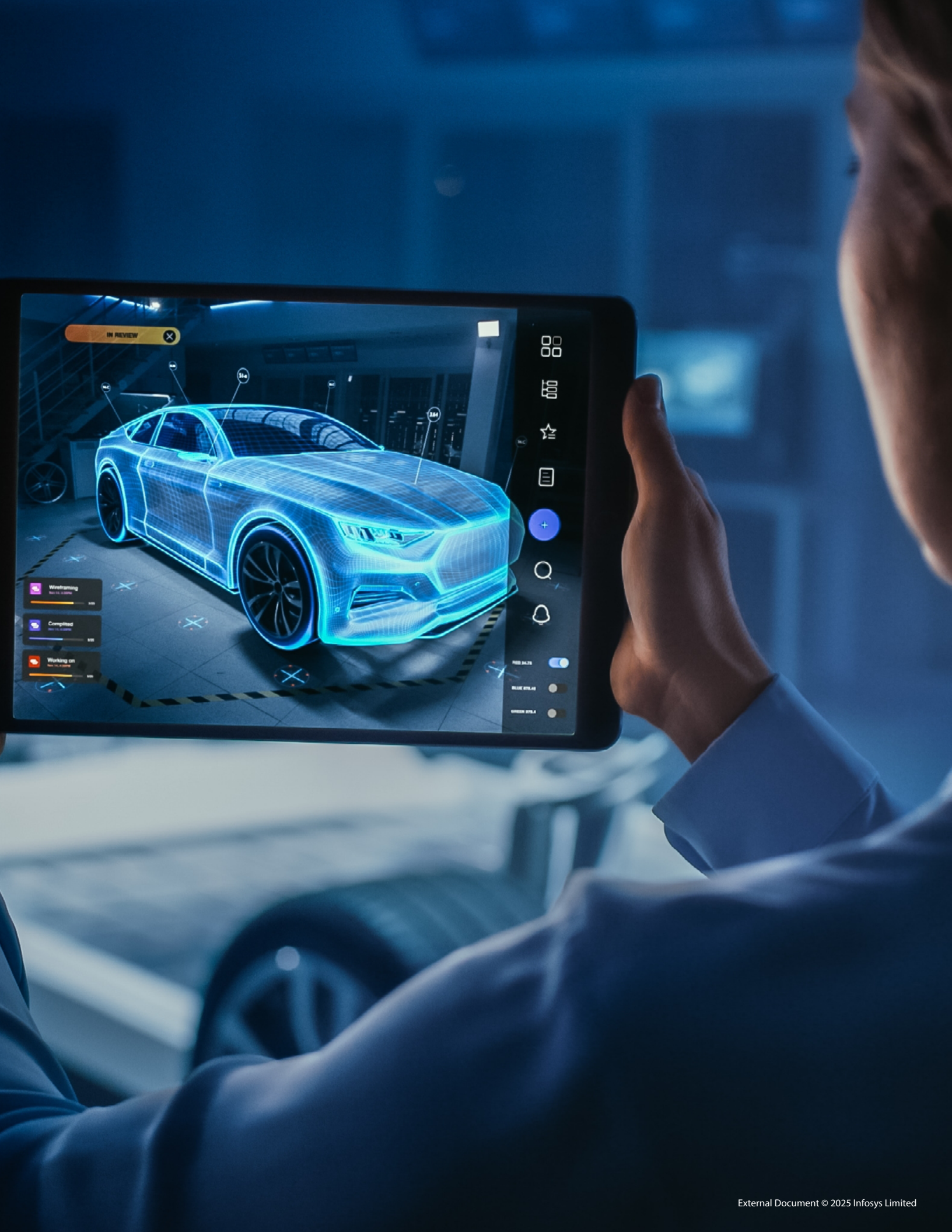
Confronting the Roadblocks to XR Integration in Automotive Value Chains

As automotive companies are integrating XR into their value chain, they are facing numerous challenges across the automotive value chain. As an automotive company embarks on integrating XR into its **design and development** process, it faces significant hurdles. High implementation costs and compatibility issues with existing software hinder progress, while a shortage of skilled professionals raises concerns about protecting intellectual property. Transitioning to **operations, sales, and marketing**, the company struggles to scale XR technology, finding existing devices unreasonable and many potential customers hesitant to engage with it. Additionally, creating and maintaining immersive content for customer engagement proves resource-intensive. In **customer experience and after-sales**, limited device accessibility and compatibility issues restrict adoption, while the ongoing costs of maintaining XR support applications and privacy concerns related to customer data further complicate the implementation process.

XR in Automotives: Driving Towards a High-Tech Future

There are numerous examples of automotive companies already investigating and testing the underline possibilities of an XR, paving the way for next-generation mobility. In the coming years, extended reality will continue to reshape the automotive landscape, driving innovation across every facet of the industry. From immersive design and development processes that shorten production cycles to hyper-personalized customer experiences that redefine how vehicles are marketed and purchased, XR will be a cornerstone of next-generation mobility. As autonomous driving technologies evolve, XR will also play a critical role in safety simulations, real-time decision-making, and connected vehicle ecosystems. With AR-powered maintenance, training, and logistics optimization, XR will not only enhance operational efficiency but also elevate customer engagement and satisfaction. As the automotive industry embraces these cutting-edge technologies, XR will pave the way for a future where the physical and virtual worlds merge, unlocking unprecedented possibilities for mobility.





About the Authors

Parul Gupta is a Senior Consultant at iCETS, specializing in the analysis of the latest trends and groundbreaking technologies that are transforming various industries. Her expertise lies particularly in emerging technologies such as AI, the Metaverse, extended reality, and beyond. Parul is dedicated to understanding how these innovations are impacting different sectors. With a background spanning across marketing, operations, business research, analytics, strategy, and consulting, she is a passionate technology enthusiast who excels at finding innovative solutions to help businesses to remain competitive and stay ahead of the curve.

Hindavi Shetye is a Senior Associate Consultant at iCETS, specializing in researching industry trends and emerging technologies, along with their impact across various sectors. She is a research enthusiast, who enjoys delving into and learning about cutting-edge and next-generation technologies.

References

- https://www.journee.ai/en/insights/blog/solution-by-industry/where-digital-and-physical-world-collide-xr-and-immersive-virtual-experiences-used-in-automotive-industry/
- https://www.youtube.com/watch?v=S0YSp2Zuw10
- https://www.youtube.com/watch?v=kkTL_UkcqTY
- https://www.techviz.net/en/xr-for-automotive-transportation-industries/
- https://www.xrtoday.com/virtual-reality/the-state-of-xr-in-the-automotive-industry/
- https://aquentstudios.com/blog/innovative-uses-for-extended-reality-xr-in-automotive/
- https://dreamtek.tv/virtual-showrooms-test-drives-and-handovers/
- https://unity.com/resources/why-automotive-innovators-embrace-xr
- https://www.idc.com/getdoc.jsp?containerId=prUS51971224

For more information, contact askus@infosys.com

Infosys®
Navigate your next