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Generative AI for the automotive industry

The automotive industry is undergoing a significant transformation, with increasing adoption of AI technologies to enhance vehicle performance, safety and efficiency. The incorporation of gen AI in the sector has the potential to revolutionize driver experience, vehicle design optimization, autonomous driving, predictive maintenance and supply chain management.

Gen AI refers to a category of artificial intelligence techniques that can generate new data or output based on patterns and examples it has learned from a training dataset. It involves models that are trained to understand and generate complex data such as images, text or even entire scenes.

A new paradigm

While traditional AI excels in tasks such as pattern recognition, decision-making and data analytics, gen AI introduces an entirely new dimension of capabilities that sets it apart:

Conversational

Human-like conversations with customers, suppliers, and more.

Referential

Refer, summarize, and interpret information such as contractual documents and more.

Creative

Create new content such as documentation, product design enhancements, software code and more.

“Gen AI” has brought AI to an inflection point

Run your business and apply AI to help

Paradigm shift →

Embed gen AI into the fabric of your business strategy

What makes gen AI different?

Customer engagement (personalization)

Conversational skills

- Understands & generates natural language
- In-depth understanding of spoken and written words
- Understands humor

Dialogue

- Understands & generates spoken language
- Ability to remember the context of your conversation
- Confirmation bias

Content generation

Image

- Generates, edits and understands image
- Creates images as per prompts, e.g. ad campaigns with AI-generated images

Video/audio

- Generates, edits and understands video and audio

Content synthesis

Synthesizes data

- Summarizes the text and gives action items
- Simulates scenarios and provides rich datasets for software training

Code generation

Code generation

- Generates code as per text prompts
- Personalizes products for different customers based on code updates

Massive potential

Gen AI has the potential to revolutionize the automotive industry in the coming years. According to Statistica, "The market size in the Generative AI market is projected to reach $44.9B in 2023," and it "is expected to show an annual growth rate (CAGR 2023-2030) of 24.4%, resulting in a market volume of $207B by 2030." The drivers for this exponential growth in the automotive industry are changing consumer behavior, cost pressures, labor shortages and disruption.

As the technology evolves, some gen AI models have gained traction in the automotive space for their wide-ranging applicability across the value chain, as shown below:

Gen AI model	Description	Application in Automotive
 Variational Autoencoder (VAE)	• Often used in image and video processing • Works by taking an input image and encoding it into a lower-dimensional representation, which is then decoded to produce an output image	• Designs complex parts • Supply chain anamoly detection and optimization
 Generative Adversarial Networks (GANs)	• Used to generate new data samples that are similar to the training data (generator) • Accurately classify the data as real or fake (discriminator)	• Document/training content generation • 3D printing • Autonomous vehicles • Route optimization
 Recurrent Neural Networks (RNNs)	• Used for sequential data processing such as natural language processing and time-series analysis • Output of each step is used as the input for next step	• Voice assistance for in-vehicle support • Customer support: Automated customer service interactions, scheduling and maintenance • Intuitive sentiment analysis, translation, summarization and response generation as well as non-critical vehicle operations such as climate control • Interactive sales assistance
 Long Short-Term Memory (LSTM) Networks	• Type of RNN that is designed to handle long sequences of data which can be complex and difficult to analyze • LSTMs can learn to recognize patterns in data that occur over long periods of time	• Demand forecasting • Predictive vehicle management • Supplier management: contract negotiation and optimization • Warranty support • Product optimization

Note: The list of Gen AI models and automotive applications listed above is not exhaustive, and examples are given to illustrate how applications may vary based on the Gen AI model

Early interest use cases

The potential benefits and use cases for the auto industry are astonishing, offering leaders the opportunity to gain a competitive advantage—but only if they have a cohesive plan in place with senior leadership and integration with business goals.

OEMs have already started their journey on some use cases, leveraging the technology's ability to process large volumes of data and offer contextual intelligence. Through experiments like those outlined here, organizations are testing the waters, with a commitment to expand the use of gen AI to other parts of the value chain.

Interactive In-Car Driving Assistant

An in-car driving assistant can improve the customer experience, especially for lone drivers

- It can make trips more entertaining by acting as an interactive partner for the driver
- It can personalize the driving experience depending on the person driving the vehicle
- It can perform tasks such as controlling A/C and playing music hands-free
- Additionally, it can save lives by recognizing a dozing or intoxicated driver, and automatically braking the car

Benefits

- In-car driving assistant could significantly improve customer satisfaction
- As customers connect with the driving assistant on a deeper level, it could lead to loyal and repeat customers
- Through personalized suggestions, it could help sell additional services

Advanced Driver Assistance Systems (ADAS)

As the number of software-driven features increases, so does the possibility of simulating the test environment. The next generation of AI could construct test cases for extreme environments or rare scenarios that cannot be tested on a physical vehicle.

Benefits

- Gen AI-powered virtual simulation could enhance the quality of vehicles by simulating an exhaustive list of test cases.
- It could reduce the cost of testing and the time required to bring vehicles to market.

Complex R&D part design generator

When designing new automotive components, gen AI could propose a better design based on a variety of criteria such as increased durability or reduced cost. By analyzing the designs of all vehicle components, Gen AI models could generate novel designs for specific components. Design engineers can then choose the most applicable design for a given situation.

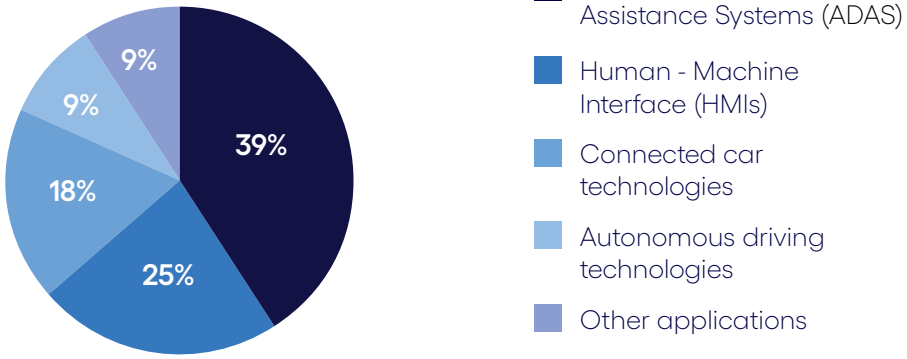
Benefits

- The part design generator could significantly accelerate the vehicle development lifecycle and decrease the time required to bring new models to market
- It could reduce the number of engineers required to design products, reducing R&D expenditures
- Better design suggestions could simultaneously improve vehicle quality and reduce costs.

Front running OEMs have already invested in the early interest use cases

Gen AI in automotive market

Share by application, 2022 (%)



OEM	Value chain	Use case
	R&D	Uses generative design to create lighter parts of its vehicles.
	Customer driving experience	Has introduced the GPT model into 900K cars as a part of a beta program. This model can be accessed through the company's voice assistant, allowing drivers to inquire about their destination and seek suggestions for new dinner recipes or answer complex questions.
	Design	Leverages an AI model that considers precise design specifications such as weight optimization, connection points and load capacity. The model generates a wide range of design alternatives, yielding innovative, efficient and visually appealing vehicle parts that meet the design criteria.
	Design	Toyota Research Institute (TRI) has introduced an innovative gen AI technique to enhance vehicle designers' capabilities. By leveraging publicly available text-to-image gen AI tools, designers can incorporate initial design sketches and engineer constraints into their creative process.
	Design	Gen AI plays a vital role in enhancing Advanced Driver Asssistance Systems (ADAS). Tesla's autopilot system, powered by AI, utilizes gen AI models to comprehend and gain insights from a wide range of driving scenarios, thereby continuously improving its capabilities.

Potential use cases

As noted above, some OEMs have already begun their gen AI journey, pursuing projects that will both bear fruit quickly and serve as a test bed for additional future initiatives.

And make no mistake, those initiatives are nearly endless. We believe that if implemented wisely, gen AI will benefit every link in the value chain: the car-buying and ownership experience, the driver and passenger interface, service and maintenance, R&D, and the supply chain. Here we present some of the many additional use cases and the benefits they bring as envisioned by Cognizant's experts—and classified into four categories:

- Customer engagement
- Content generation
- Code generation (predictive analytics)
- Content synthesis

Customer engagement

It's often said that today's autos are essentially computer systems on wheels. And it's true, but guess what? You ain't seen nothing yet. Gen AI will play a major role in the ongoing evolution of cars into centers for entertainment, information and education.

Digital cockpits:

- **Virtual assistant and voice control:** Gen AI can be used to develop virtual assistants that are capable of natural language processing and understanding. These assistants can respond to voice commands, provide information, control various functions of the vehicle and interact with the driver in a conversational manner.
- **Personalization and customization:** Gen AI can analyze driver preferences and behavior to personalize the digital cockpit experience. It can learn from individual driving patterns, environmental conditions and user feedback - to customize settings such as seat position, temperature, music preferences and automatic climate control, creating a tailored environment for each driver.
- Other use cases in this area include interior design and visualization, augmented reality and heads-up display, gesture and emotion prediction, and predictive maintenance.

Connected vehicles:

- **Intelligent routing and navigation:** Gen AI can analyze real-time traffic data, weather conditions and historical traffic patterns to optimize routing and navigation, helping drivers avoid traffic jams, save time and fuel, and reduce emissions.
- Other use cases in this area include personalized in-car entertainment, driver assistance and safety, vehicle diagnostics and remote monitoring, and behavioral analysis and insurance.

Battery management systems:

- **Battery State of Health (SoH) estimation:** Gen AI can analyze historical battery data such as voltage, current, temperature and cycle information, to estimate the state of health of the battery. By learning from this data, gen AI models can predict the remaining useful life of the battery and inform system operators about its degradation, enabling proactive maintenance and replacement planning.

Content generation

While gen AI is rewriting the experience inside the cockpit, it will also help make travel safer, more predictable, and less stressful. These use cases highlight the potential for continued development of ADAS.

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Image analytics

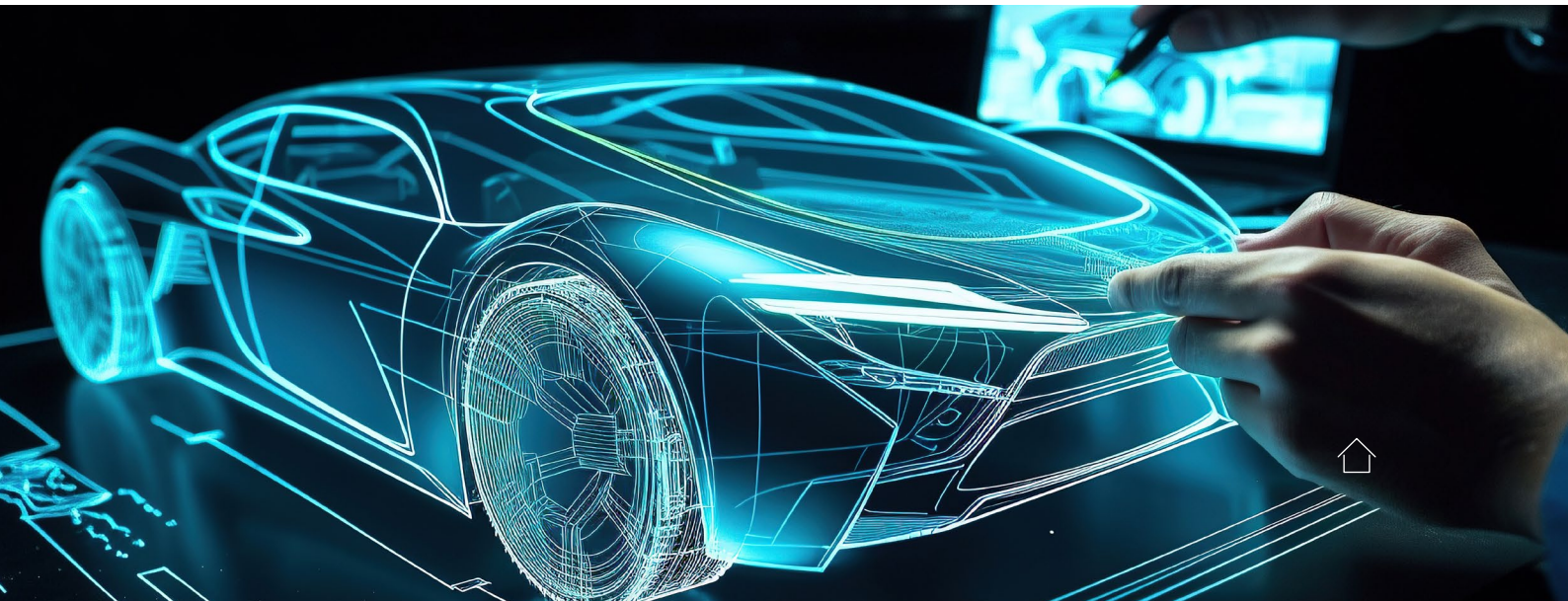
- **Object detection and recognition:** Gen AI can analyze large datasets of images labeled with various objects such as pedestrians, vehicles, traffic signs and road markings. By learning from this data, gen AI models can accurately detect and recognize objects in real-time from ADAS camera footage, providing crucial information for collision warning systems, lane departure warnings and automatic emergency braking.
- **Semantic segmentation:** Gen AI can analyze annotated images and maps to understand the semantic information of different objects and road scenes. By training on this data, gen AI models can precisely identify and segment various elements on the road such as lanes, sidewalks, traffic signs and other roadside objects. This enables ADAS systems to interpret the environment accurately and make informed decisions.
- **Object detection and tracking:** Gen AI can analyze real-time camera data to accurately detect and track objects such as vehicles, pedestrians and obstacles, in the surrounding environment. By learning from large datasets, gen AI models can understand the context and depth of the scene, enabling precise AR overlays, such as highlighting potential hazards or providing navigation instructions.
- Other use cases in this area include depth estimation, anomaly detection, environmental prediction, and calibration and accuracy improvement.

Code generation (predictive analytics)

The potential of gen AI is not at all limited to what goes on in and around individual vehicles. The technology's predictive capabilities will help OEMs optimize the supply chain, the buying experience, maintenance and relationships with dealers.

Supply chain management

- **Demand forecasting:** Gen AI can analyze historical sales data, market trends, external factors and other relevant data to generate accurate demand forecasts. By considering multiple variables and complex patterns, gen AI models can provide more precise predictions, enabling better inventory planning, production scheduling, and order management.
- **Inventory optimization:** Gen AI can analyze inventory levels, customer demand patterns, lead times and other factors to optimize inventory management. By generating optimal inventory policies, including reorder points, safety stock levels and replenishment strategies, gen AI helps minimize stockouts, reduce carrying costs and improve customer satisfaction.
- Other use cases in this area include route optimization, supplier evaluation and selection, risk management, product lifecycle management, and sustainability and environmental impact.



Dealer management solutions

- **Inventory management:** Gen AI can analyze historical sales data, market trends, customer preferences and other factors to generate accurate demand forecasts for each dealer location. By considering these forecasts, gen AI models can optimize inventory allocation and replenishment strategies, ensuring that each dealer has the right mix and quantity of products to meet customer demand.
- **Sales and pricing optimization:** Gen AI can analyze historical sales data, market conditions, competitor pricing, and other relevant factors to optimize sales strategies and pricing decisions at the dealer level. By considering variables such as product demand, competitor activity and customer behavior, gen AI models can generate recommendations on sales promotions, discounts and pricing adjustments to maximize profitability and sales performance.
- Other use cases in this area include dealer performance analysis, customer relationship management, inventory ordering and fulfillment, dealer network expansion and optimization, and after-sale service and support.

Connected vehicles

- **Predictive maintenance:** Gen AI can analyze real-time data from vehicle sensors and systems to predict potential maintenance issues before they occur. By monitoring factors such as engine performance, tire wear, battery health and other crucial parameters, gen AI models can provide early warning signs and recommend proactive maintenance actions, reducing the risk of breakdowns and increasing vehicle uptime.

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Battery management systems

- **Optimal charging profiles:** Gen AI can analyze real-time battery data such as charge and discharge rates, temperature and voltage, to optimize the charging and discharging profiles of the battery. By learning the characteristics and limitations of the battery, gen AI models can adjust charging parameters such as charging speed, current limit and voltage limit, to minimize energy loss, reduce degradation and improve overall battery performance.
- Other use cases in this area include fault detection and diagnosis, thermal management optimization, load and usage prediction, and energy storage system design and optimization.

Content synthesis

One factor holding back development of truly autonomous vehicles is the difficulty of gathering sufficient testing data, especially in extreme situations—which are, by definition, rare. Gen AI can address this by creating synthetic data. In the realm of testing everything from crash worthiness to vibration to ADAS, its potential is limitless.

ADAS and autonomous vehicles

- **Sensor data generation:** Generative AI models can be used to generate synthetic sensor data, such as LiDAR, radar, or camera images. This artificial data can be used to augment real-world sensor data, which helps in training and testing autonomous vehicle perception systems without relying solely on expensive and time-consuming real-world data collection.
- **Simulation and testing:** Gen AI can be employed to create virtual environments and scenarios for simulation and testing of ADAS and autonomous systems. These simulated environments allow comprehensive testing of vehicle perception and decision-making, and control algorithms in a safe and controlled manner before deploying them in real-world scenarios.
- Other use cases in this area include scene reconstruction, behavioral prediction, high-definition map generation and scenario generation.

Full vehicle validation

- **Crash testing:** Gen AI can create realistic virtual crash scenarios to test a vehicle's structural integrity and occupant safety. By simulating different collision scenarios, gen AI allows faster and more cost-effective crash testing, enabling engineers to evaluate and optimize vehicle designs for enhanced safety.

- **Durability testing:** Gen AI can simulate long-term usage and environmental conditions to assess a vehicle's durability. By generating virtual driving profiles that mimic different road conditions, loads and stress factors, gen AI aids in identifying potential weaknesses in vehicle components such as suspension systems, tires and chassis, enabling manufacturers to enhance vehicle reliability.
- Other use cases in this area include aerodynamics optimization, noise, vibration and harshness analysis, software validation, real-world driving emulation and energy efficiency optimization.

Simulation and testing

- **Scenario generation:** Gen AI can generate diverse virtual scenarios for testing autonomous driving systems. By analyzing real-world data and incorporating various factors such as weather conditions, traffic patterns, road types and unexpected events, gen AI models can create simulation scenarios that mimic real-world driving situations. This enables thorough testing of autonomous systems under different circumstances and helps uncover any potential issues or vulnerabilities.
- **Anomaly detection:** Gen AI can help identify abnormal behavior during simulation testing. By learning from large datasets of normal driving patterns and analyzing real-time data from sensors, gen AI models can detect anomalies that deviate from typical driving behaviors. This helps in uncovering potential risks, identifying system failures and improving the safety of autonomous vehicles.
- Other use cases in this area include sensor simulation, traffic simulation, failure mode simulation, and virtual testing environment.

Augmented Reality (AR)

- **Scene understanding and contextual information:** Gen AI can analyze sensor data, including camera feeds, LIDAR scans and GPS information, to understand the scene and extract useful contextual information. By learning from a wide range of data sources, gen AI models can identify road conditions, traffic patterns, signage and landmarks, enabling the AR system to provide relevant and meaningful information tailored to the current driving situation.
- Other use cases in this area include virtual object placement and integration, real-time simulations and predictions, personalized AR interfaces, and training and assistance for service technicians.

Getting started with gen AI

Through our interactions with clients, we understand there's growing interest in leveraging gen AI in the automotive industry. As with any new technology, organizations will benefit from a structured approach as they explore this landscape.

Cognizant recommends a five-step approach for organizations starting from scratch, coupled with supporting initiatives to embark on gen AI technology. Specifically, as companies will be at various stages of maturity; they should choose the starting point that applies to them.

Supporting Initiatives

Foundational Systems & Data Assessment and Readiness
Assesses organizational data, architecture, infra requirements and build a strong foundation, including operating model and governance

Organization Readiness & Change Management
Helps employees understand and adopt gen AI to drive business, values and strategies

Cross-Disciplinary Governance Approach
Engages cross-disciplinary teams to define AI strategy as well as track and report progress over time to provide openness on adoption and success

Security and Compliance
Evaluates potential risks, regulatory requirements and compliance and proactively manages them through policy, control, enablers and training

Developing a strategy

We believe gen AI is a core competency that needs to be underpinned with strong, foundational technology platforms, a robust governance and oversight function, and a flexible exploration/experimentation access model. This is not only to realize the benefits rapidly from the use cases identified above, but also to help automakers manage costs, ensure security and safeguard intellectual property. We therefore recommend the following steps for automakers, as they develop a clear strategy around gen AI.

Guiding principles for deploying a gen AI strategy

Automakers must invest in understanding the gen AI technology's capabilities and evaluate the benefits it can offer their businesses. This may require identifying specific functions and use cases that could benefit from gen AI. To strike the right balance between risk and demand in gen AI use case deployment, OEMs can follow these guiding principles:

- **Start with low risk and high demand use cases:** Begin with use cases that have high demand and minimal risk, to understand the capabilities and limitations of language models within the automotive business context. Gradually, expand to more complex scenarios as confidence and experience grow. Many use cases, as mentioned before, can be a good starting point of a gen AI journey. We have seen auto organizations trying to improve the effectiveness of internal process, enable automation, and improve customer experience since it is inexpensive to create a framework to supervise the output of gen AI in such scenarios. Examples could be use cases such as agent-assistive capabilities for contact centers, knowledge management, and content creation and translation.

- **Select the right tools and platforms:** As OEMs have already invested in AI, they need to appreciate that gen AI will complement their existing AI initiatives and will help them realize greater business value. Several existing tools and platforms have integrated AI into their products such as Salesforce Einstein and Microsoft 365 Copilot. But these tools do not achieve the full potential of gen AI. To unlock the full potential, OEMs must invest in capabilities which span across essential applications.

- **Adopt a collaborative approach:** Gen AI requires a truly diverse set of skills to be implemented successfully. Organizations should collaborate with stakeholders such as customer and dealer representatives, data scientists, legal experts, in addition to IT specialists. Organizations should also foster collaboration and communication to ensure a comprehensive assessment of risks and demand.

- **Use iterative deployment:** Adopt an iterative approach, continuously evaluating the performance, impact, and risks associated with language models. Implement feedback loops and mechanisms to address issues, refine processes and improve outcomes over time.

- **Training and support:** Develop a comprehensive training program to upskill the workforce on gen AI technologies. This is crucial in an area as new as gen AI. Today, the skills required to activate a strategy simply do not exist at scale.

Selecting the right partner

It is critical that automakers select the right partner as they embark on a gen AI journey. Any organization that you partner with should bring insights into your business from other OEMs, tier 1 suppliers, dealers and automotive technology companies.

Keeping in mind how critical gen AI will be in the automotive industry, Cognizant has invested in a Neuro AI platform that brings together multiple features spanning areas such as IT services, automation and gen AI, spearheading proof of concepts for multiple clients. Cognizant also has a deep knowledge of open-source language models that can be deployed for specific use cases. We are currently working with several automotive clients to plan their gen AI journey in collaboration with our hyper-scaler partners, and we would be happy to be your partner as you start your journey.

Conclusion

Gen AI has the potential to revolutionize the automotive industry—enhancing customer experience, reducing cost and driving innovation in every process. Gen AI is no longer an option, but a necessity to build competitive differentiators for organizations. While the technology is still evolving, organizations can determine high-feasibility, high-value use cases that offer a compelling proposition to explore and get started with their gen AI journey. The time to act is now!

This is just the beginning of change that will revolutionize the automotive industry. To learn more, visit the **automotive section** of our website or **contact us.**

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Cognizant (Nasdaq-100: CTSH) engineers modern businesses. We help our clients modernize technology, reimagine processes and transform experiences so they can stay ahead in our fast-changing world. Together, we're improving everyday life. See how at www.cognizant.com or @Cognizant.

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