unity Whitepaper

Top 5 Ways Real-Time 3D Is Revolutionizing the Automotive Product Lifecycle

By Ed Martin and Yao Zhai

Executive Summary

In this whitepaper, we examine the impact that Real-Time 3D (RT3D) is having on the product lifecycle in the automotive industry. While RT3D has clear implications for manufacturing as well as sales and marketing, it has future-reaching possibilities for the world of autonomous vehicles, human-machine interface (HMI), and operations and maintenance training.

RT3D tools allow designers and engineers to engage with virtual objects and environments, and help them realize their automotive vision. We have identified five main areas where RT3D is disrupting the automotive industry:

1. **Product Design Visualization:** In this area, RT3D takes 2D digital visualization to the next level. By experiencing a vehicle in an immersive environment, designers, engineers and buyers can collaborate to accelerate the iterative process and reduce costs.
2. **Simulation for Autonomous Vehicles:** The future of driving demands large-scale simulation and testing. To perfect the technology of autonomous vehicles, RT3D platforms allow test scenarios and conditions to be repeated and adjusted granularly. Simulation can occur rapidly with great precision. The cost of testing at this scale in the real world would be prohibitive.
3. **Human-Machine Interface (HMI):** With RT3D, engineers and others can better understand how drivers and passengers interact technologically within the cabin environment, both with each other and with the vehicle. This experience is essential to evolving HMI systems and improving the quality of everyone's vehicular experience.
4. **Training and Guidance:** Virtual training alleviates resources and ensures a safe environment, both for trainees and equipment. Data can be gathered to evaluate trainees, and identify – and improve – troublesome processes. Further, owners and operators can benefit from augmented reality (AR) tools that guide them in using various features and performing basic maintenance.
5. **Sales and Marketing:** Immersive 3D experiences offer consumers the ultimate research and customization tool. Showrooms can boast limitless inventory. For marketing professionals, consumer virtual interactions become a valuable source of data enabling them to capture buyer behavior and convert it into targeted sales.

RT3D is a technology transforming the automotive industry into a streamlined, efficient and cost-effective delivery system for superior user experiences.

Immersive virtual experiences are transforming automotive

"As the ways in which we interact with technology evolve, the AR/VR revolution has reached a tipping point, with enterprise adoption outpacing the consumer world. Market leaders are shifting their focus from pilots and niche offerings to strategies anchored in prototypes designed for industrialization."

– Deloitte Insights[1]

Real-Time 3D (RT3D) has quickly become a major factor throughout the automotive industry and across the product lifecycle. Major technological advances mean that diverse areas such as design, manufacturing, training, sales and marketing are benefiting from RT3D's immediacy and effectiveness.

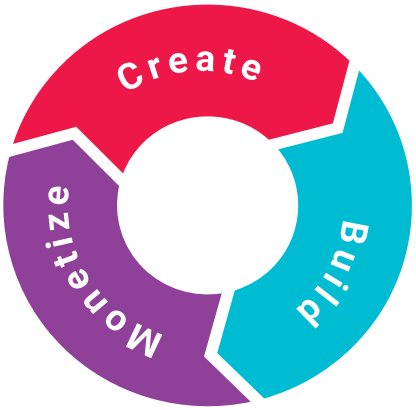
In just a few years, RT3D applications have rapidly matured from novelty experiences to valuable business tools. Innovative developers are combining leading-edge tech like head-mounted displays, interface devices, high-definition (HD) cameras, real-time rendering software, high-speed networks, and compelling audio to create and deliver rich, interactive virtual reality (VR), augmented reality (AR) and mixed reality (MR) experiences.

Collectively called XR, these immersive, real-time experiences are having an impact well beyond traditional 2D and 3D visualization solutions. That's because they are capable of engaging far more of our senses – which leads to deeper, more meaningful, and even emotional experiences, with wide implications for the entire automotive lifecycle, ranging from early design collaboration to aftermarket support and maintenance.

World-class RT3D empowers teams of developers and artists to create photorealistic products. Next, RT3D allows them to build simulations to efficiently improve and manufacture products. As a final step in the product lifecycle, RT3D helps original equipment manufacturers (OEMs) and others monetize products via interactive marketing, sales, service, and in-car experiences.

Many applications are developed throughout the product lifecycle, which ranges from R&D to Sales and Marketing. Here are some of the typical RT3D use cases throughout the product lifecycle:

RT3D product lifecycle



Create & Design

- Experience-based design
- Immersive collaboration for rapid iteration
- Human machine interface development

Simulation & Visualization

- Autonomous system development
- Virtual commissioning
- System-level simulation

Production & Deployment

- Digital factory
- HMI deployment
- Training & guidance

Service

- Internet of Things (IoT)-based experience
- AR-assisted maintenance
- Interactive training
- Connected customer experience

Sales & Marketing

- Persistent, interactive offline/ online technologies to consumers experience (AR, VR, rendering, cloud streaming, wearable tech touch screens, HD screens, apps, web, etc.)
- Dealer showroom and event XR engagement

While there are dozens of use cases for RT3D in automotive, in this whitepaper we focus on five significant areas where innovative developers, original equipment manufacturers (OEMs), and creative agencies are using it for business-to-business (B2B) and business-to-consumer (B2C) purposes:

- Product Design Visualization
- Simulation for Autonomous Vehicles
- Human-Machine Interface (HMI)
- Training and Guidance
- Sales and Marketing

What is RT3D?

RT3D tools and applications allow designers, engineers and creative studios to create virtual objects (such as fully fledged new car models) and environments (such as realistic road scenarios and weather conditions) that are immersive, interactive and immediate.

Wearing a VR headset and using hand controls, for example, participants in an RT3D application not only see rich details in three dimensions, they can move around them, interact with them, change them (or add elements and comments) and even be immersed in a full audio experience while they do so. For example, in a driving scenario, they might hear realistic wind and street noises, which add significant realism to the scenario.

1. The impact on automotive design

"Design is so simple. That's why it's so complicated."

– Paul Rand, art director and graphic designer

The value proposition of RT3D for automotive designers is substantial.

Historically, car designers have used a combination of sketches, detailed renderings, quarter- and full-scale clay models to mock up new car models. But as cars have become more complex – and consumers more demanding – the time and cost of each design stage has increased exponentially over the years. Additionally, while sketches and clay models can convey the color, product scale and design proportions, they do not offer high fidelity or any interactivity, and are quite expensive to iterate on multiple concepts/versions.

More recently, designers have employed 2D digital visualization to replace sketches and various physical models in the design process. While faster and cheaper than earlier design methods, 2D visualization is poor at conveying scale and proportion. Additionally, designers need to prepare multiple renderings to simulate the perspective and depth of field (DoF) necessary for creating a credible real-world, 3D feel. Further, most digital-visualization tools are relatively weak at incorporating interaction. Some don't even bother.

Examples of RT3D use cases

Screen Space Reflection (SSR) in action on a CG car

Cadillac Virtual Showroom

Audi Engineering Holodeck by Lightshape

Putting designers and cars in the same interactive space

For the automotive design phase, RT3D importantly brings together the strengths of digital visualization and dimensional modeling, and adds extra capabilities. It can convey the sense of scale and proportion of clay models, especially when combined with tracking, that lets the observer inhabit the scene. Not only does the vehicle model exist in a virtual space, so too does the XR participant, providing a fresh way to review and evaluate alternatives. As well, colleagues, wherever they're located, can put on an XR headset and collaborate in real-time on the same model, streamlining the review and iterative processes.

RT3D also lets you add interactivity to bring a vehicle to life. An RT3D model can hold triggers for interaction, like doors and tailgates that open, allowing for a vivid integration of interior and exterior views previously limited to advanced prototypes. Users can explore sight lines, perspective and views through the greenhouse in ways that clay models can never offer. Participants can even experience human-machine interface (HMI) systems functioning as they would in the real car.

Volkswagen VR training by Innoactive

SynCity – Advanced sensor simulations in real-time

These evolving capabilities mean that immersive visualization in the RT3D environment is much more suitable to reviewing and collaborating on complex engineering design challenges than traditional methods. RT3D can also bridge the communication gap between designers and engineers by changing the process into an immediate, immersive experience that is accessible outside the design studio. Currently, collaborators and decision-makers must gather around the clay model, or the fragile clay model must be laboriously transported from venue to venue to garner feedback. With RT3D, participants from across the globe can share in the same experience without the inconvenience, expense or time penalty of travel.

Speeding iterations and lowering costs

Since design inspiration must take place on a schedule, any tool that accelerates the process is ripe for adoption. RT3D not only lets you explore more design options and iterate faster, allowing for design issues to be identified and resolved more quickly, it also saves money – potentially minimizing the need for small-scale models and clay models in the process. This can lead to significant savings. One major OEM estimated that RT3D could lead to saving $3–5M on the cost of developing a new vehicle.

Not surprisingly, VR technology is already in use in the automotive design process of most major OEMs. BMW has built chambers to house their VR design process and prototyping, as reported in the automotive press.[2] General Motors also makes use of a dedicated space – the 3D cave automatic virtual environment (CAVE) – to explore the interplay of design and light on interior and exterior prototypes.[3]

RT3D has the power to free these design explorations from expensive dedicated spaces to more flexible, accessible environments. The cost savings can be significant. A 3D CAVE can cost upwards of $250,000 and take weeks (or months) to install or construct. In contrast, a high-end workstation with a high-resolution head-mounted display (HMD) runs less than $10,000. There are even budget VR setups that can be put together for less than $2,500.

Lightshape Holodeck at Audi Engineering in Ingolstadt
Image copyright: Audi AG

RT3D in action

The Lightshape Holodeck at Audi Engineering in Ingolstadt

In this large-scale VR installation, a team works collaboratively on a VR model, including voice annotation, real object tracking, MR integration, and conferencing with other remote participants.

The Holodeck VR experience by Lightshape, showcased in this video[4], allows Audi development and production teams to fully experience and iterate on designs virtually, before committing to a physical prototype, thus realizing immense time and cost savings. Although photorealistic 2D computer graphics are still being used, the VR holodeck gives designers, engineers, and stakeholders an experience that can be shared with remote teams for a realistic impression of the proportions of future models..

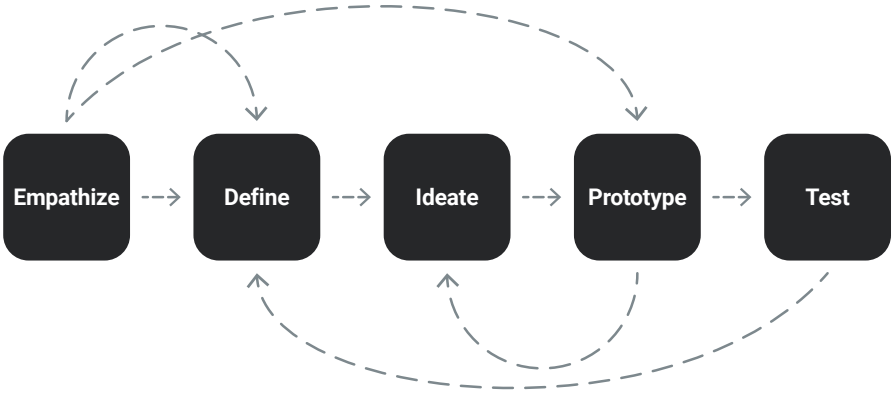
The 5 Stages of Automotive Design According to Stanford's d.school

Automotive design has evolved into an iterative process, usefully broken into five stages by Stanford University's d.school.[5] Starting with a directive, designers research and define parameters for brainstorming and ideation. Small-scale models are created, revised and perfected before full-scale 3D models emerge, and finally prototypes. Prototypes are tested, and are refined and revised until they are approved.

This iterative process has proven to be effective, yet has its weaknesses. In particular, it is time-consuming and expensive to prototype and test

designs. Design teams are often forced to narrow their focus, shelving alternative concepts in favor of one safe option. In the process, budgets are preserved, but innovation may suffer. RT3D can help to speed this stage of iteration at reduced cost, making room for creative thinking and rapid results at the same time.

Design thinking: A five-stage process



2. The impact on simulation and autonomous vehicles

"Researchers are also developing methods that would allow cars to actually learn new behavior from these simulations, gathering skills more quickly than human engineers could ever lay them down with explicit software code."

– Cade Metz, technology correspondent, The New York Times[6]

Every major automotive company today is committed to autonomous vehicles, and technology companies are either leading the charge or being dragged along by the trend's momentum. The future of autonomous vehicles is not "Will it happen?" but "When will it be a reality?" Autonomy is the new frontier for the automotive industry and will revolutionize transportation in the next decade. Companies are spending huge sums to realize the goal of self-driving automobiles.

According to a 2017 study by the Brookings Institution,[7] more than $80 billion has been invested to date in technology for autonomous vehicles. General Motors alone had 2,100 people working on autonomous vehicle technology in 2018, a meteoric rise from 90 employees in 2016 and 1,200 in 2017, as reported by CB Insights in its State of AutoTech 2018.[8]

While the media has focused on physical testing, highlighted by some widely publicized accidents, simulation as a key technology for achieving autonomy has received less coverage, in large part because adoption and scaling of simulation for autonomous vehicles is still in its early stages.

However, the need for large-scale simulation is widely recognized. While physical testing is necessary, it is expensive and slow, and impossible to replicate perfectly. And the most important test conditions have the highest safety risk. For example, evaluating how new learning models respond to complex scenarios in a crowded city is risky at best. By contrast, simulation lets you repeat a set of test scenarios multiple times, with exactly the same conditions for each test, which is not possible with physical test drives.

More test control, zero risks

With RT3D, simulations can truly measure and demonstrate the effect of granular changes – whether they are changes to the test conditions or changes to autonomous algorithms or models. That kind of repeatability is essential for evaluating relative performance of autonomous systems during development. Simulations can also be carried out with zero safety

risk, and can be made progressively more challenging to train autonomous systems across far more conditions than could ever be conducted with real-world testing.

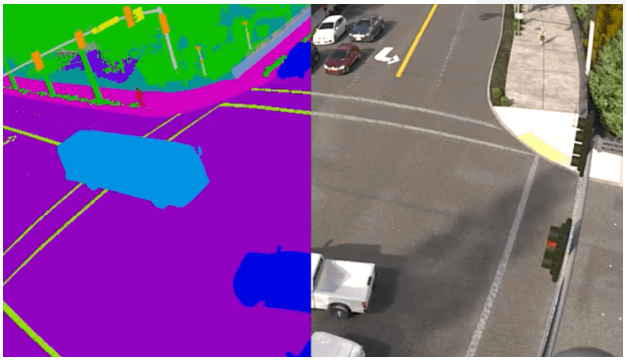
For these and many other reasons, companies and researchers are implementing RT3D platforms for autonomous vehicle applications. For example, to be effective for autonomous vehicle system testing and validation, scenarios must be dynamic because the real world is populated with an infinite number of moving or changing elements.

To accomplish this, RT3D systems are being programmed with pedestrians, cyclists, large animals, and myriad vehicles to behave in any way that testing requires; objects can be imbued with the properties that the autonomous vehicle's sensors can detect. As well, in RT3D projects, simulation engineers take into account that different surfaces and materials send back different return signatures to RGB cameras and LIDAR/radar sensors, so they can program disparate objects to behave

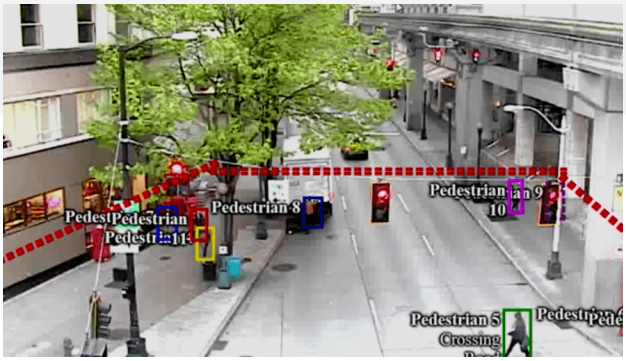
RT3D in action

"Video Analytics Towards Vision Zero" program

Unity partnered with the City of Bellevue, Washington to work towards reducing the number of people injured or killed in traffic accidents. Vision Zero is a multinational, multi-entity road-safety project focused on building a highway system with no fatalities or serious injuries involving road traffic. Bellevue's program strives to find and fix unsafe intersections through video analysis. Beyond analyzing existing conditions, the program is building simulation environments to produce virtually infinite sets of training and evaluation data – without putting any real people at risk.[9]



Screenshot of video footage showing semantic segmentation



Example of the Vision Zero annotation tool in use

in realistic ways to achieve the high fidelity necessary for credible object interactions.

Billions of miles of virtual driving

Waymo, which began as the Google self-driving car project in 2009,[10] is a pioneer in the use of simulation. The company drove 2.7 billion miles in simulation during 2017 alone, compared with 8 million miles of real-world driving since 2009. Competitors are eager to catch up with Waymo's technology and experience.

Because RT3D offers testing and validation capabilities that could never be replicated in physical testing, it can help bring the future of autonomous vehicles closer and more into focus. As it permits researchers to reliably repeat simulations with exacting precision, RT3D lets engineers and researchers compare performance of multiple systems while limiting the variables that make results murky. Another important benefit is that these capabilities allow for tremendous cost savings over physical testing.

3. The impact on human-machine interface (HMI)

"As far as the customer is concerned, the interface is the product."

– Jef Raskin, scientist and developer[11]

"If you're into video game development, consider applying to Tesla. We want to make super fun games that integrate the center touch screen, phone and car irl."

– Elon Musk, entrepreneur and engineer, Tesla[12]

When autonomous vehicles take hold of our roadways, what will the passengers do during their trips? Once we eliminate the need for continuous vigilance behind the wheel, the cabin environment will become a space for deeper conversations, work and play. That means the HMI experience will be at the forefront in the vehicle of the future, with major implications for design, production, sales and marketing, service and owner retention.

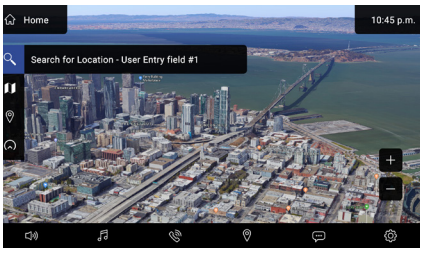
Today, many HMI systems are prototyped in RT3D, but production systems are implemented with other toolchains due to various constraints in the development and production environments. This is a missed opportunity for providing coherent context and for streamlining the ideation and production process.

As the technology evolves, however, these advances open the door to competitive differentiation, and an opportunity to engage passengers with interactive experiences that will help them recognize and seek out preferred technologies.

The gamification of automotive HMIs

With RT3D, automotive engineers will be able to develop and deploy HMI solutions to in-car 3D head-up displays (HUDs) or instrument clusters using the same technologies that game companies employ for mobile platforms.

Example of HMI for an RT3D HUD and climate controls



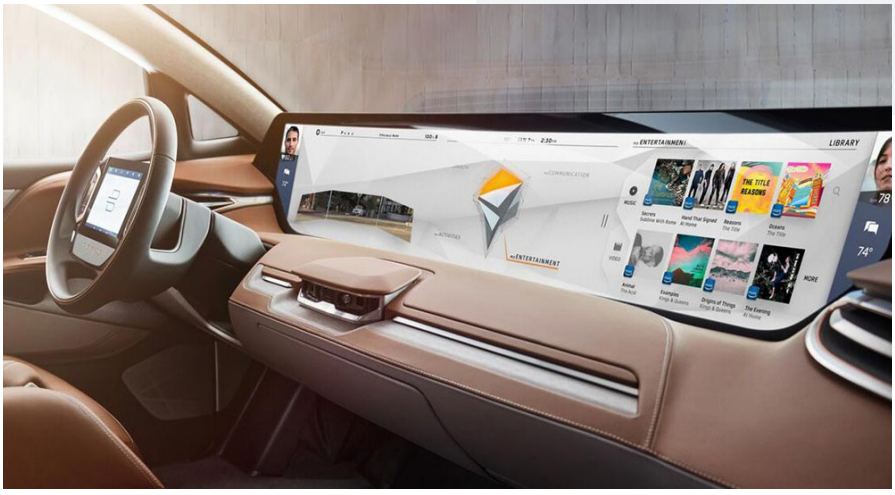
Example of HMI for an RT3D interactive map

Importantly, RT3D's maturity in the gaming industry means it is well positioned to cover all phases of HMI development, including design, prototyping, development, and mass deployment into production. The fewer kinks and breaks there are in the automotive development toolchain, the more efficient the process can be, ultimately improving quality and lowering risks.

RT3D in action

Byton's Smart Intuitive Vehicle

Byton is devoted to developing and producing electric-powered vehicles that they call "the next-generation smart device." The Byton K-Byte Concept car debuted at CES 2018. It has a 49-inch (125 cm) curved shared-experience display – a HUD/HMI that was built in Unity. A Unity toolchain is at the core of its in-car HMI development, covering all phases from design to production. This approach greatly shortened the development process, improved efficiency and lowered engineering complexity.[13]



In-car HMI display
Image copyright: Byton

4. The impact on training and guidance

"[VR] technology may also help learners retain more information than traditional training methods: In one test, surgeons retained approximately 80 percent of training material presented via VR compared to 20 percent when listening to a lecture."

– Ryan Kaiser and David Schatsky, Deloitte[14]

Training and guidance are important in the automotive industry and take place at many stages, including manufacturing, sales, maintenance and repair. Even new car owners can benefit from effective training.

But hands-on training comes with significant challenges. It is expensive to set up and attend (e.g., travel costs) and there can be significant wear and tear – and even damage – to valuable equipment and tools. Training can also be dangerous. Until an operator has acquired and honed the skills necessary for safely using equipment, there's potential for harm to themselves or others.

Additionally, training strains limited resources. Equipment and space designated for training purposes can't be used for production, and training usually needs to take place at a specific place and time. In some cases, the equipment may not be available – or may even be on the other side of the planet.

Virtual training delivers real benefits

The high fidelity and immediacy of RT3D bursts through these barriers. Trainees can explore the capabilities of equipment and tools with no risk of damage. While the training is real, the tools and equipment are virtual. Since the object of training is virtual, safety ceases to be a factor, too. And there's no need to take up space on a factory floor to train on specialty equipment because the RT3D environment can be implemented nearly anywhere; multiple training sessions can occur simultaneously in as many venues and time zones as needed.

Importantly, RT3D fits in perfectly with experiential learning theory (ELT),[15] one of the most widely used learning models. Defined by psychologist David Kolb in 1984, ELT is based on the premise that a person learns from direct experience or learns by doing. ELT takes a holistic approach that emphasizes experience, perception, cognition and behavior, all of which influence the learning process. RT3D creates opportunities for all of these, and can facilitate effective learning.

Diverse businesses like Walmart, United Rentals, and the National Football League use VR to train employees. Walmart uses VR in 187 employee training centers to help staff experience emergency situations, learn customer service, and explore shelf-stocking techniques.[16]

As well, RT3D's capabilities can capture and deliver a depth of metrics beyond traditional training technologies. This data can be used to evaluate progress, to provide feedback to participants, to help target additional training needs, and to improve processes.

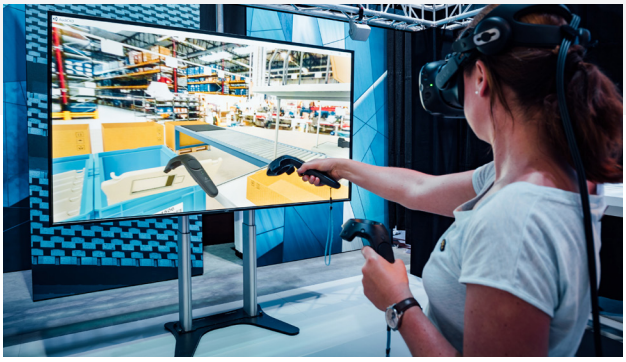
Finally, RT3D also provides powerful capabilities for step-by-step instructions for projects and tasks. For example, an AR owner's manual could guide a new vehicle purchaser through complex tasks like setting up their infotainment system or minor maintenance tasks such as replacing a set of wiper blades.

RT3D in action

Volkswagen Group was an early adopter of VR training. Its Innoactive Hub, powered by Unity, lets the company conduct training – where employees share experiences and techniques – in multiple global locations at the same time. VW emphasizes the effectiveness of VR, especially praising the ability to maintain consistent data and information across all locations simultaneously, ensuring a coherent experience for all users. A video[17] by Innoactive demonstrates the possible use cases for VR.

For real-time training, the possibilities are endless. From one end of the training spectrum to the other, RT3D promises to transform training in all aspects of the automotive industry.

VR training for manufacturing employees – using a drill to fasten door bolts
Image copyright: Innoactive Hub (Volkswagen Group)



Volkswagen Group uses Innoactive Hub for global VR training rollout with HTC Vive
Image copyright: Innoactive Hub (Volkswagen Group)

Benefits of RT3D for training and guidance

- Simultaneous global rollout of new or updated training programs
- Capture of a wide range of metrics to improve learning and training effectiveness
- Repeatability of situations and experiences, and no safety risk
- Decrease of wear and tear on tools, equipment and products
- Limitless toolsets and materials with no need for inventory or storage
- Near-instant setup and reset of complex processes
- Guess-free, concrete tracking of objects within the environment with AR

5. The impact on sales and marketing

"Traditional sales methods are being relegated to the annals of history. The new, more discerning customers of today have seen to that."

– Jonathan Farrington, sales futurist[18]

Just like in automotive design, RT3D is a game-changing tool in the world of vehicle sales and marketing.

If you've looked into buying a new car recently, you've probably spent considerable time doing research online before setting foot in a showroom. And you're not alone. Today's car buyers are increasingly savvy and don't depend on salespeople as their main source of information.

In fact, many buyers avoid the dealership altogether when making a buying decision. They research their next car at sites like Edmunds, Kelley Blue Book, Autotrader, and Autobytel, as well as on enthusiast and automaker websites. Some buyers use services like Costco Auto Program and TrueCar to execute a purchase with just one dealership visit.

According to Roland Berger, at least 20 percent of new cars are expected to be sold online by 2020. "This isn't surprising considering that 97 percent of car sales begin with online research, and 44 percent would already be prepared to complete their purchase online," according to the company's recent study, "Online Sales of New Cars."[19]

Attracting prospective buyers online requires content that is more engaging than a gallery of photos, a list of features and benefits, and a comparison tool for trim levels and pricing. Manufacturers must provide a consistent, realistic, interactive experience during all stages of the decision-making process. This includes virtual interactions through smartphones and other smart devices and desktop browsers, as well as at the dealership.

In the best of all possible situations, a buyer would customize a car with an online tool, and be able to refine and interact with their personalized vehicle with great fidelity and a compelling experience. Even such intricate details as HMI interaction should be available to a prospective buyer. As vehicles become capable of receiving and processing more and more data, this information "explosion" must be integrated efficiently and presented clearly. The HMI is not only a communication bridge between the driver and the car itself, but is also a connector between the driver and the world beyond the vehicle's confines.

Rather than just viewing a set of pre-rendered images – where only a few options are displayed alongside a list of features – potential buyers can

delight in a free-form, real-time exploration of the vehicle through multiple perspectives that address the buyers' desires for both key real-time information and lifestyle fit.

However, current car configurators vary widely across the industry. In general, they provide limited feedback, mostly related to option choices and color selection. Some of the more sophisticated web-based systems offer a 360-degree rotation of the vehicle exterior in two dimensions.

A holistic experience across devices and channels

RT3D lets you deliver a coherent experience across all digital channels. The process also allows you to collect many valuable insights into the

RT3D in action

Technology is transforming the way we experience, sell and buy cars. Light & Shadows, based in Paris, has used HDRP to produce stunningly realistic real-time images and video. Founded in 2009 in response to growing demand by major industrial companies for compelling visual content, Light & Shadows has thrived by continuously adapting and innovating the delivery of new capabilities to its customers, including the generation of high-quality rendering together with cost reduction and productivity improvement. To prove these capabilities, the company recently created a video[20] demonstrating real-time rendering of a Lexus LC500.

RT3D opens up the showroom floor to a universe of content and experiences, limited only by the creative imagination.

Lexus LC500 Configurator using real-time rendering
Image copyright: Light & Shadows

buyer's behavior during the interaction. For example, marketers will be able to detect when a buyer zooms in on a feature, like headlights or wheels, allowing them to prepare for subsequent interactions where they can guide the buyer toward special attributes and benefits in those areas.

Once consumers have easy access to this way of interactively experiencing vehicles on their preferred platform, the possibilities for offering and demonstrating vehicle options open up enormously. For example, manufacturers will be able to spotlight and upsell options to consumers, locking in preferences based on experiences. During the sales process, they can collect detailed metrics on buyer behavior to further enhance the experience.

The availability of richer data on user interaction means that OEMs can apply machine learning to optimize the configuration experience. That customer who zoomed in on the wheels, for instance, may be a prime candidate for a premium appearance package option.

Smaller and better: The virtual showroom of the future

With all of these channels operating in a coherent manner, dealerships will be able to "right fit" their physical inventory for demonstration purposes. The showroom of the future will have a smaller footprint because dealers will have limitless virtual inventory on demand at minimal cost, and interactive demonstrations will eliminate the wear and tear and extra miles added to demo vehicles, among other benefits of high-fidelity RT3D simulations.

The zero moment of truth (ZMOT)

Google's influential 2011 article, "The Zero Moment of Truth for Automotive Study," predicted the current shopping environment. The ZMOT is the first step in the purchasing process, when a potential buyer performs pre-buying activities by researching their purchase online. It comes before the first moment of truth (FMOT), when a customer sets foot onto the showroom floor to look at vehicles firsthand, followed by the second moment of truth (SMOT), when the customer actually experiences the vehicle during an interior fitting and test drive.

Google's study noted that "Even among above average sources, ZMOT outpaces traditional avenues of research." The study concluded that "The challenge for brands is generating enough influence during all of

the pre-research (ZMOT) sources they interact with to get them to go to a dealership in the first place."[21]

Enter RT3D. It offers many opportunities to enrich the ZMOT experience, making it as compelling and realistic as the FMOT experience for potential buyers, and ushering them smoothly on to the SMOT and ultimate purchase.

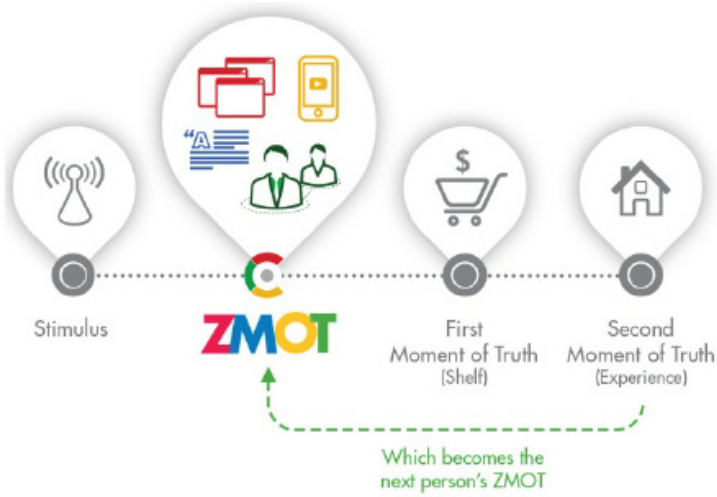


Image copyright: Google

The road ahead

This whitepaper opened the doors to five major areas where customers are using Unity productively to implement RT3D in their operations: Automotive Design; Simulation and Autonomous Vehicles; Human-Machine Interface (HMI); Training and Guidance; and Sales and Marketing.

RT3D is a technology that has the potential to transform the automotive industry from a disconnected series of related activities into a streamlined, efficient and cost-effective delivery system for superior user experiences. The power of RT3D to create engaging, meaningful experiences is driving how designers, engineers, and buyers collaborate to evolve the vehicles of the future.

For the latest trends, blog posts, webinars, and product announcements go to unity.com/solutions/automotive-transportation.

Glossary

The vernacular of RT3D for automotive

HMI: The human-machine interface is a device or software that facilitates the communication between a user and their vehicle. HMI translates data (sometimes complex, sometimes simple) into accessible information, giving the user the necessary tools to put the machine into action. In the autonomous vehicle future, HMI will have an even more critical role in the riding experience.

Real-Time 3D: RT3D lets users move within, and interact with, a scene in a way that renderings alone never can. In real-time, users can change their point of view on an object within the scene, altering their perspective just like in reality. They can move in closer to explore detail. They can step back to get a sense of scale. They can crouch down to see how lighting plays across surfaces, or step to the side to explore a three-quarter view, all while experiencing a real-time, connected shift in point of view.

Simulation: The use of digital representations of reality to evaluate a product or system and explore how it functions. Simulation can be used to both train on and validate the different elements of an automotive system. This can range from evaluating only a portion of the system, such as path planning, to a comprehensive simulation of the entire system. At the extreme, a comprehensive simulation can incorporate a high-fidelity model of the world, complete with moving vehicles, pedestrians, and variable weather conditions, sensor models as inputs to perception algorithms, communication and coordination (V2X), path planning, and vehicle dynamics.

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