AUTOMOTIVE, TRANSPORTATION AND MANUFACTURING

REPORT

Behind the scenes at VW Group's Innovation Center California (ICC)

Using advanced visualization techniques to develop future-proof concepts at Volkswagen Group of America

unity

VOLKSWAGEN
GROUP OF AMERICA

What’s inside

Get a behind-the-scenes look at the cutting-edge work taking place at Volkswagen’s Innovation Center California (ICC). In this report, the team at ICC shares in their own words how they leverage Unity and other tools to shape the future of mobility.

Contributors

Marcus Brand
Vice President
Innovation Center California

Sagnik Dhar
Senior Manager, Digital
Ecosystem Applications
Volkswagen Group of America

Developing future-proof concepts at the ICC

The Innovation Center California (ICC) in the San Francisco Bay Area is one of three global research centers for Volkswagen Group Innovation. At the ICC, we are a group of engineers, designers, scientists and futurists who work on creating the building blocks that enable the VW Group to achieve its vision of "shaping mobility for generations to come."

"Advanced visualization plays a big role in our projects as we try to predict what the world will look like in 2030 and beyond."

Advanced visualization plays a big role in our projects as we try to predict what the world will look like in 2030 and beyond. Our customers' expectations of our vehicles as well as their digital ecosystem are changing rapidly. To look into the far future and identify meaningful customer needs is not an easy challenge. We approach this by identifying different parallel future scenarios. Virtual reality (VR) allows us to not only visualize these but also iterate on variations within these scenarios rapidly and cost-effectively.

The ICC uses machine learning (ML) and computer vision extensively to develop products that improve over time and with customer usage. One of the key components of these ML-powered products is data that is structured and labelled. One of ICC's projects is investigating if synthetic data generated using Unity's software can be realistic enough to train our machine learning models. Not only would this be a highly scalable approach to generating training data, but it would also allow us to ensure our ML models are not biased toward specific scenarios.

When it comes to in-vehicle experience design, Unity's tools are helping us design richer and more immersive content for future vehicle human-machine interfaces (HMIs), which go beyond the center console screen to instrument clusters and head-up displays (HUDs).

In this report, we focus on these three areas where Unity's software helps us use advanced visualization techniques to develop future-proof concepts:

— Interaction with far-future scenarios (interior/exterior design and customer journey design)

— Synthetic data generation (large-scale training and simulation environments)

— HMI design, featuring realistic 3D user interfaces (UIs)

The Innovation Center California (ICC) in the San Francisco Bay Area

Interaction with far-future scenarios

Interior/exterior design and customer journey design

Contributors

Alisia Martinez
Software Engineer – Frontend (XR)
Volkswagen Group of America

Andrew Gwinner
Software Engineer – Frontend (XR)
Volkswagen Group of America

Dij Jayaratna
Senior Product Designer
Volkswagen Group of America

What are the challenges when designing for far-future scenarios?

Simply imagining oneself in a future scenario is often challenging for our audience. Many of our concepts are devised for vehicles that will be released well past the current generation.

How is Unity used for these projects?

Unity is a key component of our visualization pipeline. When building out that pipeline, we worked to find a fluid process that would funnel our workflows from our various fields of expertise (film, animation, software engineering, VR development and design) toward one cohesive vision.

Backed by this pipeline and in pursuit of bringing to life these cutting-edge concepts, our lab stretches Unity to its full capabilities. Using Unity, we've built projects for tethered and stand-alone VR headsets, mobile augmented reality (AR) devices, custom controllers, in-vehicle experiences, and rendered cinematic videos.

"Unity is a key component of our visualization pipeline."

The translation of a concept to an interactive experience is rarely perfect on the first pass. Being able to have our designers provide notes in real-time allows us to reach the ideal representation of the concept much more quickly than if we were using other tools.

One flow we established starts with receiving the computer-aided design (CAD) model from the designers, importing it to Unity using Pixyz, and bringing it to life by adding moving parts and interactive elements. Our designers can analyze the ergonomics of their design within the VR project. If changes are requested, the CAD modelers implement that input and the iteration cycle continues from there.

What insights does Unity help you gain regarding how people will interact with these designs? What types of platforms do you use?

Audience members react very differently to concepts depending on whether they are inside the experience or viewing 2D concept art. Concept sketches of industrial design in some cases fail to convey the complete picture. Putting people into the VR experience and allowing them to view a design from any angle solves this problem.

When looking at concepts created by our designers, we first identify the platform that can best visualize this design. Fortunately, the wide variety of platforms Unity supports continues to keep pace with our interactive visualization needs.

Visualizing and exploring design issues in VR

In the case of our virtual cockpit experiences, we ask ourselves lots of questions as we begin development:

— Do we want to use VR trackers and align a seating buck to the virtual experience?

— Do we want to add physical hardware that the user can interact with in real life that would mirror actions in the virtual world?

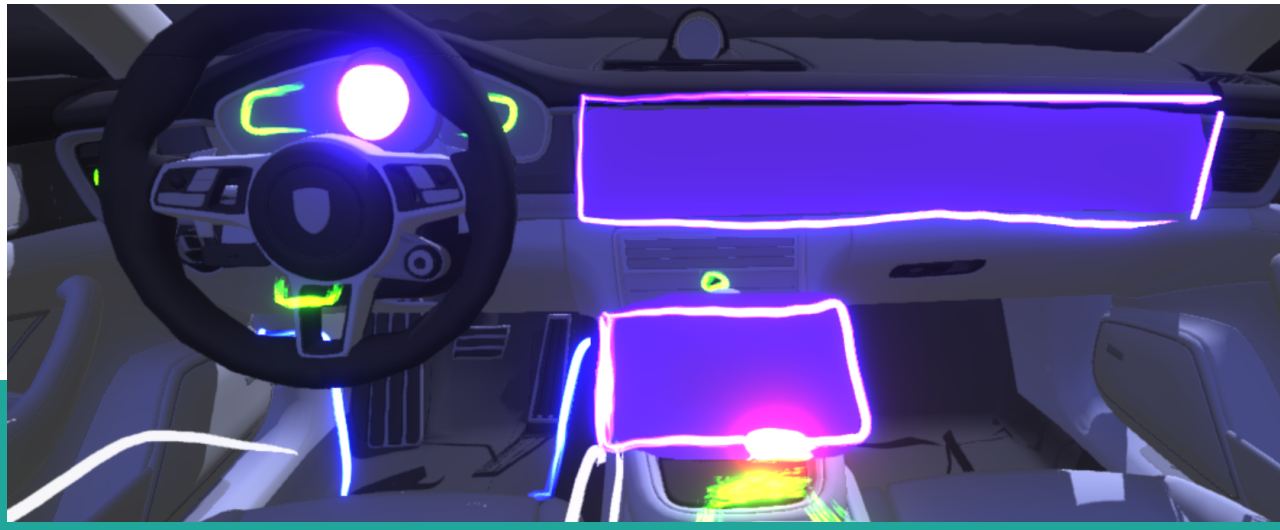
— Do we want to use the medium to wow users with beautiful and engaging environments outside of the vehicle?

With each project, we have to adapt our pipeline based on our resources. When it became clear that folks were uncomfortable entering a VR environment due to concerns over the spread of Covid-19, we had to pivot the target deliverable of a couple of our projects mid-development.

For one of our projects, we had so much storyboard art that it didn't make sense to recreate something from scratch in 3D. We identified which aspects of the story would benefit the most from a 3D recreation. Rather than Unity being our end-all medium, we used it to export imagery and video. We used Cinemachine to direct and render the 3D shots, and then sent them to other video editing software such as Adobe After Effects and Premiere to blend them with the other 2D imagery created by our traditional motion designers. After making the needed adjustments from changing build platforms, we were up and running with minimal interruption, working toward a new direction for the visualizations.

What are some examples of interior or exterior concepts you're exploring?

In keeping with one of our industry's main concerns, many of our current interior and exterior concepts explore solutions for being a more ecologically responsible carmaker. Complete vehicle exteriors have been visualized using Unity as well as several interactive interior concepts.



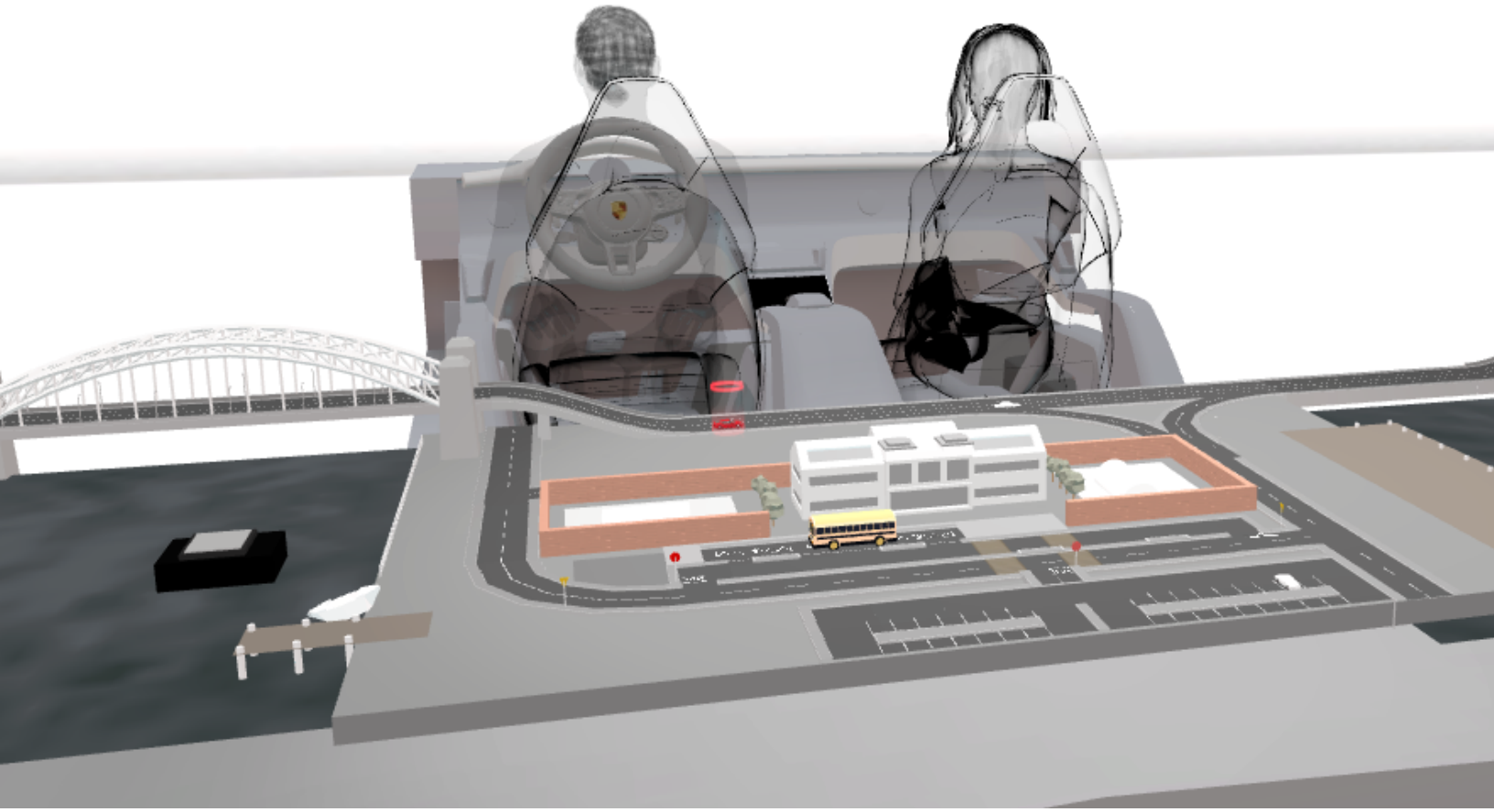
"This ability for our projects to quickly adjust to small changes from design iterations and large changes from deliverable pivots is a core reason why Unity is an important component of our visualization pipeline."

What are the key considerations for how interiors and exteriors will evolve?

Autonomy plays a big role in creating an opportunity for evolution in vehicles, especially interiors. The ability to remove or temporarily hide traditional controls provides countless new spaces and interactions to design.

How do autonomous driving and other industry changes inform your designs?

We feel fortunate to be in a position to influence an industry that is undergoing huge changes. Autonomous driving presents scenarios into which we would never normally think to put ourselves. Changes like these, including, for example, electrification and mobility, inform our designs by providing a creative directive to imagine a world which does not yet exist.



HMI interaction prototyping in VR

Synthetic data generation

Large-scale training data and simulation environments

Contributor

Elnaz Vahedforough
Technical Project Manager
Volkswagen Group of America

What are the advantages of using Unity for synthetic data generation?

Unity is capable of producing high-quality graphics. The scripting API is very robust, and provides a large number of classes to program rendering, appearance, motion – just about everything. You can write a Unity project to work deterministically. The learning curve is relatively easy, and a person with a programming background can adapt to it in a short period of time. Unity supports mesh colliders, which is an advantage over other game engines that provide primitive colliders. Unity's user interface also makes it possible to create the mesh colliders from an existing mesh.

One of the big advantages of Unity is that it supports user development of high-quality Lidar sensor simulation. Developers can use ray casting in game engines to simulate sensors such as Lidar, but since hit geometry is a collider, and mesh colliders support higher detail than primitive colliders, Unity works much better than game engines that don't support mesh colliders.

What is this data used to train?

We use image and ground-truth data generation in Unity to train neural networks for the implementation of autonomous driving components such as sensors, perception, prediction, and driving. The ICC focuses on cutting-edge research and solving open issues that are not fully resolved within our group or the industry at large.

"We use image and ground-truth data generation in Unity to train neural networks for the implementation of autonomous driving components."

Do you use synthetic training data in combination with real-world data?

It depends on the use case and maturity of the project. For some projects with limited scope, we use synthetic data as a cheaper data-generation option, whereas projects with broader goals take advantage of a mixture of real-world and synthetic data. Synthetic data plays a major role in providing engineered scenarios where data would be difficult to collect in the real world or which are impossible to replicate exactly, with controlled variation.

Synthetic data also tends to be a good resource for training models in proof-of-concept projects. These concepts get incorporated in large-scale projects later on.

What are the advantages of generating training data synthetically versus relying solely on real-world data?

Synthetic data is usually more cost-effective than real-world data. Most perception neural networks rely on labeled data, which is costly and prone to error. By using synthetic data, once the labeling task is set up, the labeling is essentially free, and other costs are minimized. However, one needs to be aware of the gap between simulation and real-world environments and use specific techniques to minimize this gap.

“Synthetic data plays a major role in providing engineered scenarios where data would be difficult to collect in the real world or which are impossible to replicate exactly, with controlled variation.”

Besides the cost considerations, synthetic data generated with Unity can be used to construct scenarios that rarely occur (e.g., accidents, unusual objects on the road, etc.) or harsh weather conditions such as fog or heavy rain. This makes it possible to recreate edge-case scenarios safely.

Synthetic data is also useful for repeatability and determinism. One can control scene variability much more precisely with synthetic data and therefore determine stronger correlations between scene parameters and performance of the system consuming the data.

For large-scale data, is training data generated on-premises or in the cloud?

Data-generation scale varies depending on the project maturity and requirements. Both on-premises and cloud-based approaches are viable, depending on the application. For instance, rendering without ray casting is fast so data can be readily generated on-premises, whereas ray casting is slow to render so the cloud is preferred.

What types of environments do you generate and what is your workflow?

Depending on the application, we use urban or highway environments. Usually, the scenarios or scripts are designed in Unity, and recorded images and ground truth are used for training AI models at the next stage.

Mostly we take advantage of prebuilt environments for projects with limited scope. Unity's vast variety of assets makes it possible to design desired scenarios.

How are these environments used?

We use environments with drivable road geometry. Drivable paths are defined with waypoints and splines, and vehicles are driven on paths through scripts. Label images are rendered with the replacement shader functionality. These scripts are developed internally and customized to the needs of the projects.

"Unity's vast variety of assets makes it possible to design desired scenarios."

HMI design

Realistic 3D UI design

Contributors

Alisia Martinez
Software Engineer – Frontend (XR)
Volkswagen Group of America

Loren Skelly
Senior Manager, UX Design & Concepts
Volkswagen Group of America

What are your overarching goals when designing new HMI concepts?

We are continually searching for new ways to enhance or simplify the user experience.

What types of HMI components do you incorporate into your designs?

We have worked on concepts that focus on only parts of the HMI, but generally, we prefer to design an overall experience across all touchpoints, including the center screen, instrument cluster and HUD.

How does Unity help prototype design concepts and user interfaces quickly?

There was an idea during development to have the HMI animations react in response to additional vehicle data. As we were working with Unity, we were able to repurpose code from a non-HMI project to power our animation system to allow for top-tier, dynamic visualizations. It's also helpful to be able to throw in 3D models, instead of working in a 2D-only context. The ability to test a proof of concept in-vehicle and give feedback directly to our software team to make adjustments to the car in real-time is unparalleled.

"The ability to test a proof of concept in-vehicle and give feedback directly to our software team to make adjustments to the car in real-time is unparalleled."

What advantages does Unity for HMI provide over other tools?

Having a game engine as our base allows us to have much more complex interactions and visualizations. We can get pretty far designing concepts on our computer screens and test benches, but to truly test our concepts, nothing compares to having an in-car driving experience. Our toolchain with Unity allows us to do that.

As we are in constant communication with the team at Unity, we know where our goals fit within their roadmap and how we can best align our future software and design goals. As experienced Unity users, we know there are a million ways to do one thing, and a million more ways to optimize it. The Unity Integrated Success team helps us identify the ideal way as we focus on the experience we are trying to create, while achieving the best design and implementation.

How do you see in-vehicle screens and experiences changing in the future?

As time spent in-vehicle changes as a result of electronic vehicle (EV) charging time and increasing autonomous functionality, we have a captive audience to engage with our in-vehicle experiences. There is so much more to explore.

“Having a game engine as our base allows us to have much more complex interactions and visualizations.”

The road to innovation starts here

Inspired by Volkswagen Group of America's innovative applications of Unity? Bring the power of these technologies to your business.

Unity Industrial Collection – Create interactive visualization experiences from CAD and 3D data for mobile devices, PCs, AR and VR devices and other platforms. Try or buy online today.

Unity Computer Vision – Create high-quality synthetic datasets for computer vision training and validation.

Unity for HMI – Connect HMI development processes, from design to deployment, to create stunning, interactive user experiences for in-vehicle infotainment (IVI) systems and digital cockpits.

About Unity

Unity is the world's leading platform for creating and operating interactive, real-time 3D (RT3D) content. Creators, ranging from game developers and architects to automotive designers, filmmakers and more, use Unity to make their creations come to life. Unity's platform provides a comprehensive set of software solutions to create, run and monetize interactive, real-time 2D and 3D content for mobile phones, tablets, PCs, consoles, and augmented and virtual reality devices.

Learn more about Unity's solutions for the automotive industry.


unity