SIEMENS

AUTOMOTIVE AND TRANSPORTATION

Hyundai

Using an enhanced sound concept as a brand differentiator for electric vehicles

Product

Simcenter

Business challenges

Create a game-changing EV customer acoustic experience as a unique selling proposition

Create acoustic signature that binds the emotional and technical aspects

Develop vehicles with extensive acoustic personalization features

Keys to success

Develop in-house active sound design skills built in partnership with Siemens using Simcenter software

Adopt granular synthesis method

Validate and tune the composed sound using system simulation driving profile models

Results

Developed an enhanced sound concept as a brand differentiator

Created a sound image reflecting the brand's strategy and style

Enabled testing of sound concept on one prototype for all vehicle variants

Accelerated development process

Hyundai uses Simcenter active sound design solution to align the acoustic experience with its brand strategy and style

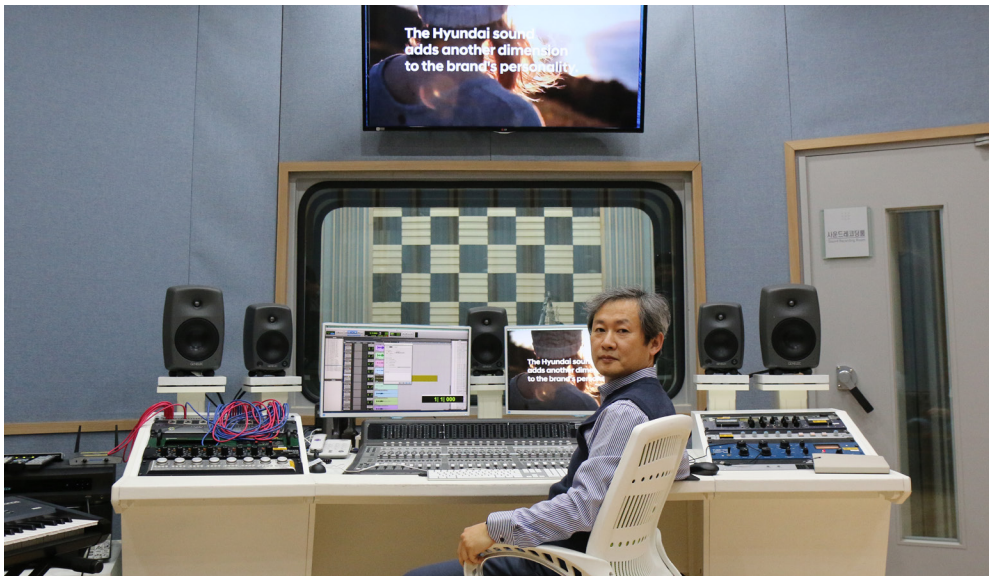
Creating a new customer experience

In developing its electric vehicle (EV) brands – Hyundai, Kia and Genesis – the Hyundai Motor Group (Hyundai) recognized the critical role acoustics play in shaping the driving experience. What's more, the company saw new possibilities for using sound to enhance the customer experience and distinguish the brand.

To pursue this opportunity, Hyundai developed a new approach to the use of active sound design (ASD), aiming to create an acoustic signature that while allowing for personalization by the customer, binds together the emotional and technical aspects of each vehicle brand.

"One of our primary goals using ASD was to create a new customer experience," says Dr. Dong Chul Park, research fellow and head of the sound design research lab at Hyundai. "To take a holistic approach and create an acoustic identity for our vehicles – sound that manifests and expresses the unique character of each brand."

In addition, the Hyundai sound design development team takes into account a further variation – the differences in acoustic perception and expectation across the globe. Each region and culture, and even each generation, has different preferences and anticipation of how a vehicle should sound.



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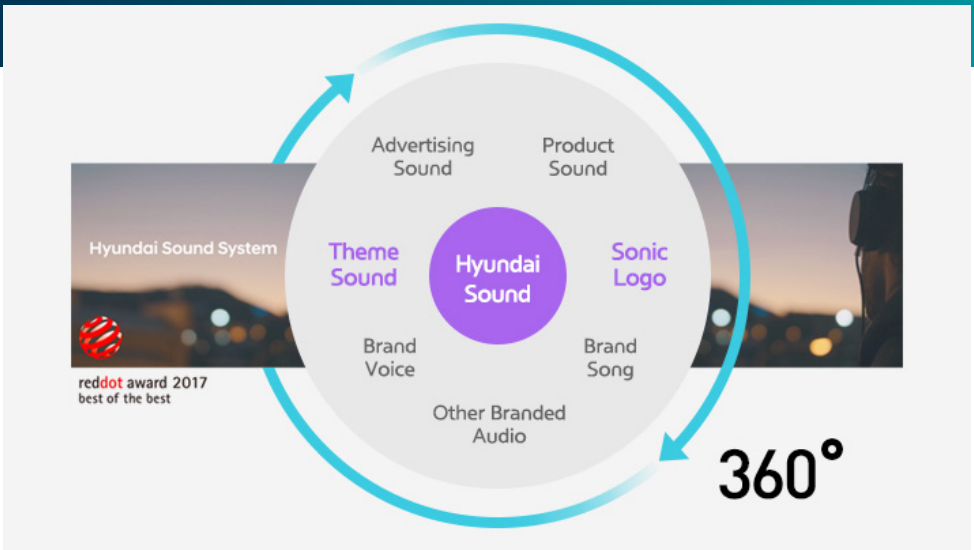
Dr. Dong Chul Park
Research Fellow and Head of the Sound Design Research Lab
Hyundai Motor Group



Although ASD can be used to mask unwanted sounds/noises that are audible in the interior of the vehicle, it is not effective for masking subpar NVH performance. Consequently, Hyundai NVH engineers use Simcenter™ software solutions to address these concerns and design a car with the optimal NVH performance. Simcenter is part of the Xcelerator™ portfolio, the comprehensive and integrated portfolio of software and services from Siemens Digital Industries Software.

New possibilities with active sound design

The use of ASD in the automotive industry is not new. Many manufacturers, including Hyundai, have used acoustic enhancement and noise control technologies to modify the sound from the smaller, quieter, engine systems developed to reduce environmental impact.

In the case of internal combustion engine (ICE) vehicles, active sound design, which is delivered through the car's sound system and adapted to current driving conditions, is used to manage and enhance the existing engine sound to make it more appealing to the customer. However, in EVs, which emit little powertrain sound in comparison to ICE vehicles, there is the freedom to create almost anything.

Active sound design in EV opens the door to new, almost unlimited opportunities to develop outstanding acoustic experiences and adds a new branding dimension – sound. It is an opportunity to create something entirely new.

> "The sound design research lab and the NVH engineers interested in composing sound find it easy to use Simcenter and combine the sound with brand philosophy and vehicle behavior."

Dr. Dong Chul Park
Research Fellow and Head of the Sound Design Research Lab
Hyundai Motor Group

"Our strategy and primary mission is to design sound that reflects and completes the brand identity of each of our vehicles; that appeals to the emotions and aspirations of our customers and becomes, in short, a kind of 'sonic logo,' an expression of the brand in sound."

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A holistic approach to create acoustic identity

In order to create a sound that people will relate to Hyundai brands, the active sound design development team works closely with the brand marketing teams.

The teams take a holistic approach to sound design, working to ensure that all the various acoustics in a vehicle are attuned and work together – even down to the welcome/goodbye message on entering or leaving the vehicle.

Park explains, "Our strategy and primary mission is to design sound that reflects and completes the brand identity of each of our vehicles; that appeals to the emotions and aspirations of our customers and becomes, in short, a kind of 'sonic logo,' an expression of the brand in sound."

Enabling acoustic personalization

Nevertheless, the Hyundai team recognized that while the vehicle sound should have a distinctive character, in the digital age it should be able to be personalized for the customer.

It would not do to offer their vehicles with the acoustic equivalent of "any color so long as it's black."

To resolve this issue, the Hyundai engineers created a clearly identifiable sound design strategy for each brand. But within the design, the customer can make adjustments; for example, alter the low, medium and high frequency acoustics or the response of acceleration pedal to meet their preferences.

This can range, for example, from combustion engine-inspired sound to a more futuristic sound. "We provide three sound concepts with each brand identity," explains Park, "so we can give customers the ability to choose the style of sound they want, but without losing the character of the brand."

Developing a car with superb NVH performance as a base

However, developing the acoustic identity for the brand is only part of the journey. Even though the motor of an EV is quiet compared to an ICE vehicle, there are many other sounds to contend with when the vehicle is in motion – commonly summarized as noise, vibration and harshness (NVH).

NVH encompasses aerodynamic sound, such as wind; mechanical sounds, road noise, noise from the brakes and electrical sounds, such as electrical actuators or the traction motor in electric vehicles.

Without the masking effect of the dominant combustion engine sound in electric vehicles, other noise sources require even more engineering effort than before for NVH engineers.

A crucial starting point is engineering a car without ASD with good NVH performance: although ASD can be used to mask unwanted sounds/noises that are audible in the cabin, it would not be effective using it to mask weak NVH performance.

For this reason, Hyundai NVH engineers use Simcenter software solutions on a daily basis to address these issues and design a car with the best possible NVH performance.

In this case, the role of the ASD can still be to mask some of the remaining existing sources of noise, but also to create a sound concept that works brilliantly in real driving conditions.

Harmonizing the sound concept in real-life conditions

Something that sounds great in the studio does not necessarily sound great in the vehicle. In the end, the sound needs to work on the physical vehicle with its existing NVH and driving performance.

You cannot work individually on each factor to develop the acoustic experience. It's a case of bringing everything together – the existing vehicle NVH, driving performance and the ASD sounds – and ensuring they all work well together. Close collaboration between the NVH, powertrain calibration and ASD development teams is required to achieve this goal.

With EVs, the ability to link these three capabilities is no longer a nice-to-have. It's a must-have. Active sound design is not a standalone field: It is closely linked to driving performance, which in turn has a huge impact on the performance of the vehicle.

"Unlike many suppliers who focus on implementing sound logic in the controller, the Siemens team is knowledgeable about EVs and understands how to enhance sound in that context," comments Park."

Linking ASD with NVH simulation and driving performance simulation

The Simcenter active sound design solution not only allows the designer to create the desired sounds from scratch in the studio, but also to test and tune those sounds on the vehicle prototype or simulator. With this, the designed ASD models can be further tuned and optimized in real-life conditions. As a final step, the created sound models are deployed on the selected tier-1 audio controller.

Siemens' Simcenter Testlab™ Sound Designer software provides the capability to work on every one of the three stages, leading to higher efficiency. "The sound design research lab and the NVH engineers interested in composing sound find it easy to use Simcenter and combine the sound with brand philosophy and vehicle behavior," reports Park.

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Simcenter solutions can also be used to make a critical contribution by linking ASD with NVH simulation and driving performance simulation. These are key reasons why the Hyundai sound designers continue to work with Simcenter, building on a relationship of more than 10 years.

Combining art and engineering

Many sound design solutions exist to compose sounds for the music industry. However, designing ASD for cars requires the marriage of sound composition with vehicle engineering.

At Hyundai the lab uses Simcenter Testlab Sound Designer for data-driven composing to craft the sound design. The input comes from the vehicle – vehicle speed, motor speed, powertrain load or throttle – and from that component the sound engineer generates a new sound.

For EVs, the team has adopted a new data-driven approach, called the granular synthesis method, which they apply using Simcenter Testlab Sound Designer. This starts with a recorded or composed sound sample matching the required driving emotion for a specific vehicle. Short sections of the sample, called grains, are synthesized one at a time and varied in position, pitch and duration as a function of the vehicle's dynamic driving parameters. This methodology maximizes the creativity of the designed sounds while taking into account its use in the vehicle.

Developing in-house skills

Given the new, extended possibilities of acoustic design in electric vehicles, and its potential for enhancing brand identity, Hyundai regards it as essential to maintain and develop sound engineering skills in-house.

Solutions/Services

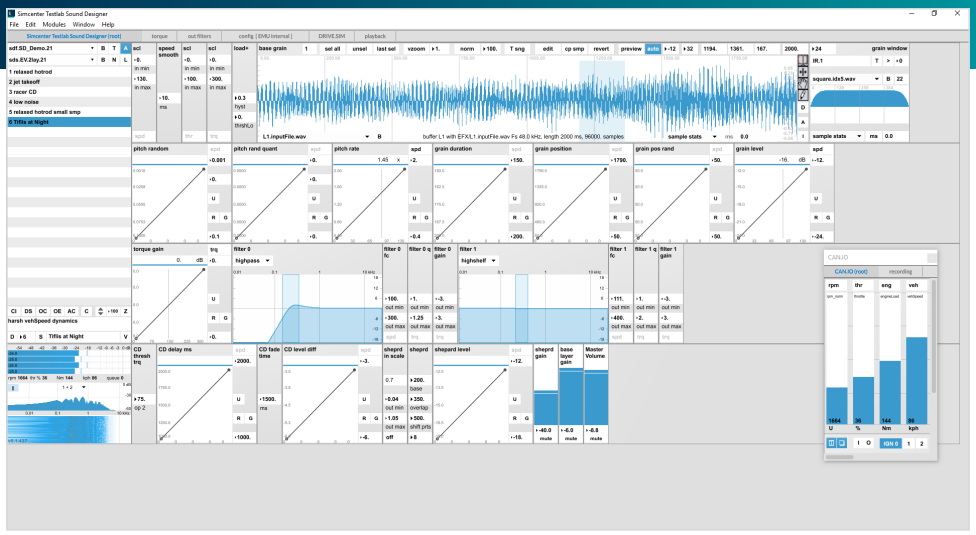
Simcenter Testlab
siemens.com/simcentertestlab

Customer's primary business

Established in 1967, the Hyundai Motor Company has a presence in over 200 countries, with more than 120,000 employees dedicated to tackling real-world mobility challenges around the globe. Based on the brand vision "Progress for humanity," the company invests in advanced technologies to bring revolutionary mobility solutions while pursuing open innovation to introduce future mobility services.
www.hyundai.com

Customer location

Seoul
South Korea



Therefore, the company has taken the strategic decision to keep active sound design skills in-house and focus on skills development – and not to spend valuable resources building its own tools.. For this, Hyundai has chosen a strong partnership with Siemens.

Front-loading sound design without vehicle prototypes

The Hyundai development team is now using Simcenter Testlab Sound Designer to design, validate and tune the acoustic concept of a vehicle before the prototype is built, thereby accelerating development of new vehicles.

First, the EV models are tuned on NVH simulators. The lab can also create or simulate driving profiles with a 1D simulation program that captures all the driveline complexity and even the controls of the vehicle. These drive profiles can then be applied to the active sound design models to link the created sound with how the vehicle drives.

Increasingly, Hyundai is looking toward tightly integrating these building blocks, which is exactly where Siemens can help. The aim is to reach the position where the design models, in conjunction with the simulator, enable creation of a comprehensive digital twin that can precisely simulate the driving experience in all its aspects.

Finally, the lab is looking to the future and getting ready for autonomous vehicles. Here sound will have the additional, critical function of relaying safety and relaxation messages to the driver/passenger.

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