

# CASE STUDY

## Magneti Marelli uses a Desktop NVH Simulator for product development and marketing

Italy  
Automotive NVH  
Desktop NVH Simulator

*Magneti Marelli is a tier-one supplier to automotive manufacturers throughout the world, developing components such as exhaust systems to exacting specifications and targets. Using a Desktop NVH Simulator brings them great advantages when communicating with their customers throughout the development process. For their Exhaust Systems department, troubleshooting, benchmarking, and meeting targets are all enhanced by the speed and ease with which the simulator allows them to virtually develop and experience different exhaust designs. Ultimately, it saves time by adding a new dimension to the process of component design that is more integrated and customer-focused.*

*Photos courtesy of Magneti Marelli*



## History

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The Fabbrica Italiana Magneti Marelli (FIMM) was founded in Milan on 8 October 1919 by Fiat Torino and Ercole Marelli & Co, in order to satisfy the demand for magnetos for engines from both the vehicle market and the aviation sectors. Developing from the production of electrical equipment in the 1930s, the company started the mass production of radios, before moving into television components in 1955. In 1967, Fiat bought out the shares they didn't already own, and in 1969, Magneti Marelli's electronic systems started to be installed on racing cars. In 1972, the company abandoned the production of radios and televisions altogether as they concentrated on automotive markets, and in 1989 the Excellence Centre for electronic systems was created.

## Magneti Marelli

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Today, Magneti Marelli is an international company based in Milan, Italy, designing and producing hi-tech systems and components for the automotive sector. Magneti Marelli is structured along the following business lines: Exhaust Systems, Powertrain, Lighting, Electronic Systems, Suspension Systems, Aftermarket Parts and Services, and Motorsport. Part of the FIAT group, Magneti Marelli mainly works with Fiat companies, but is increasingly widening its customer base to supply all the leading car makers in Europe, North and South America, and Asia, focusing its efforts especially on intelligent systems for active and passive vehicle safety.



With a turnover of €4.5 billion in 2009, 32 000 employees, 77 production units, and 26 application centres, Magneti Marelli group has a presence in 18 countries. Recognising that innovation of products and processes is critical, the company reinvests approximately 5.4% of its turnover to support R&D activities in its three separate R&D facilities in Brazil, Italy and Spain. Out of their total of about 32,000 employees, approximately 3,000 are involved in product innovation and improvement processes.

## Innovation

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Increased competition at the global level combines with the demand for more and more advanced products that promote safety, performance and respect for the environment. This has prompted the companies operating in Magneti Marelli's sector to dedicate a growing share of their turnover to the innovation and development of new solutions. Reaching out to manufacturers is key to gaining and maintaining business, and Magneti Marelli are taking a bold first step in this regard.

As the first tier-one component supplier to use a Brüel & Kjær Desktop NVH Simulator, they are taking the initiative in engaging their customers in the development process. This approach is paying off, and assisting their general drive to supply more companies than the Fiat group alone.

"It provides more than we expected from the demonstration, in terms of what you can do with it," says Massimo Ambrosino, from NVH Testing for Research and Development. "We use it as both a sales and an R&D tool in the Exhaust Systems department."

### **Desktop NVH Simulator**

*Enables the user to evaluate, modify and design NVH data interactively in an office environment, by driving in a virtual scenario using authentic car controls and feedback. The scenario is shown on desktop monitors, and allows quick changes between different vehicles, systems and components*

## Why does the exhaust division need a simulator?

For Mr Ambrosino, the simulator is highly effective for engaging with their clients during the development process. “We typically have a visit from customers every week, so they can hear the latest developments on a particular solution tier that we are working on. This shows really effectively what we can do. We believe we are the first tier-one automotive supplier to adopt this technology, so it is a valuable differentiator,” he says.

The Desktop NVH Simulator is a powerful marketing tool for Magneti Marelli, as it allows them to demonstrate their products’ capabilities in such a realistic way. It’s quick and easy to show R&D experts and non-experts alike the developments they have made – all in the comfort of a cinema-like quiet room, which is fully equipped for the task.

“When displaying our development work to customers, we can start by showing them the technical approach and specification information and so on, and then we can actually show them the tangible results, which are instantly obvious,” says Mr Ambrosino.

Critically, the simulator provides extra context that affects the noise perception of the ‘driver’, as he is concentrating on driving the car in a realistic setting, and is more actively engaged. When you factor in the impressive sound and the functional instrument display, it is easy to be fully absorbed in what feels and sounds like a real car. As Mr Ambrosino says, “It is very valuable for our customers to be able to experience this in a realistic environment with accurate visual and, of course, aural representation.”

**“It is a great tool for us to know our components better, and a much better way to perform benchmarking tests with our customers”**

*Massimo Ambrosino, NVH Test Engineer*

## Magneti Marelli’s setup

*The quiet room used for customer demonstrations contains an impressive surround-sound system and comfortable chairs from which to enjoy the experience of comparing different vehicles and new developments, while watching the faithfully reproduced context on the screen*



The simulator sits in a large quiet room where an array of comfortable chairs sits in front of a 60-inch television screen, surrounded by a speaker system that would be the envy of many cinemas. Here, representatives from the manufacturers who are Magneti Marelli’s customers can jury-evaluate the developments made by the exhaust department.

But the huge screen is in fact a repeater for the actual driving simulator at the back of the room, where the driver sits behind an array of three smaller screens and is fully immersed in the scenario – driving the different vehicles using a steering wheel, pedals, and a gearshift.

Both headphones and the surrounding speakers are used, with headphones often preferred for more analytical tasks where focusing on specific sound details is important. For general-purpose listening, the surrounding speakers give an impressively realistic sound, sweeping the room with authentically complex exhaust sounds.

Installation was made with Windows 7, with the help of Sound Evaluations (Brüel & Kjær's simulator partners), while telephone support ensured fast resolution when advice was needed. As Mr Ambrosino says, "I was really impressed with the expertise of the technicians." Learning how to use the simulator was also straightforward, and following a minimal learning period it is used every day.

One of the first projects for the exhaust department was working with the new Lancia Ypsilon, equipped with the revolutionary TwinAir engine, after its successful debut in the Fiat 500. The new two-cylinder engine designed by FPT won four prizes at the International Engine of the Year 2011 award in Stuttgart.

## Benchmarking

*The HATS (Head And Torso Simulator) assists in the normally problematic area of interior sound definition*

(Brüel & Kjær's image)



At the beginning of the development process, comparing competitor vehicles is hugely simplified with the Desktop NVH Simulator. After incorporating the measurements from known vehicles, a jury can then drive the best-in-class competitor, and even switch between a range of vehicles. This capability saves time by allowing all of the interested parties to experience this and to compare vehicles and set-ups – in one comfortable room, and on one occasion. Crucially, it allows the decision makers to get involved with the process early on.

**"It provides much more than we expected from the demonstration, in terms of what you can do with it"**

*Massimo Ambrosino*

According to Mr Ambrosino, "It's a great tool for us to know our components better, and a much better way to perform benchmarking tests with our customers. Whenever we start the development process with benchmarking, this is the right workflow to take."

The team obtain the input for the simulations with different Brüel & Kjær tools. LAN-XI Data Acquisition Hardware and PULSE software provide the backbone of their data gathering equipment, while a binaural Head And Torso Simulator (HATS) is especially useful for the interior noise measurements – an area where sound definition is often problematic. The usual approach is to gather data from three positions: from the driver's position, from the backseat with the HATS, and from outside the vehicle. In this way they get three perspectives – the driver's, the passengers', and from the outside. A SoNoScout hand-held binaural recorder is also used for rapid benchmarking, especially where engine RPM data is needed.

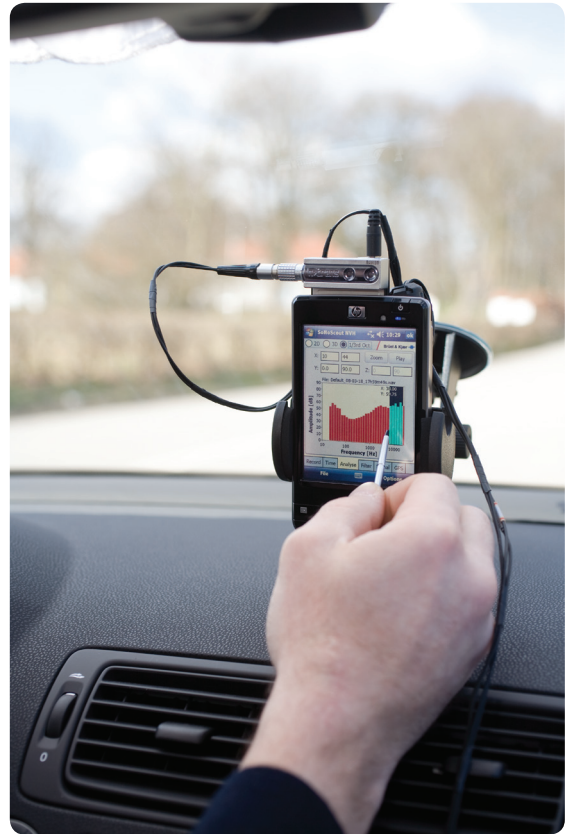
## Meeting targets

*The highly portable SoNoScout binaural data recorder is used for rapid benchmarking, and is especially useful where RPM data is needed*

(Brüel & Kjør's image)

Targets – from benchmarking or a jury – are typically given to component suppliers like Magneti Marelli by their customers, who specify criteria that components must meet. These are often one-dimensional, with manufacturers supplying an NVH target only for when the vehicle is accelerating in 3rd gear with a wide open throttle. However, in the long experience of the Exhaust Systems department, this target can often be unrepresentative of the whole picture. By contrast, the simulator highlights the importance of part-load conditions on the overall perceptions of sound quality. As Mr Ambrosino says, "In real life you don't stay in full-load conditions, so you must be able to experience more when performing evaluations. It is also here that the simulator is very useful."

The targets themselves can also be problematic, as Mr Ambrosino says, "In reality, that target might not bear a close relation to the real world." In cases like this, displaying the full range of the sound produced in different conditions can help juries to decide by using a more realistic – and subjective – evaluation. Using the simulator, they are able to explain any out-of-target differences in an instantly appreciable way, by showing the sound over the vehicle's complete sound envelope, and in a more complete context.



## Troubleshooting and isolating noise sources

### Source path contribution

*Source Path Contribution software helps NVH automotive engineers understand how noise and vibration are transmitted through various paths of the vehicle – both structure-borne and airborne. It provides a tool for optimising sound and vibration contributions according to engineering design parameters.*

During the development process, the simulator has an important role to play in troubleshooting, such as where a manufacturer might experience unusual noises. According to Mr Ambrosino, "In specific conditions something might be happening, like a 'booming noise' – maybe on certain road surfaces or at certain accelerator positions. It may be caused by the exhaust or possibly not. Using the simulator we can isolate the problematic noise and model the necessary changes."

Typically, this uses source path contribution technology. Source path contribution helps NVH automotive engineers understand how noise and vibration are transmitted along various paths through the vehicle – for both structure-borne and airborne noise. It provides a tool for optimising sound and vibration contributions according to engineering design parameters. "It's great that you can switch off the sources contributing to the noise and only listen to the ones that you want, and quickly see if you have a false or a real problem, or if it the problem belongs in a different department, like the intake or turbo department," says Mr Ambrosino.

The simulator allows them to focus on the important sound component and lose no time unwittingly investigating other things. It's also useful for road and tyre noise assessments, and has been used by Magneti Marelli to isolate tyre noise.

## Aftermarket parts

*Aftermarket exhausts present a challenge as they must sound exciting and sporty, yet not break pass-by noise limits*

A significant area of Magneti Marelli's business, aftermarket parts are another domain where development has benefitted from the Desktop NVH Simulator. Just like with the benchmarking workflow where they begin with existing vehicles, aftermarket parts have an existing component with which to start development, allowing alternative design changes to be modelled and played to the audience. Taking the stable conditions of the fully developed car, the R&D department can work on just the exhaust to shape its sound.



In addition to modifying components of standard car models, they produce modified exhausts for aftermarket engine tuners – typically ones that help produce more power and a more 'sporty' sound. Where previously they would need to use many physical models to create the new component, they can now model it virtually.

Most automotive manufacturers have an associated tuning house, which is another brand that offers higher-performance versions of production models. During development, these companies are faced with the common problem of keeping noise levels low for pass-by measurements and while driving in town, and yet providing a louder, more powerful signature when the throttle is fully opened. The simulator can help to shave considerable development time off, as different alternatives can be quickly evaluated.

## Future

For Magneti Marelli's Exhaust Systems department, simulation will continue to be a significant tool into the future. They are looking forward to developing more capabilities, and are working with Brüel & Kjær's simulator experts to develop pass-by simulation capabilities that can cut their work time significantly.

In fact, the ongoing support and development was a major part of the reason that they bought the simulator in the first place. As they are well aware, with continued development comes continued innovation, safeguarding their investment into the future. According to Mr Ambrosino, "It's a highly valuable solution, it is user-friendly, and it is being continually updated. For the R&D Manager and I, it was an easy decision to go for the Brüel & Kjær application."

In addition to expanding the capabilities, they plan to increase the channel capacity of their PULSE analyzer system, and are looking into the prospect of purchasing a Full-vehicle NVH Simulator. From the start of their purchasing process they were considering this option, but chose their Desktop NVH Simulator in order to begin their simulation capabilities with a simpler version. Both systems bring valuable interactivity and context into the evaluation process, helping integrate the development process between suppliers and manufacturers.

### Full-vehicle NVH Simulator

*This gives even more context to the tester, as a whole car is used to give vibration simulation as well as aural simulation. With shakers on the pedals, on the steering wheel, and on the seats, it is an even more realistic experience, with a life-like screen in front of the car's windscreen.*