

SOUND AND VIBRATION NEWS

ISSUE# 06

# WAVES

OCTOBER 2016

TUNNEL VISION

TOP QUALITY  
CALLS FOR HUAWEI

DRIVING SIMULATION  
IN TOP GEAR

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Brüel & Kjær 

BEYOND MEASURE

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**FRONT COVER IMAGE**

Wind tunnel © ONERA

## LETTER FROM OUR PRESIDENT

# SOUND AND VIBRATION IN A SUSTAINABLE FUTURE

Vast, pulsating, and crowded – megacities are a hotbed for noise and emissions. With serious implications for the environment, as well as for vital resources, the impact of megacities is felt not just locally, but regionally and globally.

The trend towards more people living closer together in cities induces a variety of issues. When it comes to noise challenges, Huawei has been developing and testing advanced noise-cancelling technology to ensure good-quality sound, even in noisy environments; helping to ensure we can still communicate in an increasingly urbanized world.

Tackling the issue of scarce resources is another global challenge. One approach is to try to better utilize the resources that we have and to reduce waste. In Sweden, for example, an advanced leak-finding technology, using sound and vibration analysis, has been helping to utilize district heating as an urban heat source, saving energy by mitigating leakage and waste.

Many manufacturers are also focusing on developing lighter materials as a way to optimize our limited resources and to save energy. These new materials need to be tested for usability, strength, and wear and tear. For example, we are covering China's aerospace newcomer, COMAC, who is ensuring that its passenger plane – with a new, efficient engine type – is ready to handle the effects of acoustic fatigue. The thorough testing includes ensuring the viability of new weight-saving materials and construction techniques, and in-depth aerodynamic studies in wind tunnels.

Wind tunnels also feature in another interesting article about ONERA in France, who is helping to develop the aircraft of the future with fuel-efficient engines whose noise levels still remain within the required limits.

This is just a small selection of the excellent articles in WAVES this month. As Brüel & Kjær supports sustainable growth and helps reduce negative environmental impacts, we continue to collaborate with our customers who are working towards saving energy, reducing pollution, and improving urban life.

Happy reading!

**SØREN HOLST**  
PRESIDENT



# TUNNEL VISION

High in the French Alps on what could be a James Bond film set, ONERA's large wind tunnel helps to perfect future aircraft. As they master the challenges of extracting precise acoustic data, ONERA Modane will soon offer a one-stop shop for both aerodynamics and aircraft noise.

ONERA

THE FRENCH AEROSPACE LAB

Well before the Wright brothers took the flight that changed the world, wind tunnels were already at the cutting edge of aviation. From the safety of the ground, facilities like ONERA's have helped aviation pioneers evaluate how new designs will perform in flight. Ever since ONERA's foundation in post-war Europe, their 12 tunnels have tested the aerodynamics on important new planes from Europe and beyond, including Concorde, the Airbus A380, and the Eurofighter.

Even now that advanced simulation technologies are available, wind tunnels remain essential destinations on an aircraft's journey to flight certification. By making early trials of aircraft component designs, designers can find and resolve problems before they endanger human lives, and before too much investment has accumulated.

#### ACOUSTICS IN THE ASCENDANCY

Today, commercial plane makers compete to reduce fuel burn and emissions like NOx and noise, meaning ONERA's focus is broadening. International Civil Aviation Organization (ICAO) noise regulations place limits on aircraft noise and impose costs when airlines break them, while international government programmes encourage manufacturers to reduce noise during aircraft development. Consequently, the noise that an aircraft makes is being addressed more intensively and earlier in development. As Fabien Mery, ONERA's wind tunnel R&D team head says, "In the past, wind tunnel testing was more for predicting plane behaviour, but now we see fewer models looking like a plane. We are working more on specific parts of the plane like the engine and air

## ONERA'S FACILITIES:

ONERA has 12 tunnels at three different sites, to cover all manner of test requirements. They have hypersonic tunnels for aerodynamics, low-speed, anechoic wind tunnels with open test sections, high pressure wind tunnels covering up to Mach 21, and dedicated

jet testing tunnels. In addition, ONERA has a resident science department that provides engineering services such as model fabrication and instrumentation development, and offers computational fluid dynamics (CFD)/ computer-aided engineering (CAE). ■



"WE ARE WORKING MORE ON SPECIFIC PARTS OF THE PLANE LIKE THE ENGINE AND AIR INTAKE, BECAUSE WE NEED TO BE MORE PRECISE, AND FOCUS ON NOISE."

FABIEN MERY,  
WIND TUNNEL R&D TEAM HEAD,  
ONERA

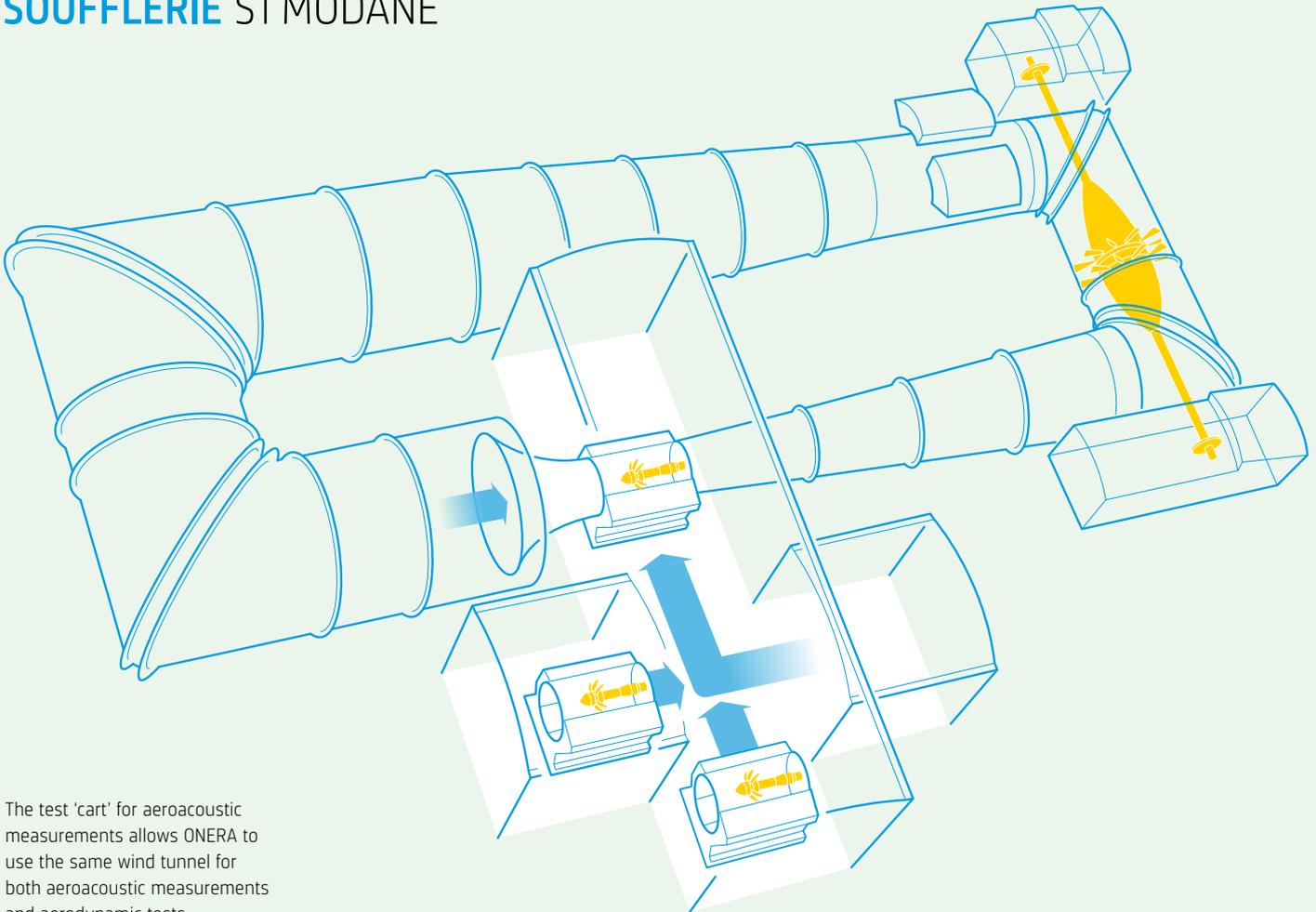
intake, because we need to be more precise, and focus on noise."

Since 2010, reducing engine noise has been in sharp focus at ONERA's Modane facility, where they have been working with Safran aircraft engines to research the viability of the manufacturer's open-rotor jet engine designs. These tests use a 1/5 scale model of the engine, which was made by ONERA's in-house engineering unit. Using compressed air to spin the engine, the model allows the team to trial different blade geometries, in order to find the optimal balance between thrust, fuel burn, and aeroacoustic noise. ►

TUNNEL  
VISION

The air in the tunnel is propelled by two large fans connected to a Pelton turbine driven by water extracted from a reservoir above the tunnel

## SOUFFLERIE S1 MODANE



The test 'cart' for aeroacoustic measurements allows ONERA to use the same wind tunnel for both aeroacoustic measurements and aerodynamic tests

CLEAN SKY PROGRAMME –  
OPEN ROTOR ENGINES

This European development programme intends to reduce emissions and lower fuel burn in future aircraft. One of the leading technology contenders is the open rotor engine in development by Snecma. This offers better fuel efficiency and lower emissions, but tends to be noisier due to the lack of shielding

when compared to conventional jet engine designs. Aircraft that use the open rotor engine would have to use sound insulation to keep cabin noise down, adding weight. So the research has focused on perfecting the design so it can deliver efficiency savings in use – with minimal extra weight. ■

## SONIC TESTING NEAR MACH 1

ONERA's cavernous S1MA wind tunnel at Modane is ideal for this. "Modane is unique in allowing large models that produce the physics we want to observe, in large enough clarity that it is useful," says Fabien. By allowing testing at up to Mach 1, the S1MA tunnel is also unique in enabling testers to capture data for normal aircraft speeds, which are the most critical for passenger noise exposure due to the time spent at cruise.

“WE CANNOT SAY THAT WE NEED TO PUT THAT RUN IN THE BIN BECAUSE THE GAIN WAS NOT RIGHT. SO WE NEED TO BE SURE THAT OUR MEASUREMENTS ARE ALWAYS GOOD.”

FABIEN MERY,  
WIND TUNNEL R&D TEAM HEAD, ONERA

For many aeroacoustic noise measurements, a complete anechoic test section – or ‘cart’ – is inserted to give more isolated acoustic conditions. As Fabien says, “Here in Modane, we have a closed test section, and even if it’s not completely anechoic, the liner makes it satisfactory for most measurements.” With bespoke arrays of microphones mounted in the test cart, ONERA’s measurements seek to understand the power, frequency content, and directionality of aeroacoustic noise from models of aircraft components.

#### SCALING THE AIR

Like the open rotor engine model, scale models of aircraft components or sections are usually around 1/5 the size of the real thing. However, even with a relatively large model, acoustic frequencies are much higher than the design will create in the real world. This is because the frequency of the noise created using a scale model is inversely proportional to the size of the model.

After measurements have been successfully recorded, the high acoustic frequencies must be scaled down. To do this accurately requires ‘dense’ data that has been gathered at a fast sampling rate, so ONERA and Brüel & Kjær collaborated closely on the development of a module for the LAN-XI data acquisition hardware system that samples the signals over 250,000 times per second across many channels. “Brüel & Kjær designed the module to our requirements,” says Fabien. “As a result, ONERA had the first really big system with 100 kHz data acquisition in the world.”

#### FLEXIBLE DATA ACQUISITION DEMANDS

When measuring in the wind tunnel, one challenge for ONERA is avoiding noise in the signals. This is because the analogue cables connecting the transducers to the



digital data acquisition system are more affected by electrical noise when measuring high frequencies. The answer is to locate the data acquisition units nearby. “The modular LAN-XI data acquisition system lets us move a module close to each array of transducers, and convert the data to digital ASAP,” says Fabien.

ONERA’s test set-ups change regularly, with microphone arrays at different parts of the wind tunnel for an open rotor

engine test than for a new helicopter blade design test. “We split the system all around the circumference of the wind tunnel and then connect the modules with an Ethernet cable,” says Fabien. ONERA also moves data acquisition units around between their different facilities in France, to meet the demands of specific tests. “We have 200 channels in Modane, and more at Saclay and Chatillon, so we can easily combine them to about 500 channels,” he says. ▶

TUNNEL  
VISIONSCALE MODELS  
OF EVERYTHING

When measuring smaller aircraft models in wind tunnels, the air needs to be scaled too, to prevent it being too 'thin'. These are known as Reynolds effects, which ONERA's

testers compensate for when testing. Acoustic frequencies are also scaled, so what would be 50 Hz in the real-world could equate to 250 Hz in the wind tunnel. ■



## PIVOTING ON PRECISION

The team needs such high channel counts to gather as much and as accurate data as possible in one go. As Fabien says, "It's very expensive to make tests, and we do a lot of acoustic beamforming. The classical beamforming antenna uses about 60 microphones, and we use several. So we would even like to get another 100 channels." Maximizing the meaningful data from each measurement is also critical in a programme of tests, because big decisions hinge on each one. As Fabien says, "Customers are waiting. They need to adapt the test campaign based on the results from one run. We cannot say that we need to put that run in the bin because the gain was not right. So we need to be sure that our measurements are always good."

Getting the correct range in a wind tunnel is both critical and challenging because ONERA measures very small amplitudes at high frequencies, and low



frequencies at very high amplitudes. Their next challenge is testing ultra-high bypass ratio (UBHR) engine designs, which are quieter than open rotor designs, making the important signals harder to discern from the background noise from the wind tunnel's 8-metre fans. "We need to have something with impressive dynamics," says Fabien. "The main advantage of our aeroacoustic system is the Dyn-X technology in LAN-XI, with its twin analog-digital convertors and automatic input ranging. It ensures we always get it right the first time."

## INTEGRATED FUTURE SERVICES

In the near future, ONERA plans to broaden Modane's capabilities as a one-stop-shop for aircraft testing. "New aircraft designs have always had two separate test campaigns for aerodynamics and aeroacoustics, but we are looking to align them," says Fabien. The idea is to reduce customer time and expense, and increase data validity by making aerodynamic and aeroacoustic measurements in similar conditions. "We are working on new methods to enable us to perform all the necessary acoustic measurements in non-anechoic environments, where we can de-noise the results."

The pièce de résistance for ONERA's vision is that it will enable customers to use their (larger) budget for aerodynamics on aeroacoustics. "We have been doing aerodynamics for 100 years," says Fabien. "Aeroacoustics is a newer science with fewer established methods and a smaller knowledge base. It is challenging, as they are more dynamic tests. But we need to develop them. We need to understand what's happening so we can make the best measurements." ■

# SOUND ART IN EXTREMIS: MAPPING THE SOUND ECOLOGY OF ANTARCTIC WEATHER

Sound artist and RMIT University academic, Dr Philip Samartzis, travelled to the Antarctic's Casey Station as an Australian Antarctic Arts Fellow in early 2016, to explore the interaction of katabatic wind with the built and natural environments. ▶

## SEE MORE

The collaboration with Speak Percussion titled 'Polar Force' will premiere at the MONA FOMA Festival in Hobart in 2018.

[www.mona.net.au](http://www.mona.net.au)



**SOUND ART  
IN EXTREMIS:  
MAPPING THE  
SOUND ECOLOGY  
OF ANTARCTIC  
WEATHER**



BY: PHILIP SAMARTZIS

Artistic director of the  
Bogong Centre for Sound Culture,  
Coordinator of Sound in the  
School of Art – RMIT University  
Australia



My project emerges from a fascination with the innovative photography of Herbert Ponting and Frank Hurley, who by combining subject, composition and climate conveyed a deeply mysterious and alien place. I am particularly intrigued by Hurley's depictions of life on the ice through two iconic photographs, *The Blizzard* and *Leaning on the Wind*, both taken in 1912. The photographs convey the ferocity and atmospheric effects of the conditions using a mix of techniques including staged scenes and composite printing to viscerally express something that is close to impossible to articulate through conventional documentary photography. Inspired by these evocative depictions of abstract landscapes that have been shaped by volatile conditions, I wondered how I could produce an equivalent account using sound recording techniques to render an embodied experience of extreme climate.

**THE KATABATIC EFFECT ON SOUND**

With images of ferocious gales and phantasmagorical landscapes etched firmly into my mind, I undertook three weeks of fieldwork at Casey Station in Eastern Antarctica, interrogating the effects of katabatic wind on the station and surrounding environment. Katabatic wind is a low gravity wind that gains force as it travels down elevated slopes. It is particularly prevalent at Casey due to its location at the base of Law Dome, which gently rises to an elevation of 1395 metres. When the cooler temperature of a katabatic wind mixes with the warmer temperature of the onshore wind, an erratic weather system emerges, making Casey the ideal location for my project.



Blizzard at Cape  
Denison – Photo by  
Frank Hurley – 1912

Katabatic wind is particularly notable for the way it shapes the manner in which

sound is experienced within the built and natural environment. Its trajectory can push sound away from you or it can draw it closer to you. Its intensity can mask sound and its absence can heighten it. At its most ferocious, it simply obliterates everything in its path. A collision with the built environment transforms katabatic wind into an intense series of ascending and descending pitches – a supercharged aeolian harp. Inside the steel-framed and insulated-panel buildings, pervades a silence that imposes a profound sense of isolation from the immediate environment. Outside, the volatility is expressed through a variety of resonances emitted by miscellaneous surfaces and materials undergoing tremendous stress. On one occasion, while recording from an ice-encrusted, cold porch, I am informed that wind gusts are exceeding 185 km/h. The piercing shrieks of the anemometer emerging from the white abyss provide testimony to its ferocity.

### EXTREME SYMPHONY

Over three weeks, I recorded an assortment of sound activated by wind and shaped by the cold. Ice granules dancing across sheet metal, agitated flags, murmuring cables, brittle plastic sheets billowing in the wind, indifferent buildings and infrastructure, wind gusting across desolate ice fields, and the transformative effects of warming and cooling upon the polar environment. In order to document the volatile conditions, I deployed various combinations of Brüel & Kjær equipment across the station limits, comprising four legacy studio microphones and two weatherproof microphone and preamplifier assemblies, a miniature hydrophone, and four miniature piezoelectric accelerometers. This enabled me to undertake simultaneous recordings of air-, water-

and structure-borne sound, to demonstrate the effects of turbulence and stress on the polar station and its attendant environment.

The sound recordings will form the basis of a new series of compositions for exhibition and performance designed to generate tactile and immersive experiences of the sonic ecology of extreme weather events. In development is a new concert work for Melbourne-based ensemble Speak Percussion, combining multichannel sound recordings with acoustic instrumentation, including specially designed ice instruments and wind machines. Through the convergence of site, sound and space expressed within the mutable framework of sound art and experimental performance, vivid and dramatic impressions of nature in extremis will be achieved. ■

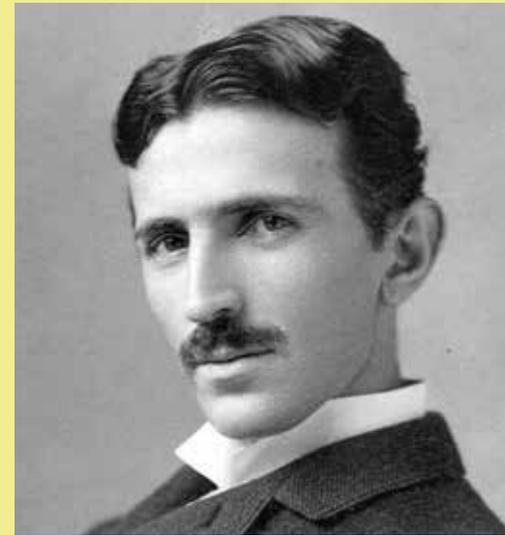
*Philip Samartzis would like to acknowledge the generous support of Maurizio Demontis, Brüel & Kjær Melbourne, The Australian Antarctic Division, and Creative Victoria for their support of this project*



Listen to the raw recordings (1:30)



# WHO SAID WHAT?



“IF YOU WANT TO FIND THE SECRETS OF THE UNIVERSE, THINK IN TERMS OF ENERGY, FREQUENCY AND VIBRATION.”

NIKOLA TESLA (1856 – 1943)

*Nikola Tesla*

Among many pioneering innovations, the first wireless transfer of power was achieved by the famous Serbian-American inventor, electrical engineer and futurist Nikola Tesla. It must have seemed like magic as he lighted electric lamps without any cables, to the amazement of the crowd. But in fact, the stunt used resonant magnetic inductive coupling: carefully controlled vibration. ■

# DEVELOPING A SMOOTHER RIDE

Supporting safer and more comfortable vehicles, Sumitomo Riko uses advanced polymer materials and comprehensive evaluation technology to manufacture anti-vibration rubber for the automotive industry.

With its headquarters in Japan and subsidiaries in 23 countries, Sumitomo Riko holds the largest market share of automotive anti-vibration products. Its highly durable anti-vibration rubber products absorb vibration from car engines and suspension, helping deliver greater comfort and improve NVH performance.

## ANTI-VIBRATION RUBBER IN VEHICLES

Anti-vibration rubber is present in a vehicle in the form of mounts and bushes. These non-linear components are important to NVH as they absorb the energy that would otherwise be transmitted to the driver and passenger. The use of anti-vibration rubber in vehicles fit into four main areas: the engine system, suspension system, body system, and the exhaust system. A large quantity of anti-vibration rubber – 60 to 70 pieces at most for a single

vehicle – is needed to reduce the vibration and noise that occurs both inside and outside the vehicle, delivering a comfortable driving experience and stable handling.

Depending on where it is used in a vehicle, anti-vibration rubber needs to have a well-balanced combination of the following properties to control vibration:

- Spring properties
- Heat-resistance
- Durability
- Reliability

The spring properties of the rubber combine stiffness with inherent damping in the material that converts the dynamic energy into heat. The absorption characteristics can be defined as hysteretic damping (which is constant with frequency) and referred to by the industry as loss and viscous damping (which increases linearly with frequency). By altering the geometry and compound of the rubber, the manufacturer can tune the mount to a specific load and isolation specification. For example, right now there is a demand for anti-vibration rubber with high performance in terms of durability and heat resistance for vehicles driven in harsh environments, such as on unsurfaced roads and in regions with intense heat. This has spurred the development



In 2009, Sumitomo Riko enhanced their PULSE™ system by investing in three LAN-XI modules and a Time Data Recorder. Along with transducers, triaxial accelerometers and DC accelerometers, the current testing set-up now includes eight LAN-XI input modules, LabShop and PULSE Reflex™ Core for post-processing analysis.

of rubber that possesses high vibration control characteristics covering a wider range of the vibration frequency bands.

### SIZE AND WEIGHT ARE ALSO CRUCIAL

The automotive industry is also facing tighter regulations on emissions; therefore, there is interest in reducing the weight of automotive parts to help with fuel savings. Vehicle manufacturers are actively adopting lightweight materials, such as high tensile strength steel, aluminium parts and resin based materials. Similarly, Sumitomo Riko has been developing lightweight technology for anti-vibration rubber.

However, the success of reducing the size and weight of anti-vibration rubber products has brought to light another challenge: smaller anti-vibration rubber products are subject to larger input distortion and result in lower durability. To address this challenge, Sumitomo Riko has developed a high-durability rubber using polymer materials technology. The rubber is twice as durable as conventional rubber, and enables a size and weight reduction of products, while still maintaining durability.

### FLEXIBLE TESTING SET-UP

Planning tests around the specific needs of customers, Sumitomo Riko evaluates product properties, including durability, ensuring the desired performance of the rubber material is achieved. "We meticulously analyse materials, products and systems from multiple perspectives. Simulating the use conditions of the final product, we evaluate whether our components can satisfy customer requirements," explains Hideki Ohshima, manager at Sumitomo Riko.

"We develop the optimum solution through not only evaluating the structural design but also through a molecular-level analysis of polymer materials. This sophisticated approach leads to proposal-driven manufacturing that anticipates the needs of customers around the world," says Hideki Ohshima.

Using PULSE to measure vibration, Sumitomo Riko ensures products meet customers' requirements during the early stages of development. "The PULSE system helps us demonstrate our ability to meet design specifications and win the confidence of our customers," explains Hideki Ohshima.

"The real value of the PULSE system for us is its high flexibility and mobility," says Hideki Ohshima. "We always have to complete measurements within a limited time and some tests are conducted

## ANTI-VIBRATION RUBBER PRODUCTS:

- Plain rubber mounts are designed to have different stiffness in each direction to optimize the balance between isolation and load resistance. More complex mounts have progressive stiffness characteristics to handle transient events
- Bushes made from highly durable rubber reduces the size and weight of the anti-vibration rubber, which contribute to energy-savings
- Electrical Active Control Mounts (E-ACM) are electrically activated mounts that alter characteristics under certain driving conditions. Controlling a built-in actuator, these mounts instantly minimize vibrations transmitted to the vehicle body
- Adaptive hydraulic suspension bushes are designed to minimize suspension system vibration, reducing unpleasant vibrations felt when driving on rough or uneven road surfaces ■



at external facilities. This means that we have no extra time to accommodate failed measurements. PULSE is a really good solution to make sure we complete testing successfully."

### COMFORT, EVEN IN HARSH CONDITIONS

Sumitomo Riko continues to develop a range of high-function and high value-added product designs, concentrating on decreasing the size and weight of materials while maintaining high durability performance. Using rigorous testing methods, Sumitomo Riko meets customers' demands for smaller and lighter products that can still be used in challenging environments. ■

# TOP QUALITY CALLS FOR HUAWEI

## HUAWEI FACT FILE

- China's largest telecom company, established in 1987, now has more than 170,000 employees and revenue of 60,839 billion USD (2015)
- A worldwide builder of telecommunication networks and services
- Huawei's market share in the Middle East and Africa more than quadrupled in the two years prior to 2015
- Began focusing strongly on the European market in 2015
- Huawei's R&D centres worldwide include a facility in Finland devoted to developing audio codecs in cooperation with Huawei's chipset development department HiSilicon and with the future technology from China HQ ■



Suddenly Huawei phones are everywhere. That's how the mobile phone market goes: rapidly changing to suit our demands. First came SMS messages, then selfies and video calls. Now the top brains at Huawei are implementing audio technology that pushes the limits of physics – ready for the HD voice evolution.



It was only back in 2015 that Huawei smartphones became widely available in Europe. Here, the sharp lines of models like the Honor V8 offer a crisp new alternative to the conventional brands. Already the largest telecom company and the highest-selling smartphone maker in China, Huawei has grown rapidly in the Middle East and Africa too. And now, after achieving success on such a scale, Huawei has intensified its focus on giving the best overall quality of service.

However, the top end of the phone market is a crowded and competitive place. High quality is expected as a minimum, and it depends on top audio performance in every situation – whether playing music or speaking. So as Huawei pushes out strongly into the premium sector, its acoustic developers need to work hard if they are to catch the attention of quality-conscious users.

#### CLEARER THAN BELL

In the near future, a major component of quality audio will be effective high-definition (HD) voice capabilities. Waiting just around the corner, this new technology promises to transform our phone conversations, making them as realistic as if we are talking together in the same room.

HD voice will bring more frequency bandwidth for speech, meaning people will sound less muffled. There will be better definition of high- and low-frequency sounds, giving better differentiation between sounds like 's' and 'f'. As a result, conversations will be more natural, with instant recognition of the caller and fewer repetitions necessary. Such effortless communication will also bring better perception in noisy environments like crowded streets. ▶

“A PHONE MUST BE VERY THIN, VERY BEAUTIFUL, WITHOUT LOTS OF OPENINGS. SO WE ARE LIMITED TO DESIGNING VERY SMALL COMPONENTS THAT DELIVER HIGH AUDIO QUALITY.”

MAHMUD ALRAWI,  
CHIEF ENGINEER, HUAWEI

## TOP QUALITY CALLS FOR HUAWEI



Background noise levels are generally louder in Asia, requiring a higher receiver loudness rating (RLR)

## VOICE OF THE FUTURE

Phone technology has advanced amazingly over the last decade, at almost everything except the one thing that phones were originally made for: speaking to each other. HD voice does this by allowing much more frequency bandwidth for speech than at present. The current standard frequency range is based on the bandwidth limitations of copper wire, which were settled during studies in the Bell lab in the 1920s – the Plain Old Telephone Service (POTS), which is easy for handsets to satisfy.

But as the world turns away from conventional wire networks and sends voice over internet data networks instead – using VoLTE (voice over long-term evolution) – we are about to circle around the network limitations on frequency range. HD voice is already available in limited instances, like certain networks in Germany. ■

As mobile network infrastructures are being upgraded to support VoIP (voice over internet protocol) all around the world, such voice calls will soon be possible for everyone. This will unleash manufacturers, allowing them to compete over the best voice call quality. As Huawei's Chief Engineer Mahmud Alrawi says, "We think HD voice will break through when the operators provide this service, so we need to be ready." Imagine: the actual conversation quality of a handset might just help determine the fate of brands.

### A DESIGNER STRAITJACKET

For Huawei and its competitors alike, delivering high quality audio is already a huge challenge. Since phones are so small and their industrial design is so tightly defined, there is very



“WE THINK HD VOICE WILL BREAK THROUGH WHEN THE OPERATORS PROVIDE THIS SERVICE, SO WE NEED TO BE READY.”

MAHMUD ALRAWI,  
CHIEF ENGINEER, HUAWEI

little space for the audio components like microphones and receivers. “A phone must be very thin, very beautiful, without lots of openings. So we are limited to designing very small components that deliver high audio quality,” says Mahmud. For speakers too, there are serious physical restrictions. “We are talking about moving air volume,” he says. “These are things that we cannot get around.”

Adding to these challenges are the demands of customers, who want to play music out loud without headphones – with good audio quality and higher sound pressure levels (SPL). “These components are very small, like 6 x 15 mm,” says Mahmud. “And with HD voice, these components must provide us with a 250 Hz to 10 kHz range. So now we have to deliver quality audio over twice the previous frequency range, and also at higher SPLs with no distortion.”

#### NEW MATERIALS AND ALGORITHMS

The answer is to get smart. “We rely on technology, discussing with suppliers to create really good components that give really good acoustic performance, using high technology like special new materials for the diaphragm, magnets and coils,” says Mahmud.

The higher frequency capabilities require speakers and receivers whose diaphragms must move much more rapidly – generating heat. So many of the speakers that Huawei uses feature a smart power amplifier that avoids distortion and damage by actually measuring the temperature of the diaphragm and calculating its excursion. In fact, the latest Huawei phone – the P9 Plus – uses a dual smart power amplifier so that in speakerphone mode it uses the earpiece as a tweeter, for better high-frequency playback.

Besides the hardware, audio coding is playing an ever-larger role in improving sound quality. One example is echo. Just as some ‘over the top’ VoIP phone services do now, mobile HD voice faces feedback problems. “It’s a major challenge to develop advanced echo cancellation algorithms to overcome this,” says Mahmud.

Such coding technologies also allow Huawei to tweak the handset’s performance for specific requirements. “Sometimes we get requirements from operators for a higher receiver loudness rating (RLR). This is especially for Asia, where background noise levels are generally louder,” says Mahmud.

#### TESTING FOR TRAINS AND DOUBLE-TALK

Before they can sell a phone into a market like Europe, operators require that Huawei performs hundreds of test ‘cases’ that realistically evaluate the ways the phone will be used. Standardized tests for double-talk – when two people speak at the same time – and noisy environments, including a cafeteria and a train station, ensure the noise and echo cancellation abilities come up to the operators’ minimum requirements for perception-based metrics such as PESQ (perceptual evaluation of speech quality).

In addition, Huawei replicates the modern ways we use phones today, such as holding them at different angles to our mouths, and during face-to-face videoconferencing. ▶



## TOP QUALITY CALLS FOR HUAWEI



## HD VOICE SPECIFICATIONS

### Sampling rate:

- Traditional digital calls sample our voices at 8 kbps
- HD voice will sample at 16 kbps, twice as many samples per second, for greater call clarity and authenticity

### Frequency range:

- The range of the human voice extends from 80 Hz to 14 kHz
- Current POTS phones limit this into a 300 Hz – 3.4 kHz narrow-band range and 250Hz – 8kHz wideband range
- HD voice will give a universal standard range of least 50 – 10 kHz
- Trials of possible future 'Full-HD voice' have given 20 Hz to 20 kHz, visit [www.full-hd-voice.com](http://www.full-hd-voice.com)



To check the frequency response of the phones at the higher frequencies and SPL levels that better quality audio brings, Huawei uses Brüel & Kjær wideband couplers. These are 'high-leak', so they accurately simulate situations where people hold the phone away from their faces. According to Mahmud, "Brüel & Kjær's wideband couplers are unique. When a phone is unstable at higher frequencies, Brüel & Kjær's equipment is stable enough to give you the reason why."

### LEADING BY EXCEEDING THE STANDARDS

The Brüel & Kjær Head and Torso Simulator (HATS) is also a trusted favourite at Huawei, both during development testing and when testing samples of finished handsets from the production line. "We use HATS partly because it is the same as they use at the Chinese standards organization, so it makes sense to use the same. Brüel & Kjær has been working with standardization for a long time, so we know we are in the hands of people with deep knowledge of the area," says Mahmud.

Merely satisfying standards is not enough for Huawei, however. To broaden their appeal at the top of the market requires audio performance that leads the field. And make no mistake, when the HD voice evolution introduces quality audio into our everyday phone calls, Huawei intends to lead. "Now our phones are ready for HD-quality voice, but all our competitors can do that as well. Everyone is trying to do it better than the others," says Mahmud. "We want to be the market leader. We want to be on top when it comes to sound quality and delivering an amazing experience. For that reason, our own internal quality standards are far higher than any operator's standard." ■

"SOMETIMES WE GET REQUIREMENTS FROM OPERATORS FOR A HIGHER RECEIVER LOUDNESS RATING (RLR). THIS IS ESPECIALLY FOR ASIA, WHERE BACKGROUND NOISE LEVELS ARE GENERALLY LOUDER."

MAHMUD ALRAWI,  
CHIEF ENGINEER, HUAWEI

# TAPPING INTO THE ACOUSTIC PROPERTIES OF A WATERMELON

Many of our customers are engineers, and the different applications they explore outside the scope of their daily work are quite extraordinary.

## LOOKING FOR A HOLLOW SOUND

When Alex Reinhart was a junior in high school, he had noticed that his mother would try to determine the ripeness of watermelons at the supermarket by picking them up, tapping them vigorously and listening to the sound. Curious to see if there was any scientific basis behind her approach, and because he needed a project for the school science fair, he developed a test using an accelerometer and an analyzer to determine the correlation between the acoustic response of a watermelon and its ripeness.

Armed with eight watermelons, a wrench and an accelerometer, Alex went to work. He tapped each watermelon 10 times with his wrench to provide the impact



and used the accelerometer to measure the natural frequency, reverberation time and 1/3-octave spectrum of each impact. Alex then compared his results with the subjective evaluation of 20 volunteer taste testers (guests) who, taking into account juiciness, sweetness and overall ripeness, ranked the watermelons on a scale of 1 to 5 (5 being the best).

The results showed that the best predictor of ripeness was natural frequency normalized by melon length. Alex calculated a correlation between his test and the subjective rating of 71%, which was slightly more accurate than the 67% accuracy achieved by the human tester – his mother. ■

“ENGINEERS LIKE TO SOLVE PROBLEMS. IF THERE ARE NO PROBLEMS HANDILY AVAILABLE, THEY WILL CREATE THEIR OWN PROBLEMS.”

SCOTT ADAMS,  
AMERICAN CARTOONIST

## KNOWING WHAT'S RIPE

As watermelons ripen, their natural frequency drops, and so does damping. If a watermelon is overripe, the damping increases dramatically, resulting in a dull thud when you tap it. Generally, you want to pick a melon that gives a hollow, ringing sound when you tap it. But beware, you really don't want the watermelon that emits an extremely hollow sound when tapped, because it's probably about to turn into mush. If you get a dull thud, it has already turned to mush. ■

# LOST IN LIMOGES –

## THE ART OF BEING A GOOD NEIGHBOUR



Iggy Pop, The Shoes, Fakear – just a few of the headline acts at the Lost in Limoges festival. It is the summer of 2016 and the former military site Mas de l'Âge comes alive as 10,000 music fans descend on the small French town of Couzeix near Limoges. But despite the extra earning potential for local businesses, most locals view such events with a good dose of scepticism and unease.

Festivals provide entertainment, but they are not always welcome by local residents who often dread the noise and disruption. As always, the challenge is to maintain a balance between the benefits of such an event and the impact on local residents. For the first ever Lost in Limoges, the organizers were keen to implement a unique awareness and prevention plan covering issues from ambient air quality to noise pollution. This would prove to

the local community, the health and safety specialists, even the festival goers, that a lot of care and thought was given to minimize any negative impact the event might have and make it a safe and secure event for all concerned.

For Frédéric Tron, one of the festival's organizers and Associate Professor of Engineering Sciences in metrology, vibration and acoustics at the University of Limoges, the festival was also an excellent opportunity for his students to take part in a practical acoustic measurement project that would result in a publicly available acoustic overview of the festival. Keeping noise levels below prescribed limits is essential to maintaining permits, but it is just as important to gain valuable community buy-in by transparently sharing noise information, especially if you want to ensure the survival of the festival in years to come.

#### SAFETY FIRST

The project's main objectives were to measure the noise exposure experienced by festival technicians; to evaluate the noise levels observed on-site during the concert and at neighbouring residences; and to adjust exceeded legal limits. Selected technicians and festival goers were, therefore, equipped with shoulder-mounted, cable-free personal noise dose meters. This small unit would accompany them throughout the day, measuring and registering all relevant data about their noise exposure. The students' task was to extract the data, post-process it and identify the accurate noise exposure. Based on these results, the festival organization committee was able to select the appropriate hearing protection for technicians and comply with legislation.



To measure the environmental impact of this event, Brüel & Kjær set up real-time monitoring to follow, prevent and correct acoustic impact. Two noise monitoring terminals (NMTs) were used, each equipped with a sound level meter, outdoor microphone, autonomous power supply and a wireless communication device to transmit information in real time. One was placed close to the festival and the second, 300 metres away in a neighbour's garden.

#### GOING PUBLIC

The NMTs provided the students and organizers with reliable and accurate noise information, enabling them to make real-time decisions and adjustments to avoid breaching noise restrictions. And to reassure neighbouring towns and local authorities, the information was publicly available via a smartphone app or the Internet.

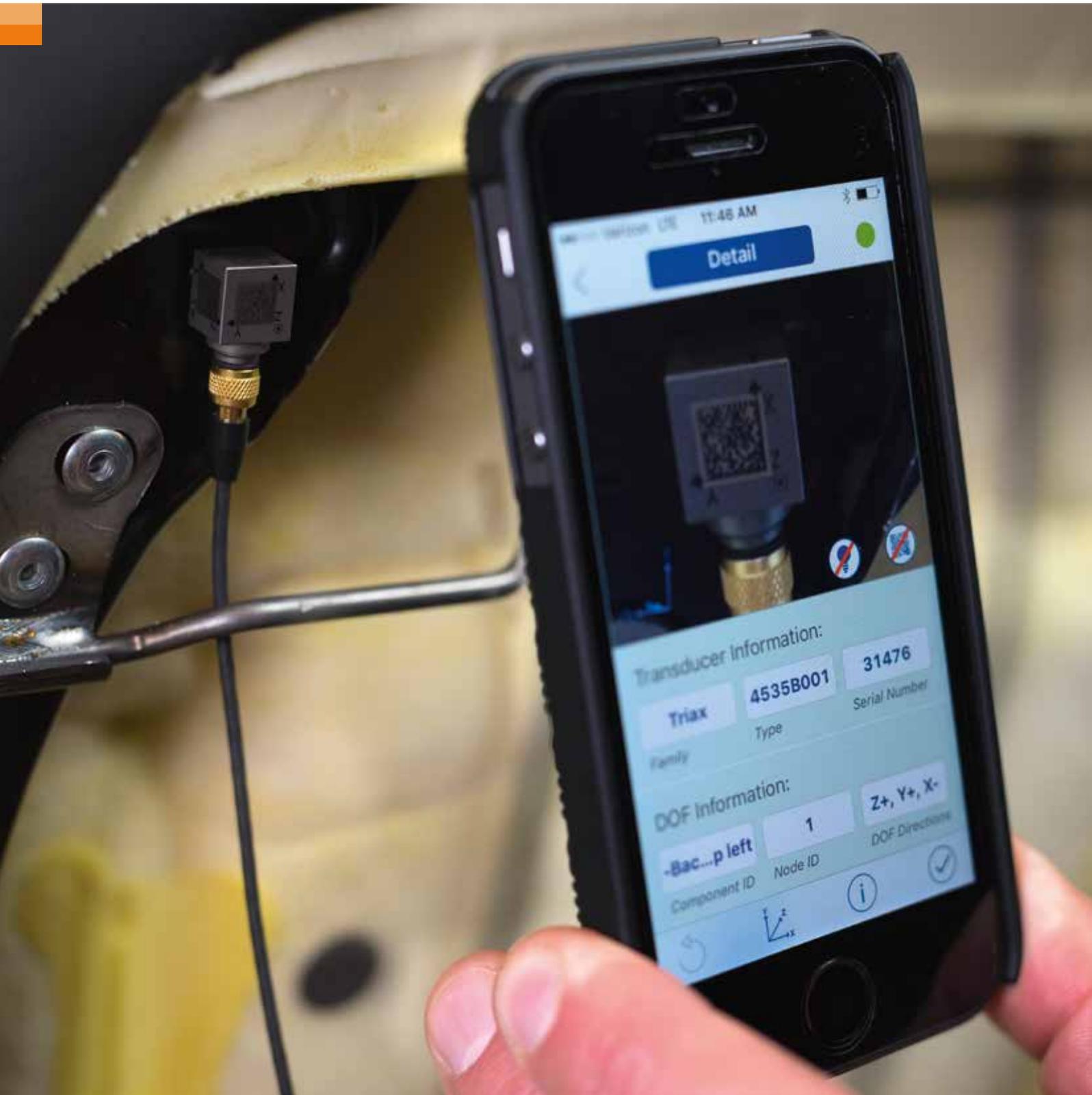
Frédéric Tron describes the measures taken to minimize the negative impact of noise on the local community and festival (1:57)



Frédéric says, "Although the event takes place in a bucolic setting, high technology and efficient and reliable digital tools were an essential part of this event. The monitoring and the sharing of noise information with the public definitely helped to get the local community's acceptance and the sensitive approach used by the organizers will hopefully ensure that Lost in Limoges becomes a recurring highlight for festival goers and local residents alike". ■



# SMARTPHONE APP SHIFTS TESTING INTO **A HIGHER GEAR**



To simplify modal analysis of automotive seating, Faurecia uses the Transducer Smart Setup app – and cuts hours out of their large test set-ups.

Whether generated by the vehicle or the road, vibration transfers to the driver or passenger through the car seats. And although some vibration is acceptable, too much can cause great discomfort. “The seat is one of the customer’s first impressions when test-driving a vehicle,” explains Chris Kus, NVH Engineering Expert at Faurecia, a global leader in automotive equipment. “We always strive to supply products that provide the best driver and passenger experience.”

Reducing vibration for the driver requires that Faurecia understands the real-life response of their seating to the vibrations coming from the power train during operation. Chris continues, “Understanding the natural frequencies and mode shapes of our seats allows us to evaluate the design and make any necessary improvements.”

Modal analysis is vital to Faurecia NVH engineers’ understanding and optimization of the inherent dynamic properties and behaviour of car seats. It leads to lighter, stronger and safer constructions, less energy consumption and greater comfort.

#### COMPLEX TESTING REQUIRES A LENGTHY SET-UP

The testing challenge is complex, as many different forces and factors interact. “Modal analysis of automotive seating is necessary to find the first and second mode shapes and natural frequencies,” says Chris. “Lateral and fore/aft motions in an unoccupied passenger seat become coupled with vehicle input frequencies, causing the seat to shake, which is undesirable for the driver and passengers. We try to find areas to which we can add stiffness to avoid this, but we also look for potential areas from which we can remove mass. This is a growing criterion for the automotive industry as gas mileage improvements are an increasing demand.”

When Chris had to perform modal analysis on a complete front row seat for complete assembly mode shape and natural frequency estimations, with several accelerometers placed on



the seat cushion and seat back, he knew he was in for a long haul. He explains, “A normal set-up with multiple accelerometers can take hours to complete even before testing begins. In fact,” he continues, “the set-up is the longest part of the whole testing procedure.” ▶

“FOR ME PERSONALLY, THAT’S THE MAIN BENEFIT – THAT THE FRUSTRATION AND WORRY OF MAKING DATA ENTRY ERRORS JUST GOES AWAY.”

CHRIS KUS,  
NVH ENGINEERING EXPERT

## SMARTPHONE APP SHIFTS TESTING INTO A HIGHER GEAR

### KEEP CALM AND LET THE APP DO THE WORK

Being able to simplify the process and save time is a huge benefit for Chris and his team. The Transducer Smart Setup app is specifically designed to do just that, making transducer set-up as simple and automated as possible by reading the data matrix codes on the transducers and seamlessly transferring the information to PULSE Reflex™ Structural Measurements software on the PC.

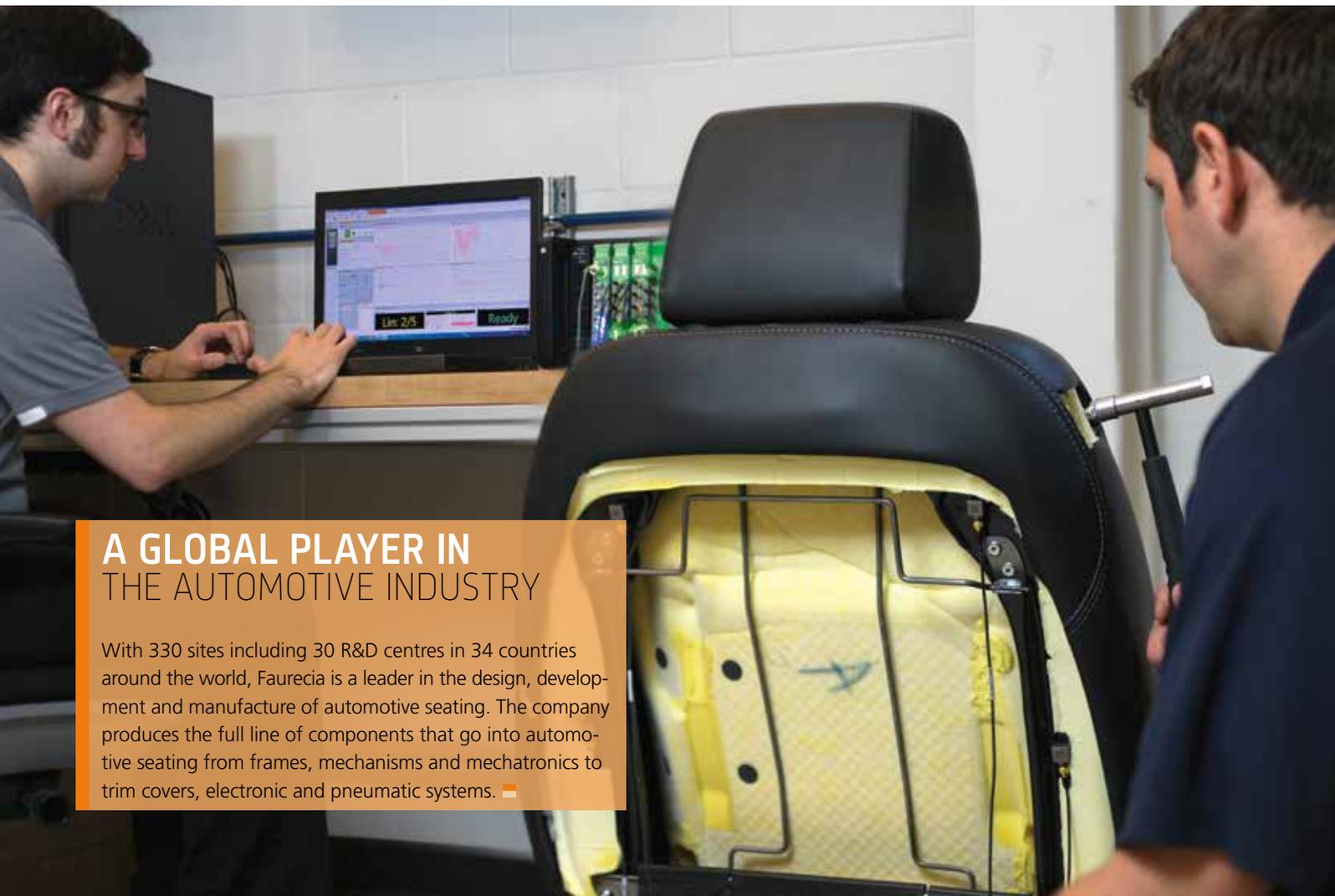
Using a smartphone camera to perform a quick scan of each transducer's data matrix code, the app recognizes the transducer and its orientation. Associated data, such as component ID (position) and node ID can either be scanned from a customized 2D label next to the transducer or simply typed in.

Chris was not disappointed. "The smart transducer app has saved us well over an hour on our large test set-ups by eliminating the step of finding each accelerometer's position and orientation and entering them manually into the system. I have to admit that I was very surprised to discover that the app works with our other accelerometers – those without a data matrix code."

"The app eliminates the chance of human error that easily happens when you have to manually find and input the local orientation into a global coordinate system," Chris concludes. "For me personally, that's the main benefit – that the frustration and worry of making data entry errors just goes away." ■

## A GLOBAL PLAYER IN THE AUTOMOTIVE INDUSTRY

With 330 sites including 30 R&D centres in 34 countries around the world, Faurecia is a leader in the design, development and manufacture of automotive seating. The company produces the full line of components that go into automotive seating from frames, mechanisms and mechatronics to trim covers, electronic and pneumatic systems. ■



# TRY IT OUT

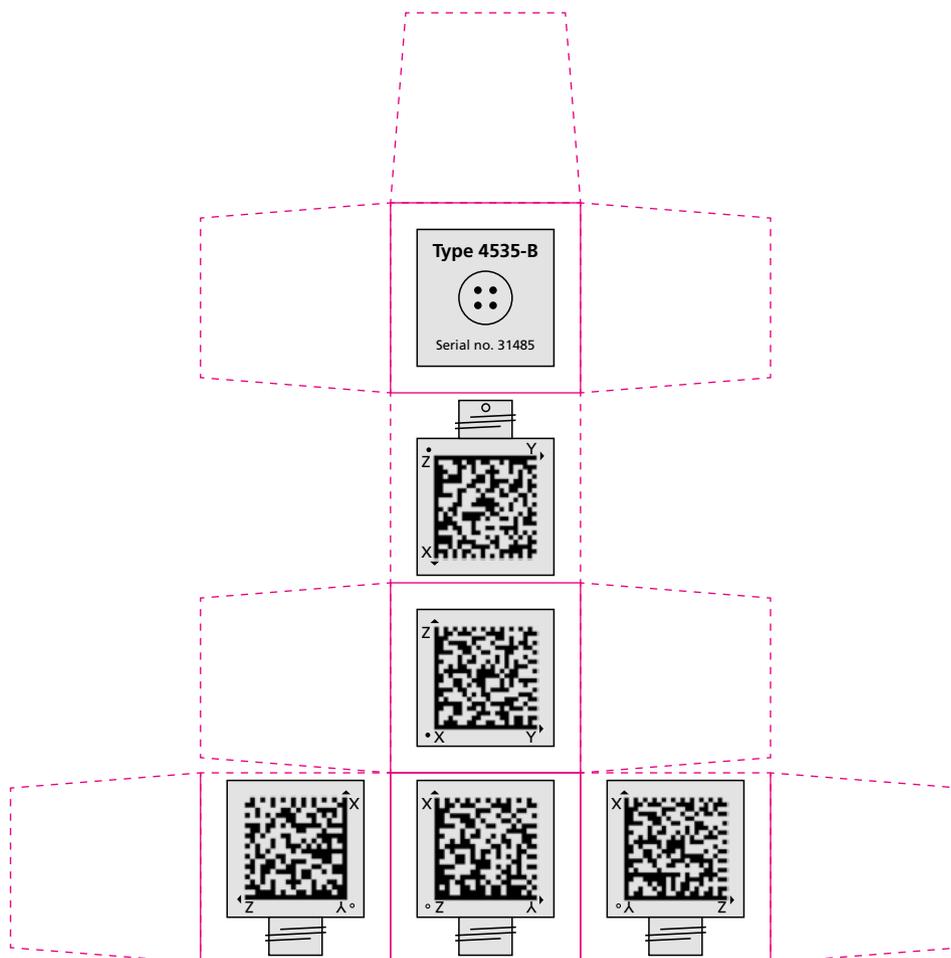
## GET ACCESS TO COMPLETE TRANSDUCER DATA

1. Assemble the accelerometer
2. Scan the data matrix codes with a matrix code scanner on your smartphone or tablet

## ENABLE ADDING LOCATION AND ORIENTATION, ETC.

(Requires an iPhone® or iPad®)

1. Assemble the accelerometer and position it on a test object
2. Download the 'Transducer Smart Setup app' from the App Store®
3. Scan the data matrix codes via the app and experience how easy a set-up can be

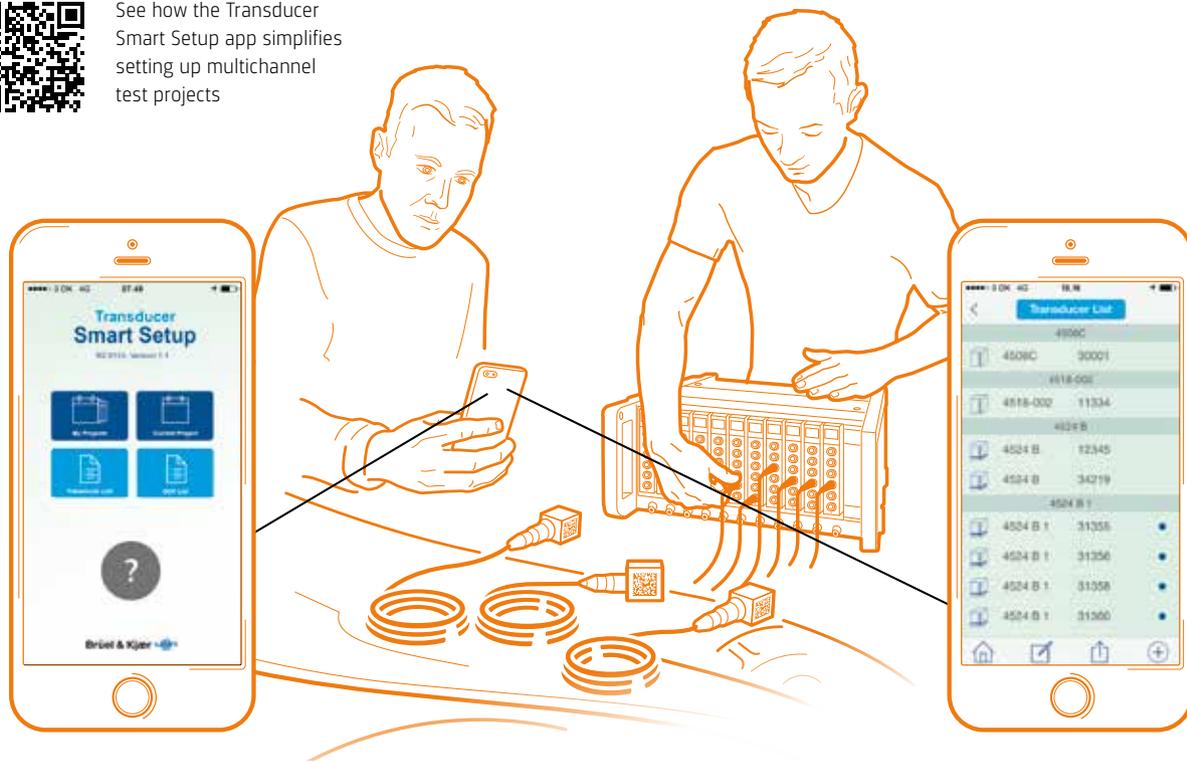


See page 27 for more information about how to work smarter with transducers.





See how the Transducer Smart Setup app simplifies setting up multichannel test projects



# WORK SMARTER WITH TRANSDUCERS

Smart technologies can make a positive difference to your daily work. With this in mind, Brüel & Kjær continues to improve the ease of use of its products – latest with the new Transducer Smart Setup app.

Many Brüel & Kjær transducers are now equipped as standard with a data matrix code, which is similar to a quick response or QR Code®, but superior in code recognition. When scanned using a barcode scanner on your smartphone or tablet, the data matrix code provides immediate access to detailed information about your transducers, such as technical specifications and calibration data.

The data matrix code is encoded with an accelerometer's orientation in a Cartesian coordinate system, and labelled symbols on the data matrix code indicate the orientation of the accelerometer using a patent-pending method. Each matrix code is unique since each one encodes a unique accelerometer orientation.

Used in combination with Brüel & Kjær's Transducer Smart Setup app, data matrix codes on transducers can simplify multichannel test set-up and help you to:

- Quickly catalogue transducer identity and DOF information, including transducer orientation
- Create and edit hardware set-up tables, then import them to PULSE Reflex™
- Eliminate the need to trace cables, by letting PULSE Reflex match transducers to input connectors
- Access help, calibration information and technical documentation from within the app

The Transducer Smart Setup app recognizes the accelerometer, its location and its orientation, including the component ID, node ID and the DOF direction. The app then automatically synchronizes this information with your measurement software. This means that you don't have to manually identify each transducer and how it is oriented and then trace each cable to the data acquisition hardware to add information about alignment and location. With a modal test involving 100 accelerometers, this can save you hours. ■

# SAVINGS IN THE

According to the EU, one of our most promising untapped sources of renewable energy is the energy we can save by mitigating leakage and waste. Arne Jensen is at the forefront of harnessing wasted energy with his acoustic technology that detects and stops leakage in district heating systems – before it even begins.

In February 2016, the EU launched its Heating and Cooling strategy. The strategy is the first-ever published plan to reduce the enormous amount of energy used to heat and cool buildings throughout Europe. Part of the strategy focuses on minimizing energy waste within industry. That's because enough heat is leaked into the air and water by industry to meet the EU's entire heating demand in residential and service sector buildings.

#### WHAT IS DISTRICT HEATING?

District heating plants are usually sites



# PIPELINE

where both heat and power are produced at the same time. The heat that is created when producing power is harnessed and used, for example, to heat water within that particular area. This heat would otherwise have been a mere by-product of the energy production. Any energy source can be used in a district heating system, and renewable sources such as biomass, solar energy and waste are becoming more popular, making it an even more environmentally friendly option. But even such district heating plants lose valuable heat.

“Approximately 10–30% of heat can be lost, depending on the network condition and temperatures,” explains Arne Jensen, environmental consultant. “20% of this loss can be related to corrosion, or to loss of water and wet insulation. This is what I focus on helping to save.”

## THE KEY TO TANGIBLE ENERGY SAVINGS

Arne Jensen owns a Swedish consultancy company that specializes in finding leaks within district heating systems. Jensen has been using Brüel & Kjær equipment for finding leaks since 1968. He developed his first leak detection equipment using a Brüel & Kjær Integrating Sound Level Meter Type 2225. By adding an accelerometer and headphones, he created an effective system to detect the noise caused by water leakage from pipes, which he patented in Sweden. By listening to the sound at various points within the pipe, he can estimate the size of the leak and its position.

Jensen’s company first uses thermal imaging cameras to find the general area, or hotspot, where the leak has occurred. They then rely on acoustics, vibrations and time measurements to



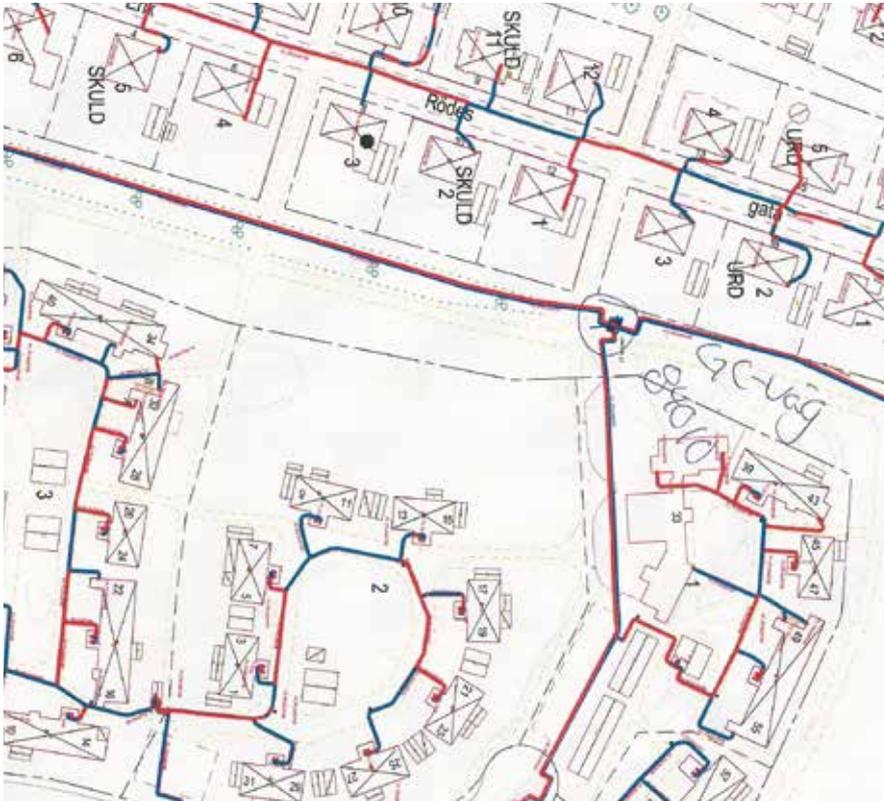
locate the exact location of the leak. Jensen explains, “There is pressurized water in the pipes. When there is a hole in the pipe, the pressure will drop causing vibrations and a hissing noise. This noise is then propagated through the water in the pipe in both directions.”

They attach Brüel & Kjær accelerometers to the pipe in different locations and listen with headphones to find two positions on the pipe: one where the noise peaks and one where it begins dropping again. They then use a PULSE data acquisition system to measure the distance between these two positions, or the propagation speed, which then determines the location of the leak – usually within a few metres.”

“A major advantage of PULSE is that it is a Windows®-based real-time analyzer,” explains Jensen. “That means I can make judgements on the probable position of a leak right on the spot. By seeing the data as it is collected, I can decide on the next positions to place the accelerometers and, in this way, I can quickly narrow down the area of the search.”

The solution saves energy and, of course, money. “A typical district heating system in Sweden would serve about 100,000 people and cost EUR 30 million. If 20% of this is lost, it amounts to a loss of 0.6 million EUR per year,” explains Jensen. “District heating might already be a sustainable energy source, but it makes sense to invest in leak detection.” ▶

## SAVINGS IN THE PIPELINE



Example of primary and secondary district heating system

### DETECTING LEAKS BEFORE THEY BEGIN

It is of little surprise that Jensen's service is popular and that his company is growing. Currently they are developing a permanent monitoring system that detects leaks before they start. "We've started monitoring the internal condition of pipes to assess how worn they are. Then they can be repaired before a leak even occurs," says Jensen. "Last year, one man actually died in Sweden as a result of a damaged pipe that burst. So preventative analysis, or condition assessment, is vital."

With Jensen's new monitoring system, there is no leak to create a vibration, so a signal is generated and sent out into the pipes and the response is measured

to determine the level of wear on the pipe walls.

"Again, we look for the two positions on the pipe where the noise peaks and begins to drop again, and we measure the propagation speed of the vibration waves. If we know the type of pipe material and its dimensions, then we know what the propagation speed should be if the pipe is healthy. The difference between these two figures tells us if the pipe needs to be changed."

This type of system monitoring makes it possible to get a complete overview of the maintenance needs of a district heating system, including prioritizing which pipes need to be changed and when, and budgeting for that accordingly. Prototypes of the system are currently being tested in Helsingborg and in Gothenburg, Sweden.

### SWEDEN – CHILLED AND SUSTAINABLE

The EU's Heating and Cooling strategy commended district heating, specifically using Gothenburg as an example, where 90% of apartment blocks are heated with waste heat from nearby industrial plants and waste incinerators. Until recently, Jensen's work has primarily focused on colder regions, such as Scandinavia, Russia, the Baltic States, Germany, France and the UK, where heating is crucial and sustainability is becoming increasingly valued. But Jensen is on the front lines of expanding acoustic leak detection across the globe, educating engineers and municipalities, even in warmer regions, about its benefits and application. As the focus on energy and waste prevention intensifies, this technology seems destined to find endless applications around the world. ■

A hole the width of a sewing needle leaks approx. 500 litres/day at a pressure of 2 bars ■



## A NEW WHITE PAPER FROM THE STACKS

# PREDICTING DETECTABILITY AND ANNOYANCE OF EV WARNING SOUNDS USING PARTIAL LOUDNESS

Electric vehicles (EVs) are so quiet at low speeds that they can be a danger to pedestrians, cyclists and other road users. So the challenge for car manufacturers is to create sounds that are detectable but not annoying.

To avoid them becoming a hazard, proposed legislation requires EVs to emit warning sounds at low speeds. For consistent evaluation, an objective algorithm is needed to predict how quickly subjects can detect the sounds and their perceived annoyance level.

Generally, there is agreement that detectability and annoyance are strongly related to loudness and that a loudness model can potentially objectively predict and assess them. However, EVs operate in urban environments, so to account for the masking effect of background noise, a partial loudness model should be used. The model used for this paper was Moore-Glasberg time-varying loudness, which computes loudness following an advanced model of the human ear based on the auditory filter bank concept.

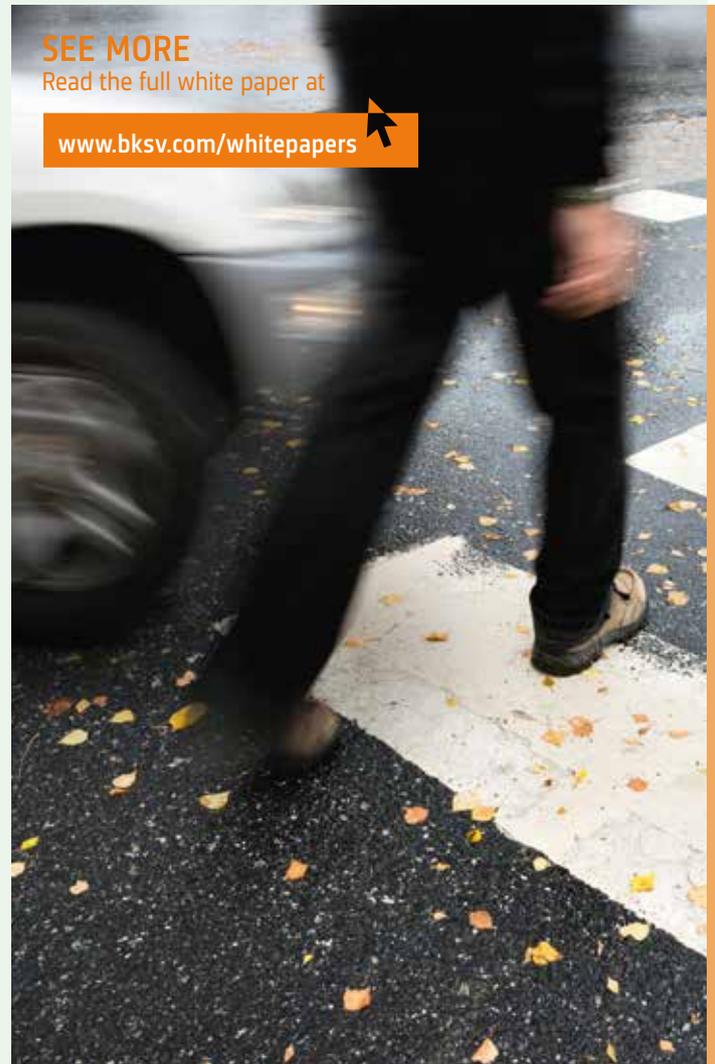
Twenty-three people took part in three tests to obtain subjective detection thresholds. For the first test, subjects listened to warning sounds without background noise to familiarize them with the stimuli. The subjective reaction time was measured by asking the subject to press a button as soon as they heard a short noise impulse. The subject was then presented with one of the four warning sounds in the presence of one of five background noises, totalling 20 combinations.

The second test used an adaptive force choice paradigm to reduce the effects of individual bias when detecting warning sounds in background noise. The subject was presented with three consecutive sound samples, all containing the same one-second segment of simulated urban noise, but one also containing a one-second segment of a warning sound.

The third test investigated the influence of background noise on perceived annoyance. The warning sounds were evaluated in five

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Read the full white paper at

[www.bksv.com/whitepapers](http://www.bksv.com/whitepapers)



noise conditions and the subjects told to imagine themselves in an urban environment, for example, sitting outside a café.

The results confirm that the detection thresholds are heavily influenced by subject's confidence when they provide their responses. The detection thresholds in terms of partial loudness are similar for stationary warning sounds. The perceived annoyance increases with partial loudness as expected, and the model explains the effect of background noise on annoyance perception rather well. ■



# COMAC'S



## ABOUT COMAC

- Established in 2008, The Commercial Aircraft Corporation of China (COMAC) is an airframe supplier focusing on aircraft design, final assembly and manufacture of aircraft, marketing and customer service, and the acquisition of certification
- COMAC has the certification success of the COMAC ARJ21 regional jet
- to build on, and is scaling up that knowledge for the C919
- In 2015, COMAC began establishing a flight test centre near the Dongying Shengli airport in Shandong province
- By working with international specialist suppliers, COMAC is gathering the experience to produce and test their own large jet

When China's first large jet lifts its wheels from the runway, two new LEAP engines will power it into the skies. But before the aircraft could be certified to fly, COMAC needed to map how the LEAP's acoustic energy will impact the structure – long before it actually flew.

# GREAT LEAP

“THE IMPACT OF THE ENGINE'S NOISE DURING CRUISE IS HARD TO PREDICT, AND THE METHODS ARE NOT WELL PROVEN. SO JUST A SIMPLE TASK LIKE MEETING SPECIFICATIONS IS DIFFICULT.”

CYRILLE BREARD,  
C919 NOISE & EMISSION  
MANAGER AT COMAC

Developing a commercial jet airliner is a project so complex that only a handful of companies have managed it. But in a land where a challenge and an opportunity are the same thing, just because they haven't doesn't mean they can't. COMAC's medium-range C919 jet will enter the lucrative 'narrow-body' market, which covers more than half of the aircraft in service, and where Boeing and Airbus have long enjoyed a 'duopoly'.

The resources required are huge: 10 billion dollars is the ballpark figure according to industry analysts. After teams of designers refine the concept of a new aircraft like the C919, there are in-depth aerodynamic studies in wind tunnels. New, weight-saving materials and construction techniques need testing and proving. Then there are integrations

of hundreds of thousands of physical parts and millions of lines of software code.

COMAC must then prove the aircraft's readiness beyond doubt, in a demanding test programme that sees ground vibration testing (GVT) followed by engineering flight tests and noise certification. And all this while keeping the whole programme to a schedule where months cost millions.

#### CRUISING FOR A BRUISING

Of the many physical forces that aircraft contend with, the effects of sound alone need significant testing. As interior noise is increasingly important to aircraft buyers, manufacturers compete on passenger comfort levels. But perhaps more importantly, manufacturers must prove their aircraft against the damage from acoustic energy. ►



COMAC's Liu Peng and Pang Mingbao attach surface microphones, that are designed to withstand the full operating envelope: Mach 0.8, 40 000 ft, and  $-55^{\circ}\text{C}$ , as well as de-icing sprays



The LEAP-1C is the variant of the LEAP designed specifically for the C919 by CFM International: a joint company comprising General Electric Aviation and Snecma

'Sonic fatigue' is caused by the energetic sound waves from an aircraft's engine beating against the structure's components and flexing the joints between materials. Over the plane's lifespan of 60,000+ flight cycles, the tiny, progressive cracks from this process degrade the plane's structure to such an extent that catastrophic damage can result. Since most hours in the air are spent at cruise, it is during this calm phase that both sonic fatigue and interior noise are critical.

#### A LEAP OF FAITH

COMAC has designed the C919 for this, basing the noise transmission and structural build on predictions of the engine's emissions at cruise. But not only is COMAC building an all-new aircraft, they also have an all-new engine: the LEAP-1C. This means they had to design the new aircraft based on predictions of the engine's acoustics – before any engines were available.

However, predictive modelling is no easy challenge. As Cyrille Breard, C919 Noise & Emission Manager at COMAC says: "The impact of the engine's noise during cruise is very hard to predict, and the methods are not well proven. Despite being the longest period of the aircraft mission, cruise evaluation methods are not well documented or validated. They are not commonly published or even understood. So just a simple task like meeting specifications is difficult." Added to this, COMAC

“FOR SONIC FATIGUE, THE COUPON TESTS COULD LAST A YEAR. THE EARLIER WE COULD PREDICT SONIC LOADING DURING FLIGHT, THE EARLIER WE COULD DEFINE THE TEST CYCLE.”

CYRILLE BREARD, C919 NOISE & EMISSION MANAGER AT COMAC

is building and refining their predictive models without the decades of historical data that its competitors enjoy.

### ONE RIDE ON THE FLYING TEST BED

Naturally, COMAC was keen to check the engine’s emissions in the real world, so as soon as an opportunity arose, they grabbed it. The engine’s makers had scheduled a battery of flight tests on the LEAP-1C. For this, General Electric Aviation mounted the engine on their Flying Test Bed: a special Boeing 747 for testing new technologies. COMAC’s budding flight-test department mounted surface microphones on the fuselage, to characterize the engine’s acoustic emissions onto the structure.

The surface microphones on the outside of the aircraft fed data through a false window and into a LAN-XI data acquisition system. This recorded data using battery power, and avoided interfering with any of the plane’s systems. The IRIG-B time code it attached to the acoustic data allowed it to be precisely synchronized to the aircraft’s recorded data, for easy correlation to flight operations, such as engine speed.

In a packed test programme, COMAC had just this one flight to work with. “We needed to get it done the first time we used it,” says Cyrille. They also had new instruments to operate, and inexperienced testers. “This was one of the first tests for our flight test engineers,” says Cyrille, “We’d had Brüel & Kjær training in Shanghai, but we also wanted to have a Brüel & Kjær specialist on site. We got two! During the pre-flight check, the specialists were meticulous in explaining the calibration and installation of surface microphones. They also solved a connector

issue; it seems that anything can be connected to LAN-XI. So we felt comfortable and ready.”

### REMOVING THE 747

The test successfully assessed the preliminary noise level of the LEAP-1C during cruise. However, to bring the flight-test data back to China and apply it to the C919, Cyrille’s team needed to isolate acoustic phenomena in the data. “The fuselage is exposed to two types of noise: engine noise and turbulent boundary layer noise,” says Cyrille. Since the test was performed on a

Boeing 747, they needed to eliminate that aircraft’s turbulent boundary layer noise. “Separating the two types of noise is crucial for specification compliance and for evaluating transmission into the cabin,” continues Cyrille. “Such tasks rely heavily on predictive tools, which flight tests like these enable us to validate, increasing the confidence level in the contribution of each component.”

As well as validating their estimations of the C919’s sonic loading, COMAC could determine the remaining risk level and define mitigation plans. ►

## CHINA’S JET MARKET

- China is currently the world’s second largest market for air travel and increasing rapidly – by over 400% since 2000
- The industry expects that in 20 years’ time, the Chinese internal air travel market will overtake the US domestic market
- Various predictions expect that around 30,000 new commercial aircraft will be needed over the following 20 years – roughly double the current fleet of around 17,500
- Most of these will be short/medium-range jets like the C919
- About 4,700 of the expected new aircraft, valued at about \$500 billion, are likely to be delivered to Chinese carriers, which are expected to fly 15% of the world’s total compared with 9% today (Wall Street Journal) ■



Under Brüel & Kjær’s guidance, COMAC became comfortable with their instrumentation during high-stakes testing. From left: Cyrille Breard (COMAC), Sun Yifeng (COMAC), Helene Orsi (CFM/Snecma), Tony Spica (Brüel & Kjær), Huang Chunxin (COMAC)

COMAC'S  
GREAT LEAP

During the flight test, COMAC's Mei Yadong monitors acoustic data from the surface microphones – via LAN-XI data acquisition hardware



They could also begin testing the aircraft's materials for sonic fatigue resistance and noise transmission. "For sonic fatigue testing, the coupon (material sample) tests could last a year. The earlier we could predict sonic loading during flight, the earlier we could define the test cycle,"

says Cyrille. "Having representative flight test data as early as possible is crucial during a development programme."

**CERTIFIED EXPERIENCE**

Crucial to the aircraft's flight certification, the test marked the beginning of

"MOST OF OUR FLIGHT TEST ENGINEERS HAVE JUST GRADUATED, AND PRACTICAL EXPERIENCE WAS CRITICAL FOR THE SUCCESS OF THIS TEST CAMPAIGN."

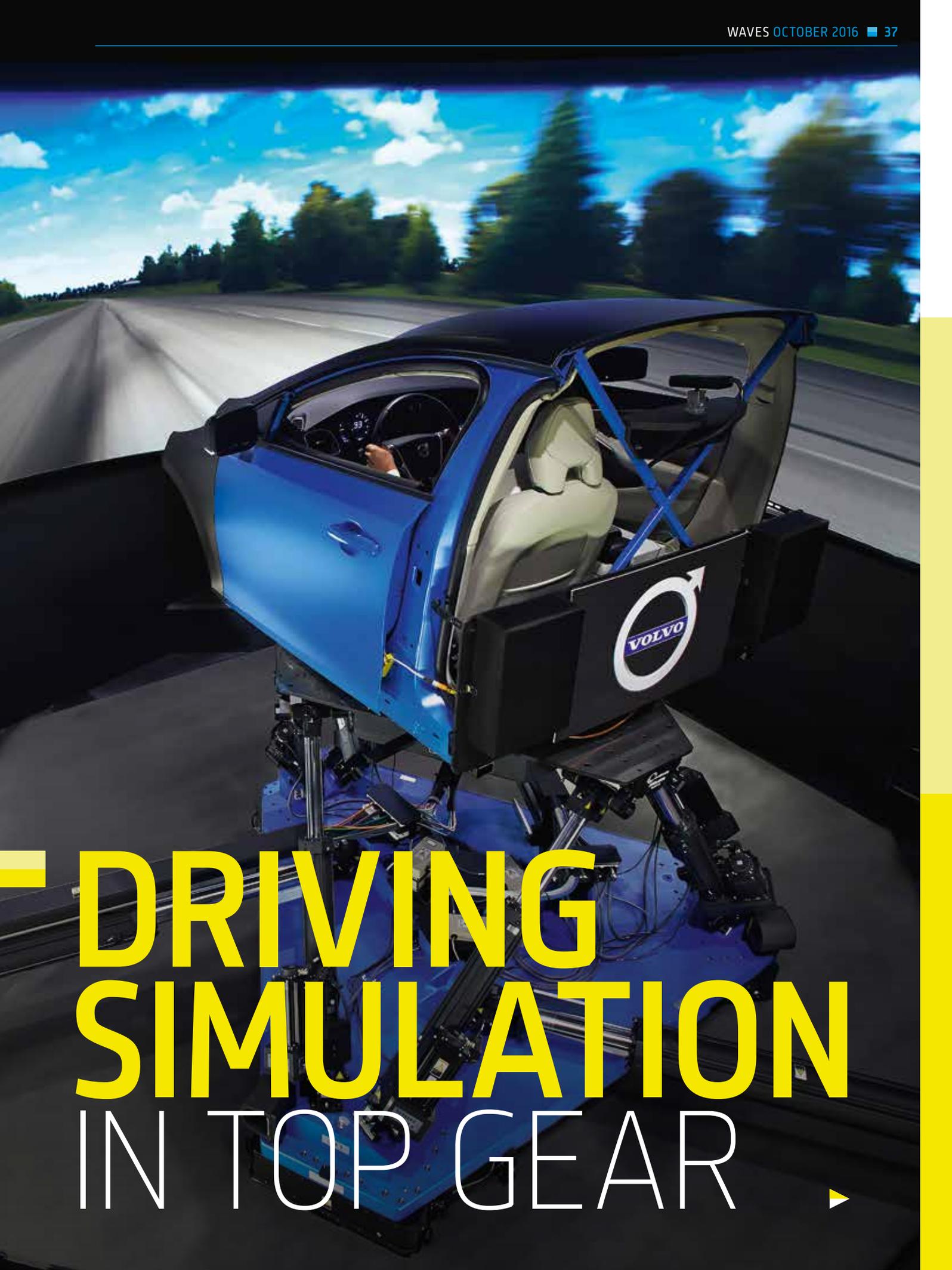
CYRILLE BREARD,  
C919 NOISE & EMISSION MANAGER AT COMAC

## THE NEWCOMER'S CERTIFICATION CHALLENGE

Newcomers to the aircraft market face a tougher route to certification than established competitors. All manufacturers must prove their aircraft can safely withstand the effects of sonic fatigue over their complete life cycle according to FAA's safety standards in 14 CFR Part 25.271. Established plane makers can prove this by demonstrating that a similar aircraft has enjoyed a fatigue-free life cycle. But COMAC must demonstrate – with full-scale fatigue test evidence – that widespread fatigue damage will not occur within the design's service goal of: 60,000 flight cycles. ■

COMAC's efforts to gather evidence for the regulator CAAC, to prove the structure's ability to resist the forces of sonic fatigue over the aircraft's expected lifetime. "We needed a good mapping of the sonic loading," says Cyrille.

With a successful flight test under their belts, COMAC's new flight-test department is now more experienced. "Most of our flight test engineers have just graduated, and practical experience was critical for the success of this test campaign," says Cyrille. "Brüel & Kjær was present during all phases, from hands-on training, to calibration and installation in the USA, to pre-flight checks, to the post-flight briefing and feedback session. We got tremendous support." ■



# DRIVING SIMULATION IN TOP GEAR



Today's automotive engineers want the most realistic simulated driving scenarios, capturing essential vehicle characteristics, including sound. A driving simulator facilitates active safety tests and lets drivers evaluate different set-ups and feel the dynamics of a virtual car.

With a background in virtual prototyping, VI-grade helps customers get the most out of system-level simulation. Bridging the gap between testing and simulation, the company recently patented the innovative Driver-in-Motion (DiM™) platform. It's a revolutionary design, with a cockpit built on nine hydraulic actuators to simulate the experience of driving a real vehicle. The nine actuators provide a large simulation workspace and make it possible to study both low-frequency vehicle dynamics and high-frequency ride, on the same motion platform.

Founded in 2005, VI-grade has its headquarters in Germany but all the product development happens in Italy. This is where contact with Brüel & Kjær was first established in 2013, with a shared customer – Ferrari.

Ferrari installed a Brüel & Kjær NVH Simulator to achieve engine sound targets rapidly and cost-effectively. At this time, VI-grade was also implementing a driving simulator in Ferrari's test lab, to simulate the experience of driving a new vehicle. Using a cylindrical widescreen to visually simulate the racetrack and the motion platform together with the NVH Simulator to provide fully accurate sound, Ferrari test drivers could experience and evaluate a car's handling and sound together – in a highly authentic context.

Guido Bairati, Managing Director at VI-grade, Italy, explains: "We realized that VI-grade had technology that we could share with Brüel & Kjær and vice versa. We could see that our experience, equipment and knowledge could complement each other. The idea was to improve sound quality on the DiM™ and we started talking together to make this happen."

The result is that now the NVH Simulator technology is an integrated part of the DiM™ platform, offering customers a

simulator that includes lower frequency vehicle dynamics, with advanced sound, as well as high-fidelity cockpits in which the driver can be exposed to high frequencies.

"The sound has now been enhanced in the virtual vehicle, offering the highest fidelity," explains Guido Bairati. "Sound plays such an important role in the driving simulator because it increases the realism and provides an overall improved and more realistic driving experience. The goal is to replicate the exact sound of the driving experience, as close to reality as possible."

#### TESTING DIFFERENT SET-UPS

In the advanced cockpit, VI-grade has also included vibration technology in the form of shakers and actuators from Brüel & Kjær to give a more accurate driving experience. The NVH Simulator enables vehicle design and development teams to use customer preference and satisfaction input, set accurate NVH targets, design with specific differentiations to competitors, and work efficiently with all NVH data throughout the development process.

A real-time, accurate dynamic vehicle model has been developed by VI-grade, in which key parameters, such as springs, dampers and tyres, can easily be changed, allowing test drivers to try new configurations on the same part of the track. Substantial time and money can be saved by not having to test physical prototypes. The DiM™ platform enables manufacturers to test vehicles on simulated test tracks with laboratory-like consistency, using both customer-specific tracks as well as a library of predefined tracks.

In this way, the integrated DiM™ platform helps to sort out problems early in the design cycle, allowing the testing of several different set-ups in one day and letting drivers hear how different configurations affect how the car sounds.

#### SIMULATING A COLLISION

In real life, it can be difficult to replicate and test situations where a car interacts with other vehicles, for example, parking, lane changing, emergency braking or reacting to sudden manoeuvres. In the safe virtual environment, however, these situations can be tested in a controlled way, many times a day.

It's important that the driving experience is as realistic as possible, especially for tests that are too dangerous to perform live, for instance, simulating a collision or a puncture at high speed to see how the driver will respond. In these situations, a



“THE SOUND HAS NOW BEEN ENHANCED IN THE VIRTUAL VEHICLE, OFFERING THE HIGHEST FIDELITY.”

GUIDO BAIRATI,  
MANAGING DIRECTOR, VI-GRADE

realistic simulation can be invaluable to facilitate the development of systems to help the driver stop the car safely.

#### DIFFERENTIATOR IN THE MARKET

“Having the Brüel & Kjær solution as an integrated part of our DiM™ platform is unique in the market and positively differentiates us,” explains Guido Bairati. “We’re the only driving simulator offering such high frequencies and such a wide range of frequency solutions. The fact that the DiM™ is equipped with unique sound and vibration technology makes this a fully integrated solution for customers in their design process. In today’s competitive business environment, it’s very important to work with reliable partners that allow us to offer a complete product offering and range of expertise.”

In April 2016, Brüel & Kjær set in place a partnership agreement with VI-grade that allows VI-grade to promote and sell the SimSound™ software and supporting services as an integral part of the DiM™ solution. “Our automotive and motorsports customers have all responded very positively to our partnership with Brüel & Kjær,” says Guido Bairati. “They have confirmed to us that this integrated solution refines and expands the system, significantly expanding the value for them by providing a superior driving experience whilst increasing the range of possible applications. This approach already proved to be successful, since recently, two major automotive companies purchased DiM simulators in conjunction with SimSound technology. Both simulators will be ready for operation in the first half of 2017.” ■



# PARTNERING TO REACH NEW TESTING HEIGHTS

To accelerate development of its high-accuracy inertial systems and put in place state-of-the-art on-site testing practices, iXblue traded its external test lab for its own on-site test facility.



“WE CONTINUE TO IMPROVE OURSELVES EVERY DAY THANKS TO EFFICIENT BRÜEL & KJÆR SUPPORT SERVICES THAT CONTINUE TO BE AVAILABLE TO US DURING OUR TESTING SKILL IMPROVEMENT PROCESS.”

XAVIER COTTIN, HEAD OF TESTS & QUALIFICATION, IXBLUE

Inertial navigation systems are navigation aids that use computers, accelerometers and gyroscopes (rotation sensors) to continuously calculate the position, orientation and velocity of a moving object. They are used on ships, aircraft, submarines, guided missiles and spacecraft. French industrial group, iXblue specializes in the design and development of inertial systems. The company is one of few companies in the world that produces all of the critical electrical and mechanical components required to build an inertial system, including the accelerometers and fiber-optic gyroscopes.

iXblue's customers include both civilian and military organizations within marine science, aeronautics and aerospace. As these customers produce equipment used in extreme environments, such as on-land vehicles, ships, submarines, space rockets and aircraft, vibrations and shock are a major part of the landscape. As a supplier of high-accuracy systems, iXblue must develop and test products that can handle these environmental challenges in order to guarantee a high level of product reliability to its customers.

#### IXBLUE'S BUILD-YOUR-OWN TEST LAB

Until recently, iXblue was using external lab services near Paris to perform vibration and shock tests on their products. In order to decrease test duration and development costs, as well as perform effective tests with homemade performance evaluation strategies, they needed to put in place their own on-site shaker and acquisition system. As iXblue already had a strong partnership with Brüel & Kjær, they were the obvious company to call for help.

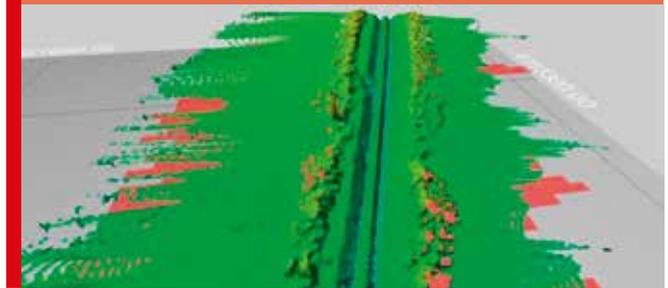
Xavier Cottin, Head of Tests & Qualification at iXblue explains the process: “We started by drawing up our requirements, such as vibration and shock levels, performance frequency, mass and dimensions of the specimen to be tested, etc. On this basis, Brüel & Kjær proposed several technical solutions. A cross analysis was then carried out between the available budget, the dimensions and mass of the shaker, its potential in terms of displacement, force, velocity, acceleration and frequencies and compliance with other iXblue-specific performance requirements. Brüel & Kjær provided strong support for that and managed to propose the best solution aligned to our budget.”

#### A COMPLETE SOLUTION

iXblue's complete shaker solution is a fully integrated system. “The schedule for this project was very short with a non-flexible deadline,” Cottin continues. “At the same time, construction of iXblue's new building with test facilities was going on – this

## ABOUT iXblue

- Global leader in the design and manufacturing of innovative solutions for navigation, positioning and imaging markets
- Recognized throughout the industry for its pioneering work on the development of fiber-optic gyroscope (FOG) technology, which has revolutionized the maritime and naval inertial fields in the last decade
- Achieves 15–20% growth every year, with 80% of its business taking place in more than 30 countries around the world
- Counts on full value-chain expertise: all of its systems are produced internally, from design to manufacturing ■



was also a great challenge. The fact that Brüel & Kjær proposed a fully integrated solution was a key driver for us, because we were not specialized in the deployment of such test facilities, and we wanted to decrease as much as possible the number of supplier interfaces to limit risk and guarantee delivery on time.” iXblue chose the LDS V875 shaker along with a high-pressure table HBT 750 – a flat table connected to the shaker where objects are shaken side to side. The shaker also has a square head expander that makes it possible to carry oversized or oddly shaped payloads. It also features an integrated air-glide system that uses compressed air to easily lift and rotate the 5-ton shaker (to test different geographic orientations).

“IMO Certification requires orientating a gyrocompass at specific orientations during vibration tests,” Cottin explains. “The gyrocompass needs to be aligned to these orientations for the three tested axes. That means we need to rotate the shaker – and not the equipment being tested – as is typically done. The integrated air-glide system is very useful to orientate the shaker quickly and easily without using any additional lifting means.” ▶

**PARTNERING  
TO REACH NEW  
TESTING HEIGHTS**



“THE FACT THAT BRÜEL & KJÆR COULD PROPOSE A FULLY INTEGRATED SOLUTION WAS ALSO A KEY DRIVER FOR US. AS WE WERE NOT SPECIALIZED IN THE DEPLOYMENT OF SUCH A TEST FACILITY, WE WANTED TO LIMIT RISK AND GUARANTEE DELIVERY ON TIME.”

**XAVIER COTTIN**  
HEAD OF TESTS & QUALIFICATION, IXBLUE

**REPRODUCING REAL LIFE**

iXblue’s complete test system also includes a 12-channel data acquisition system composed of two LAN-XI modules including a time data recorder and signal analysis software.

The signal analysis software is for real-time FFT analysis, filtering functions, SRS calculation, and operational deflection shapes to compare the test to predictive behaviour from CAE models and order analysis. The system, which is modular, can also be used in the operational field to measure and characterize specific vibration and shock environments in order to reproduce them with the iXblue shaker, if needed.

“We are able to bring the data acquisition system onto a land vehicle, a ship or even an aircraft to record and analyse the environmental vibration and shock levels and then simulate these scenarios in our test lab,” says Cottin. “We can then evaluate the equipment’s design or perform specific functional investigations.”

iXblue customers seem to appreciate that they have their own on-site test facility. It shows that iXblue continues to deploy strong efforts to develop highly accurate and reliable navigation systems that can be exposed to severe environmental constraints.

**SUCCESS STORY ENABLED BY BRÜEL & KJÆR**

iXblue had worked before with external test labs using LDS shakers, but had not had the chance to work with Brüel & Kjær engineers before the beginning of the project. “We had never experienced any deployment of such a test facility before this project,” says Cottin. “Nevertheless, thanks to Brüel & Kjær engineering services, we were able to build a fully operational test facility on time. We were also able to train end users to manage the lab and to promote the vibration and shock testing skills for the benefit of iXblue engineers and products.”

Cottin continues, “Vibration testing requires many skills. We continue to improve ourselves every day thanks to efficient Brüel & Kjær support services that continue to be available to us during our testing skill improvement process. That success story was made possible mainly thanks to the close cooperation between Brüel & Kjær’s and iXblue’s teams, their construction architects and workers, as well as CFM Schiller in charge of the seismic mass.” ■

# CELEBRATION CAUSES EARTHQUAKE



After a poor performance the year before, Leicester City Football Club had an amazing 2015/16 season, where they dramatically turned their fortunes around to win the English Premier League.

As the club's performances increasingly thrilled their long-suffering fans, a team of geoscience students from Leicester University decided to measure the vibration signals in the ground near the stadium.

The phenomena they recorded soon got a name: 'Vardyquake', named after top scorer Jamie Vardy.

One of Vardy's last-minute goals caused the crowd to jump up and cheer so energetically, that they scored 0.4 on the Richter scale. ■

# GOOD VIBRATIONS...

What happens when a budding rock star trades in his electric guitar for medical books? In Peter Michael Nielsen's case, the result is an invention that relieves pain in a unique way.

Like many young Danes, Peter Michael Nielsen dreamed of rocking Roskilde musical festival...and he did just that in '78. But he soon realized that he needed something more and strived instead to become a doctor. During this time Nielsen was still fascinated by the way that the human body perceives music, in particular the bass.

## IS MUSIC THE ANSWER TO PAIN?

Nielsen first became a neurosurgeon. After some years of opening craniums, he was haunted by a memory from a different time... when he was just 15 years old, attending organ vespers at Westminster Abbey. The performance ended on one note – a deep C – that cannot be heard by the human ear. However, everyone in attendance could sense this note through the vibrations that the intense bass created. From that moment, Nielsen understood that an important part of the sound we perceive is not audible. Subsonic frequencies are not perceived by our ears but by a system in our inner organs that detects vibration.

"Imagine an earthquake, or a herd of buffalo on the Savannah. Humans survived these events by sensing the vibrations that



“OUR TRIALS HAVE DEMONSTRATED THAT PATIENTS NOT ONLY EXPERIENCE PAIN RELIEF DURING THE SESSION, BUT ALSO REMAIN PAIN FREE FOR 1 TO 2 DAYS.”

DR PETER MICHAEL NIELSEN

warned of the approaching danger,” explains Peter Michael Nielsen. “Small corpuscles consisting of one nerve fibre sense these deep vibrations and send a storm of signals to the brain. Think of it as an age-old alarm system that helped early man to survive by perceiving danger before it was audible or visible.”

During the '90s, MRI scans discovered that the signal pathway in the brain for both pain and vibrations was the same. Nielsen began to consider pain relief in a completely new way – could multiple low-frequency vibrations delivered to a patient potentially block pain perception, thus leaving the patient free of pain? The fact that the same procedure could potentially block depression made his research even more compelling.

#### LOUNGING TOWARDS A PAIN-FREE EXISTENCE

Based on his unique understanding of music and the vibrations caused by deep bass, Nielsen invented a chair that can relieve pain. By simply sitting in the chair and using an app connected to a control station, the patient relaxes and enjoys prescribed doses of music. The music consists of two complimentary tracks played simultaneously, both composed specifically for this purpose by Nielsen himself. One of the tracks plays the type of music to which we are most accustomed, music that we can hear. In this case, the role of this track is to transport the patient to the relaxed mental state needed to perceive the second track, the bass. The second track is based on high-amplitude, low-frequency sound impulses. It is the bass in this track that has the ability to block the pain perception in the body, Nielsen found out. ►



Dr Peter Michael Nielsen demonstrates how the patient relaxes in the chair while enjoying the prescribed dose of sound and vibration

## GOOD VIBRATIONS...



The specially-prepared – and enjoyable – musical track (2:00)



Though not so enjoyable on its own, it is this mathematically-produced sinus track that forms the basis of the treatment together with the vibrations (0:30)



The data was recorded at Brüel & Kjær using an accelerometer and PULSE Time Data Recorder software

## ASSESSING WHOLE BODY VIBRATION

The test compared a specially-prepared musical track to a mathematically-produced track and assessed how comfortable the experience was. The vibrations were measured as follows:

Less than 0.315 m/s <sup>2</sup>	Not uncomfortable
0.315 – 0.63 m/s <sup>2</sup>	A little uncomfortable
0.5 – 1 m/s <sup>2</sup>	Fairly uncomfortable
0.8 – 1.6m/s <sup>2</sup>	Uncomfortable
1.25 – 2.5 m/s <sup>2</sup>	Very uncomfortable
Greater than 2 m/s <sup>2</sup>	Extremely uncomfortable

Reference: ISO 2631-1, Annex C

### TREATMENT FOR ANYONE, ANYWHERE

“The patient feels the vibrations from the chair through a transducer,” says Nielsen. “It’s just like the transducers used in a home theatre system, so it is based on the same technology which reproduces the sensation of an earthquake at the cinema. And it does this without any acoustics, so the vibrations are not transmitted to the rest of the room. This makes the chair perfect for home use.”

For Nielsen, it was also vital that the audible music tracks can be enjoyed by patients from every culture and every ethnic background. As an avid music lover, he prides himself on understanding culturally diverse music styles and aims to design and produce a catalogue of tracks that please a wide audience.

“Our trials have demonstrated that patients not only experience pain relief during the session, but also remain pain free for one to two days,” says Nielsen. “The patients actually enjoy the treatment and want more – and it’s most effective if they enjoy the music that they hear. As the low-frequency vibrations block pain perceivers, it makes it a very flexible treatment that is effective for all types of pain and all types of patients.”

### PROVEN THERAPY, PROVEN SAFETY

Nielsen knew that his expert opinion was not enough, that it needed to be backed up by irrefutable, scientific proof.

“My chair is not an alternative therapy device targeting the wellness market. It is a healthcare system based on sound research in psychiatry and neurology,” says Nielsen. “This is one of the reasons why I contacted Brüel & Kjær, because I wanted to find out just how much vibration is transferred to each patient and to be sure that the experience is both safe and comfortable. Now I have the scientific proof needed to demonstrate how effective my chair is – and I have even more confidence in my invention.”

For the testing at Brüel & Kjær, Nielsen used one of his specially-prepared musical tracks and compared it to a mathematically-produced track. The data was recorded using an accelerometer and PULSE Time Data Recorder software. Within the test environment, the mathematical track was perceived as being uncomfortable, whereas the musical one was perceived as being far from unpleasant.

“MY CHAIR IS NOT AN ALTERNATIVE THERAPY DEVICE TARGETING THE WELLNESS MARKET. IT IS A HEALTHCARE SYSTEM BASED ON THOROUGH RESEARCH IN PSYCHIATRY AND NEUROLOGY.”

DR PETER MICHAEL NIELSEN

“We know that vibrations can be unpleasant – think about people working with machinery who overdose on vibrations and can have problems with the blood vessels in their fingers,” explains Nielsen. “But this test was not just a safety measure for me. Being able to measure the vibration effect with a sensor built into the chair means that the dosage can also be measured, so the patient can increase or decrease their treatment. For me this was the most important aspect of the test.”

#### A MARKET THAT IS READY AND WAITING

Around the world, 1.5 billion people suffer from chronic pain, and in 2012, there was only capacity to offer 2,500 patients in Denmark professional pain treatment. Peter Michael Nielsen has treated thousands of patients during his career and has

witnessed many patients experience negative side effects from pain relief medication.

“I’ve been working on this concept for 25 years, and right now, people are probably most open to this type of treatment,” says Nielsen. “10 years ago people wanted to use the best medicine available. Now it’s changing, and people are more aware of the dangers of addiction and other potential side effects of pain medication. They want a solution that is not a drug, that is non-radiative, and without side effects.”

And what could be better than relaxing in a comfortable chair, chilling out to a truly appealing track, and walking away free of pain? ■



# SHAKING IT UP



## INTRODUCING A NEW CLASS: THE AIR-COOLED 80 kN SHAKER

Brüel & Kjær has been shaking things up with the introduction of the new 80 kN air-cooled shaker for a range of applications. The new high-capability air-cooled shaker is truly in a class of its own: it is quick to install, easy to maintain, and has a reduced overhead compared to high-force water-cooled systems.

Of particular interest is the robust, hydrostatic bearing design and the 3 kNm overturning moment, which ensure users can exploit the full performance of the shaker, even with unbalanced payloads. The high overturning moment gives the system stability when testing irregular and unbalanced payloads without the need for guided head expanders or intricate mounting assemblies. This speeds up test set-up times and minimizes wear and tear of the system, allowing users to complete their tests whilst benefiting from the shaker's full performance spectrum.

Overall, the air-cooled shaker delivers enhanced testing capability. This is down to its outstanding performance:

- 80 kN sine force for cost-effective testing of complex and heavy payloads
- 3 kNm overturning moment – reducing the need for guided head expanders
- 3 kHz frequency for testing smaller payloads
- 101.6 mm (4 inch) stroke – enhancing shock performance through a combination of higher displacement and velocity ■

### SEE MORE

including the shaker in action

[www.bksv.com/V8900](http://www.bksv.com/V8900)



## New and improved – latest Brüel & Kjær products and solutions

### PRECONFIGURED SOFTWARE PACKAGES

Our preconfigured, general purpose signal analyzer packages contain all the tools needed for sound and vibration testing and analysis – from in-field recording or laboratory analysis, to reporting results and archiving data.

### PULSE COMES OF AGE

Focusing on enhanced performance, PULSE 21 – the latest version of our data acquisition platform – provides PULSE Reflex with more speed and flexibility. Additional highlights include stepped sine measurements for structural testing and more PULSE Reflex Telephone Test suites.

### NEW GROUND VIBRATION MONITORING TERMINAL

Brüel & Kjær's new, simple-to-use Vibration Monitoring Terminal provides uninterrupted, real-time vibration level measurement to help avoid harming nearby buildings during industrial operations.

### NEW NOISE MONITORING APP FOR MOBILE DEVICES

Our Noise Sentinel Stakeholder app provides the public with access to environmental data, using mobile devices. The Web-based system provides continuous, unattended noise, vibration, dust and air quality monitoring on urban and industrial sites.

### NEW FREE-FIELD MICROPHONE FOR HIGH-PRECISION, ACOUSTIC MEASUREMENTS

With its new press-fitted backplate technology, this ½-inch Prepolarized Free-field Microphone Type 4966 has improved mechanical accuracy and robustness – and is available at a very reasonable price. ■

**SEE MORE**  
about the latest PULSE updates

[www.bksv.com/PULSE21](http://www.bksv.com/PULSE21)

## Brüel & Kjær acquires SVT Ltd. and Discom GmbH



Earlier this year, Brüel & Kjær acquired two automotive-related businesses, boosting its service and solution proficiencies for customers.

The first purchase in July was of Brüel & Kjær's long-term partner, Sound & Vibration Technology Ltd. Located at the Millbrook Proving Ground in Bedford, UK, Sound & Vibration Technology Ltd. has a dedicated team of sound and vibration engineers with a proven track record of delivering high-value engineering services for automotive and aerospace customers.

Later the same month, Brüel & Kjær acquired Discom GmbH; a producer of automotive transmission sound and vibration test systems for acoustic quality analysis at the end of production lines. This collaboration has helped Brüel & Kjær to evolve into a solution provider, as Discom – with its fully integrated, Web-enabled production test solution – brings on board new insights, domain knowledge and new opportunities within production. ■



Product manager Jason Kunjo introduces our new preconfigured software packages (3:03)



## CUSTOMER NEWS

# RBA ACOUSTICS WINS VIBRATION CATEGORY AT ANC'S ANNUAL AWARDS



Specialist consultancy, RBA Acoustics won the Vibration category, sponsored by Brüel & Kjær, at the Association of Noise Consultants (ANC) 2016 awards.

The company's winning project involved the conversion of office buildings within the exclusive area of Mayfair, inside Central London, into a series of high-value apartments. Located just above the

London Underground's Jubilee Line, the site was originally affected by high levels of groundborne noise and vibration from underground train movements.

RBA Acoustics' solution used a comprehensive range of techniques including the removal of the existing basement floor and cutting 'pockets' into original walls to mount the new floor joists.

Despite the Listed Building restrictions, RBA managed to reduce the  $LAF_{max}$  levels by over 15 dB and achieve full compliance with the client's stringent requirements.

As part of the prize, RBA Acoustics' staff received a brand new 2250 Light sound level meter. ■

## Thales shakes up production test capabilities

The Thales Group has expanded its industrial vibration test abilities with a new LDS V8 shaker. Based at Thales Cryogenics in Eindhoven, the Netherlands, the V8 shaker enables the company to carry-out vigorous vibration tests on its cryogenics coolers and lithium reserve batteries, to ensure the products can withstand harsh application use within sectors such as military, industrial, airborne and space.

With increasing customer demand for equipment, Thales approached Brüel & Kjær's exclusive Benelux distributor, ENMO Sound & Vibration Technology, to discuss upgrading its existing shaker system. Following the consultation, ENMO recommended the LDS V8 vibration test system, which combines high payload capacity with high-level performance across the frequency range, making it ideal for Thales' many different application test requirements.

Thales is a European high-technology group renowned worldwide for its expertise in electronics-based systems, acting in areas such as defence, aerospace, airlines security and safety, information technology, and transportation. The Group is a leading prime contractor and systems integrator with industrial operations and clients throughout the world. ■



## Brüel & Kjær provides Heathrow airport with 50 noise monitoring terminals



Brüel & Kjær has agreed on a contract with Heathrow Airport to deliver, install and service 50 new noise monitoring terminals. The units will increase Heathrow's noise monitoring capacity and expand its leading-edge noise abatement program.

A mix of permanent and portable terminals will provide unattended sound level monitoring to accurately and reliably measure, record, process, store and transmit noise data to Heathrow's

airport noise and operations management system, ANOMS.

Matt Gorman, Heathrow Director of Sustainability and Environment said: "These monitors will allow Heathrow and our local residents to better understand the impact of aircraft noise in local areas. New monitors, along with other noise reduction steps, like fitting quiet technology to A320s and establishing a voluntary Quiet Night charter, will help us be a better neighbour to our communities." ■

# FIVE QUESTIONS FOR YUMIKO SAKAMOTO

35-year-old [Yumiko Sakamoto](#) from Tokyo, Japan, who once studied pipe organs, juggles two roles for Brüel & Kjær. She is both an Automotive Application Engineer and a Marketing Manager. Knitting is a great passion that sometimes continues well into the night. Her favourite book is the all-time Canadian classic, *Anne of Green Gables*.

MOTTO:

**“LET BYGONES  
BE BYGONES”**

[Name one challenges in your line of work?](#)

How to maximize the outcome by working as a team and not as individuals.

[Who or what inspires you and why?](#)

Customers! I love working with them especially when they give me new ideas and inspiration.

[Name one barrier for females in a male dominant workplace?](#)

I've not experienced any significant barrier yet – I'm probably a bit insensitive. On the more practical front though, there is often no ladies' bathroom close to the test bench.

[What irritates you most about your own personality?](#)

Shyness.

[If you could have two super powers, what would they be and why?](#)

Being able to speak fluently to anyone in the world in their own language, because gaining knowledge about things outside Japan is exciting. The other would be finishing all my housework in a split second!

