

SOUND AND VIBRATION NEWS

ISSUE# 04

# WAVES

NOVEMBER 2015

MANCHESTER AIRPORT GROUP  
BRINGS COMMUNITIES ON BOARD

UPLIFTING SOUND QUALITY AT CROWN

DIVING DEEPER INTO  
THE SOUND OF BLUE WHALES

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Brüel & Kjær 

BEYOND MEASURE

# CONTENTS

Bringing communities on board .....	04
Calibration is key to trust – and trade .....	09
Cutting the commute .....	12
Women in sound and vibration .....	16
Vehicle noise tests are getting tighter .....	22
Diving deeper into the sound of blue whales .....	24
Recording sound at sea .....	30
A new white paper from the stacks .....	31
Uplifting sound quality .....	32
The conductor's point of view .....	38
The fauna philharmonics .....	41
News .....	44

## Bringing communities on board

04



## Cutting the commute

12



## Women in sound and vibration

16



## Diving deeper into the sound of blue whales

24



### EDITOR-IN-CHIEF

Camilla Travis

### MANAGING EDITOR

Peter Sims

### COORDINATOR

Charlotte Stampé

### WRITERS

Carsten Frederiksen, Elisabeth MacMillan,  
Sheelagh Crewe

### CONTRIBUTORS

Andreas Høg Christensen, Bert van  
Amerongen, Frank Rasmussen,  
Gary Newton, Kent Espersen, Niels V.  
Bøgholm, Woo-Keun Song, Yun S. Ryu

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### EDITORIAL OFFICE

Brüel & Kjær Sound & Vibration  
Measurement A/S  
Skodsborgvej 307  
DK-2850 Nærum  
Denmark

Phone: +45 7741 2000

Fax: +45 4580 1405

Comments: waves@bksv.com

www.bksv.com/waves

**Subscribe:** [www.bksv.com/subscribe](http://www.bksv.com/subscribe)

### FRONT COVER IMAGE

Blue whale (*Balaenoptera musculus*)  
diving

**Brüel & Kjær**   
BEYOND MEASURE

## LETTER FROM THE MANAGING DIRECTOR

# TAKING THE LEAD AT BRÜEL & KJÆR

As the new Managing Director of Brüel & Kjær, I am pleased to welcome you to Waves.

One of the first tasks in my new role is to observe and listen. I intend to get the clearest picture of our customers' needs by understanding every inch of our business. One of the best ways to achieve this is to learn from the talented people at Brüel & Kjær as well as from the specialists who use our solutions every day.

Many of these experts are featured in this magazine. Not only do their fascinating achievements reveal the exciting directions our industry is taking, but they serve to highlight some of Brüel & Kjær's greatest strengths: innovation and knowledge sharing.

On one hand, new technologies have made our world smaller. Businesses have never been able to cooperate so closely together, with no barriers to distance, discipline or language, as they can today. On the other, new tools and ways of thinking are enabling us to broaden our horizons and open doors of opportunity that were previously far beyond our reach.

At Brüel & Kjær, we embrace both these aspects and today we are helping customers worldwide to explore new ways to simplify their processes, improve their products and expand their knowledge.

Take Crown for example; together we have developed sophisticated sound analysis tools and methods to improve their forklift trucks; or the University of Iceland which is using our equipment to discover how ship noises affect the behaviour of blue whales. Alternately, find out how Manchester Airport Group is using our system to optimize operations and build trust with surrounding communities.

Working alongside these – and many other – businesses is the driving force behind our innovation. The experience it brings not only allows us to support our customers' continued growth, but it enables us to break new ground with ever better ways to solve their sound and vibration challenges.

Happy reading!

**SØREN HOLST**  
MANAGING DIRECTOR







# BRINGING COMMUNITIES ON BOARD

"TO MAINTAIN OUR WORLD-CLASS CSR STANDARDS, WE NEEDED A WAY TO REDUCE NOISE IMPACT, OPTIMIZE OPERATIONS AND BUILD TRUST WITH SURROUNDING COMMUNITIES..."

TIM WALMSLEY, ENVIRONMENTAL MANAGER,  
MANCHESTER AIRPORT



## How Manchester Airports Group's new noise and operations management system is building trust through transparency

Managing noise is a crucial factor for any airport to run efficiently and to build stronger links with the local community, which is why modern noise management systems have become a vital part of their infrastructure. On one hand, these complex platforms give rise to an incredible amount of data that gives valuable insights into the airport's operations. On the other, they

facilitate the sharing of this data with the public, helping environmental departments to be more transparent about aircraft comings and goings, and more responsive towards people who raise concerns about their environmental impact.

For Manchester Airports Group (M.A.G), upgrading their noise management technology was a unique opportunity to optimize operations across its network of UK airports and build on its already impressive and well-established Corporate Social Responsibility (CSR) programme.

### SETTING STANDARDS AND EXPECTATIONS

M.A.G is the country's largest UK-owned airport operator. It currently runs a network of four airports – London

Stansted, Bournemouth, East Midlands and Manchester – which together serve around 48.5 million passengers every year.

The group has always been actively engaged in environmental management initiatives and has taken a lead in maintaining world-class CSR standards. As a key driver to improve this, the group wanted to find new ways to reduce noise impact, optimize operations and facilitate dialogue with the surrounding communities in order to build trust and help to manage noise expectations. This is vital for the airport's ongoing success; maintaining good community relations via a well-executed environmental management policy provides the licence an airport needs to expand and grow its business. ►



## BRINGING COMMUNITIES ON BOARD

Portable noise monitors provide total flexibility to M.A.G and can be deployed quickly



## A DEDICATED AIRPORTS DIVISION

Brüel & Kjær brings almost 40 years of experience to building solutions that manage noise and operations for its 250 airport clients, including major locations such as Amsterdam, Frankfurt, Heathrow, Madrid, New York and San

Francisco. Today, there are more than 100 people dedicated to airport noise management, including 30 developers, whose extensive knowledge and experience are culminated in the ANOMS 9 system. ■

### BRINGING IT ALL TOGETHER

M.A.G therefore made the decision to replace the noise management systems across all its airports.

The existing systems at each airport had become very outdated and were built around several different technologies that made any form of centralized data integration, monitoring and reporting virtually impossible. In addition, the noise monitoring terminals in use were also beginning to show their age, and as a result, the whole system was becoming expensive to manage and maintain.

With the aim of bringing this all together under a single, easy-to-use system, M.A.G identified several key requirements that needed to be met, namely:

- To optimize operations by monitoring where aircraft are, what they are, who is operating them and how much noise they make every time they arrive and depart, in real-time
- To be able to collect, correlate and design reports based on this data centrally across all its airports, including graphical, statistical, spatial and trend analyses of noise management
- To enable environmental teams to keep a close eye on how each airport and airline was performing and take action if rules were not being met
- To provide an up-to-date, easily accessible way to share this information publicly and provide a simpler way to process and manage complaints

### ANOMS 9

The solution came from Brüel & Kjær in the form of a highly sophisticated, flexible and integrated noise management system known as ANOMS, or Airport Noise and Operations Management System. The

The ANOMS Web Client is already proving an invaluable tool for M.A.G's Community Relations teams, particularly when discussing airport operations at community events



system is currently in its 9th generation and is the culmination of 40 years of knowledge and experience in flight tracking and noise measurement across 250 airport clients worldwide.

The platform fuses data from a wide range of sources (such as weather, radar, track points and flight information as well as data from noise monitoring terminals) to give a real-time, comprehensive view of an airport's operations and to help them understand and manage the subsequent environmental impact.

#### NEXT-GENERATION MANAGEMENT

A vast array of data is collected and processed by sophisticated algorithms that correlate and then display the results through an intuitive smart client that allows users to drill down, splice and analyse the information in a huge variety of ways. An additional Web-based application also gives users access to information via the Internet, anywhere

and at any time. Furthermore, as a fully hosted solution the airport does not need to take on board any additional hardware investment or worry about system maintenance, downtime or upgrades.

The system's added features and functionality are designed to provide M.A.G with a wide array of operational and efficiency benefits. Management is now able to keep a close check on aircraft activity to ensure that they are keeping to their airports' infringement rules, noise-abatement policies and night curfews, and that environmentally efficient procedures, such as Continuous Descent Operation (CDO), are being used appropriately.

ANOMS 9 also gives M.A.G a depth and breadth of analysis that was never possible before. By centrally managing data across each airport, management teams can quickly and easily find and compare information to illustrate trends and report activity to all stakeholders – including

members of the public who contact the airport to complain about excessive noise levels or unusual aircraft activity.

For M.A.G's Environment Department, this is where the long-term value of ANOMS 9 truly lies. By having highly accurate real-time and historical information about the position, speed, height and noise of each aircraft, the Community Relations team can process and respond to complaints quickly and with transparency, which is an important factor to build trust within the local community.

#### WEBTRAK AND WEBTRAK MYNEIGHBOURHOOD

Like every airport, worldwide, M.A.G's Environment Teams receive complaints or enquiries ranging from where aircraft fly, to the noise generated on departure or arrival, to flight route changes, even to general questions about how the airport operates. By using a system that can automatically pull in these enquiries, log them in a database and reply quickly and informatively, the process becomes far more time and cost efficient and people feel that their concerns are being heard, responded to and genuinely taken into consideration.

However, if people are also able to self-investigate the nature of their enquiry by checking detailed flight track data (down to aircraft type, number, altitude, flight track, holding patterns, distance to any point on the map and the actual noise levels), they can see for themselves whether they are justified in complaining before taking any action.

If not, then not only have they saved their own time and trouble, but the load on the airport's Community Relations team becomes significantly lighter. ►

“THE PROJECT HAS BENEFITTED FROM OUR LONG RELATIONSHIP WITH BRÜEL & KJÆR...IT WAS DELIVERED IN A WAY THAT ALLOWED US TO MAINTAIN OUR MONITORING AND REPORTING CAPABILITIES WHILE PROVIDING OPPORTUNITIES FOR USERS TO FULLY UNDERSTAND THE SYSTEM.”

TIM WALMSLEY, ENVIRONMENTAL MANAGER,  
MANCHESTER AIRPORT



BRINGING COMMUNITIES  
ON BOARD

Photo by Anthony Appleyard

This is precisely what the public-facing side of ANOMS 9 – a community engagement portal known as WebTrak – provides. Designed to help facilitate dialogue as well as give flight information, WebTrak is an essential tool for anyone who wants to understand more about their airport's activity or as a way of quickly, easily and directly making a complaint if necessary.

WebTrak MyNeighbourhood provides a slightly different perspective by allowing people to look more closely at flight trends and statistics rather than just at individual aircraft activity. This enables people to look deeper into the impact of an airport on their specific neighbourhood by summarising data over long periods, helping them

to get a more comprehensive overview of what sort of noise levels they can expect.

**VALUE BEYOND MEASURE**

Right now, everything is in place and the system has been launched across the group with great success. M.A.G is safely covered by a 5-year support contract with Brüel & Kjær that covers all system hosting and maintenance, including verification of radar data and the upkeep of all noise management terminals.

One additional and notable benefit that M.A.G also receives from this hosting agreement is system updates; Brüel & Kjær manages systems for a large number of airports worldwide, which, over time, require various tweaks and improvements. As these developments are made, they are standardized, implemented and shared across the entire ANOMS 9 platform.

The extent of the value that this new system gives M.A.G is almost impossible to quantify; however, there is no doubt that as time goes by it will continue to

prove itself as an invaluable asset in many different areas. As Tim Walmsley, Environmental Manager at M.A.G, observes:

"For the Environment Teams, ANOMS delivers what we asked for, which is the ability to quickly analyse performance and get that information out to our stakeholders that use the information, whether for other parts of the M.A.G business, the community or airlines."

Tim also commented on the advantages the new system is already bringing to their CSR programme, saying: "The Web Client is already proving an invaluable tool, particularly with the Community Relations teams who have been able to sit down with members of the community at outreach events to immediately address any questions that they raise."

All this, of course, is very good news for M.A.G; however, it is even better news for the many people who live close to its airports and whose lives are affected by them. ■

"INTEGRATING ANOMS 9 ACROSS MULTIPLE AIRPORTS FOR M.A.G WAS A CHALLENGE – ESPECIALLY AS WE WERE DOING THE SAME THING FOR FIVE AIRPORTS IN NEW YORK AT THE SAME TIME. NEVERTHELESS, EVERYTHING WAS COMPLETED TO SCHEDULE AND IS NOW FULLY OPERATIONAL."

KENT ESPERSEN, HEAD OF EMEA SALES & OPERATIONS,  
EMS, BRÜEL & KJÆR



# CALIBRATION IS KEY TO TRUST – AND TRADE

Trust is the basis of all human relationships and a valuable business commodity. Calibration is a matter of trust, and though trust in itself is almost unmeasurable, measurements made with calibrated equipment create confidence.

Units of measurement are among the earliest tools invented by humans – and they have become more important than ever. All over the world, we make an almost infinite number of measurements every day. They play a very important role in our day-to-day lives in trade, industry and science. Measurement standards ensure reliable and consistent data – building confidence and trust.

## MEASUREMENTS GUARANTEE QUALITY

We all use standards and units of measure in daily life – just think of shop weighing scales, petrol pumps, thermometers and speedometers. Litres, gallons, grams, ounces, watts, volts, metres and yards – we use an elaborate system of standard measures without even thinking about it.

The science of measurement – metrology – and its practical application is a key part of societal infrastructure today and plays a vital role in our lives. In our high-tech world, proper measuring is of fundamental importance.

Economists have estimated that the spending on measurements in industry adds up to around 1% of GDP in the European Union, while the total benefits are 2.7% of GDP. Similar figures apply for the US.

## CALIBRATION ENSURES CONFIDENCE

The industrial need for comparable, accurate and precise measurements has led to standardization, and as a result, a growing need for calibration. ►

“VIRTUALLY EVERY COMMERCIAL TRANSACTION HAS WITHIN ITSELF AN ELEMENT OF TRUST, CERTAINLY ANY TRANSACTION CONDUCTED OVER A PERIOD OF TIME.”

KENNETH JOSEPH ARROW,  
NOBEL LAUREATE IN ECONOMICS



Senior Research Specialist  
Mr Ebenezer Neequaye  
Kotey is head of the Energy  
Technologies Programme at  
CSIR-IIR in Ghana

## CALIBRATION IS KEY TO TRUST – AND TRADE

### GHANA



#### RAISING THE STANDARD

##### – CALIBRATION TO BOOST INDUSTRY

In Ghana, the Council for Scientific and Industrial Research (CSIR) has acquired Brüel & Kjær calibration systems. The acquisition is part of an initiative funded by the European Union (EU) to boost business development in Ghana.

Ghana, located in West Africa, has witnessed annual economic growth averaging over 6.4% since 2000, which is largely driven by expanding service and industrial sectors. The start of oil production in 2010 has the potential of transforming the economy.

The President of Ghana Academy of Arts and Sciences, Professor Francis Allotey, states, “Modern science, technology and innovation enterprise is expensive but a necessary investment for the future”.

The Government of Ghana’s agenda is to use science, technology and innovation as the driving forces towards the economic development of the nation, but according to CSIR, Ghana’s scientific institutions are struggling with challenges such as obsolete scientific equipment and inadequate training.

In 2011, the EU and the Republic of Ghana initiated a trade-related assistance programme. Among others, the programme focuses on the basic step of implementing the national quality policy covering areas such as metrology, accreditation, standardization, conformity, certification and regulation.

The acquired calibration systems will function within the Institute of Industrial Research (CSIR-IIR), a leading institute of CSIR. The mission is to drive national development and global competitiveness in industry through research into process and product development, and promotion of scientific instrumentation and calibration.

The central quality control services will soon be in place and the hard work to establish a market for calibration in relatively new, export-oriented industries can begin. ■



Boxes with new calibration systems arrive at CSIR-IIR in Accra, Ghana

Calibration is a fundamental step in the practice of measurement. It is the process of determining the relationship between the values indicated by a measuring instrument or system and the corresponding units of a defined system of measurement.

In practice, the simplest calibration is a comparison between measurements – one made with the instrument under test and another measurement with known uncertainty made in a similar way with a second instrument, the reference unit.

We can trace the measurement of the reference unit back to international standards through a chain of measurements with known uncertainties. This traceability is a fundamental principle in any type of calibration work.





**"IT CAN BE PLAUSIBLY ARGUED THAT MUCH OF THE ECONOMIC BACKWARDNESS IN THE WORLD CAN BE EXPLAINED BY THE LACK OF MUTUAL CONFIDENCE."**

KENNETH JOSEPH ARROW,  
NOBEL LAUREATE IN ECONOMICS

### QUALITY IS KEY

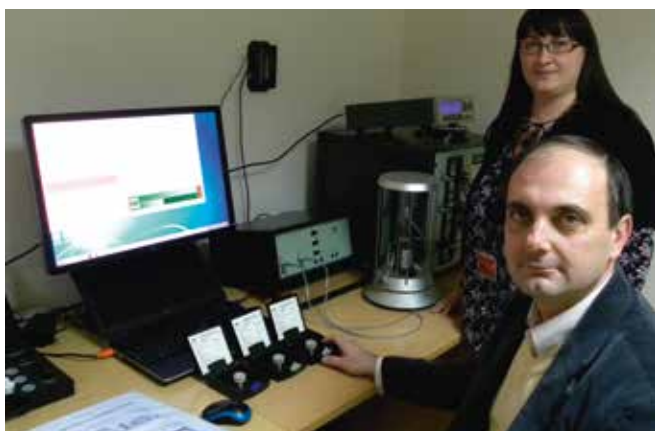
As components of our instruments age and undergo changes due to environmental or mechanical stress, performance gradually degrades, or drifts. When drift happens, test results become unreliable, and quality suffers. We cannot eliminate drift, but we can detect and contain it through the process of calibration.

The economic success of most manufacturing industries depends on the quality of their products, a requirement in which measurement and the adequate functioning of measurement instruments plays a key role. Likewise, measurement is important in innovation as it can certify that a new product is better than existing ones.

Regardless of what products we manufacture, we need absolute confidence in the integrity of our measurement instrumentation. Neglecting calibration can lead to production or machine downtime, process quality issues, cost over-runs or even product recalls.

Industrial metrology ensures quality in industrial activities – national and international trade increasingly requires demonstrated conformity to standards and specifications and mutual recognition of measurements and tests. For developing countries and countries in transition, metrology and calibration is a way to establish the trust in products and services that is needed to hook up to global business. ■

The Technical Manager of Laboratory for Electrical Quantities Mrs Stanislava Kroneva Petrovska and a colleague in the new acoustics laboratory at Bureau of Metrology in the Republic of Macedonia



## MACEDONIA



### ACOUSTICS LABORATORY SUPPORTS MARKET INTEGRATION

In 2014, the national Bureau of Metrology (BoM), in the Former Yugoslav Republic of Macedonia acquired Brüel & Kjær calibration systems to establish a national acoustics laboratory. The Republic of Macedonia, located in south-eastern Europe and with a population of just above two million, is applying for membership of the European Union (EU).

In 2011 – 2012, the Macedonian government and EU implemented a joint project to build up the capacities of BoM in relation to scientific and industrial metrology and to harmonize Macedonia's relevant legislation with that of the EU.

The Economy Minister of the Republic of Macedonia, Valon Saraqini, has stressed that the project contributes to free movement of goods, "Its implementation lays out a structure for quality and a developed metrology system, meaning that all technical barriers for functioning trade have been lifted".

The break up of Yugoslavia in 1991 led to the dissolution of the federal metrology infrastructure. As a result, all republics had to establish their own standardization and metrology institutions. In 2002, the Macedonian government adopted a Law on Metrology adequately harmonized with EU requirements. In 2004, BoM started its operational activities and began to set up a system of accredited calibration laboratories.

"Our economic benefit will be visible," says the Technical Manager of the BoM acoustical laboratory, Mrs. Stanislava Kroneva Petrovska. "We have widened our scope of services, and domestic customers benefit from having shorter procedures and lower costs".

The acoustical laboratory is now on a higher level and BoM can take part in scientific projects regarding acoustical metrology. The metrological infrastructure can be internationally recognized and with further accreditation, BoM will be able to provide traceability to other laboratories in the region's other countries. ■

# CUTTING THE

## AVOIDING CROP LOSS

Harvesting is a trade-off between harvesting speed, the quality of the harvested grain and straw, and the grain left in the field. New Holland combines analyse the grain dropping out of the mechanism by detecting their vibration signatures as they hit a plate. The analysis gives an essential performance parameter on the driver's display screens. ■



# COMMUTE

Only in the final hot weeks of late summer do combine harvesters appear, carving their dusty trails through dry cornfields. To exploit every last minute while conditions are optimal, New Holland's developers work hard to reduce the time driving between fields.

Just as the summer nears its end, many fields begin to ripen. For the farmers who have tended these crops since spring, timing is critical. Corn must be harvested as dry as possible; too much moisture requires expensive fans and heaters to dry it. At this tense time of year, farmers face a jigsaw puzzle of fields to prioritize during the precious hours of good weather conditions.

Humidity in the corn varies widely between fields, due to very specific conditions like a field's angle to the sun, shelter from the wind, and topography. With widely spread farms, modern farmers must dispatch harvesters to the right field at the right time, not half an hour later when the dew has fallen. Every minute on the road is one less in the field while the corn is at optimal humidity – it may never be so profitable again.

Nowadays, more and more of the work at harvest time is done by ever-larger contracting companies, who service large areas with centralized fleets. In France, contractors even drive the length of the country to work on the later harvest in the north. Unsurprisingly, combine customers keep calling for higher road speeds.

## 20-TONNE NOISE CHALLENGE

To drive unassisted on EU roads, combines must fulfil road vehicle legislation such as a 3.5 metre width, stability checks and speed requirements. Just as trucks have a lower speed limit than cars, there are progressively lower limits for agricultural vehicles. These differ by country: in France the limit is still 25 km/h, while in Germany and Belgium, combines can now legally reach 40 km/h – if they pass relevant tests.

Passing the tests for 40 km/h is challenging. Higher speed limits place stricter requirements on vehicles, like braking. Remaining within noise limits is particularly hard. As New Holland's Test Engineer Pieter Calmeyn says, "With noise it is often very hard to interpret what you are seeing."

As vehicles go faster, noise increases. However, the legal limit remains 90 dBA, regardless of speed, and combines are large, powerful, complex machines. They have a decoupled powertrain where many noise-making components, like hydraulics and hydromotors, drive the wheels. In some cases, there are no wheels at all, because rubber tracks reduce soil compaction.

At 40 km/h, noises above 90 dBA could be due to a specific component or amplification in the sound's path through the structure. As Pieter says, "It's no good just having a sound level; we need to interpret the results. And the earlier, the better." Since any new components require field testing over two to three harvest seasons, early identification of noise problems avoids years of wasted durability proving. "Noise also reveals overloaded components, so by listening to the machine, we can really tell how it is working," says Pieter. ►

Road driving means wasted time, which higher speeds reduce



CUTTING THE  
COMMUTE

Without any suspension, combines present challenges for pass-by testing. The standard dictates a sudden full-throttle acceleration, which makes the machines rock back and forth, causing noise oscillations



See the  
pass-by test

"IT'S NO GOOD JUST HAVING A SOUND LEVEL; WE NEED TO INTERPRET THE RESULTS. AND THE EARLIER, THE BETTER."

PIETER CALMEYN,  
NVH SPECIALIST,  
NEW HOLLAND

**EARLY PASS-BY INTERPRETATION**

At New Holland's Center of Harvesting Excellence in Belgium, Pieter and his team use a pass-by noise measurement system to assess legal noise compliance at all stages of a combine's development, so engineers can see which frequencies cause exceedances as a prototype drives past the microphones. "Just having the spectra in relation to the vehicle's position is our first level of interpretation. If certain noise peaks are highest before the microphones or just after, we can see which area of the vehicle they come from," says Pieter.

A GPS capability in the data acquisition hardware makes this possible. This also implants a highly accurate 'time stamp' in the sound and vibration data. Because it is a common time signal, it allows precise synchronization with other datasets like the vehicle's own CAN Bus data. Therefore, engineers can correlate machine parameters like engine speed, hydraulic pressure and hydromotors with sound peaks measured outside.

To further drill down into details, New Holland mounts microphones and accel-





“ONE REDESIGN OF A DRIVETRAIN COG TOGETHER WITH OUR SIMULATION DEPARTMENT REDUCED NOISE BY 7 DB BECAUSE WE COULD PASS ON PRECISE IDENTIFICATION AND SOUND FREQUENCY COMPONENTS TO THE FE (FINITE ELEMENT) MODELLING DEPARTMENT.”

PIETER CALMEYN, NVH SPECIALIST, NEW HOLLAND

erometers on the vehicle, and synchronizes them with the pass-by data, giving very detailed correlations between specific components and the acoustic levels where the legal limit is measured. “I can extract components easily,” says Pieter. “I make a source path contribution analysis based on the frequency spectrum and then extract the orders related to a component.”

The best mitigation strategy is to resolve noisy components, which might be the diesel engine, a specific hydromotor or hydraulic pump. In some cases, designers



Comfort reduces the driver's fatigue, and New Holland's Harvest Suite cab leads the market with a 73 dB(A) noise level thanks to significant investigations into glass layups combined with frequency-optimized materials

can select an alternative sub-supplier, or take a component from another machine, which also avoids field-proving it. Another strategy is to interrupt the noise's path through the structure. They can also use noise shielding, though field trials can prove too demanding.

#### INTEGRATED TESTING SNOWBALLS

The key is to try out different ideas and alternatives and assess their effect on pass-by noise. In a little over a year, New Holland has performed 600 such tests.

“But more important than the amount, is the level of interpretation this means,” explains Pieter. “Before, designers had a certain noise level to work with. Now we give them specific components or paths that are problematic. A better interpreta-

tion of their design at the beginning of a project is a great advantage.”

With detailed information, departments can collaborate more effectively. As Pieter says, “One redesign of a drivetrain cog together with our simulation department reduced noise by 7 dB because we could pass on precise identification and sound frequency components to the FE modelling department.” Moreover, as such test outcomes generate awareness throughout New Holland, a snowballing effect brings ever-more test requests.

Such valuable test integration is necessary to meet the challenging noise limits at faster road speeds, and according to Pieter, his equipment is key. “The tools are getting better and better,” he says. “Now measurement equipment has changed, we should take advantage of it, and also change and adapt to it.” It is not so different from agricultural machinery. “You used to have to brake when you saw a tractor,” says Pieter. “But today they're driving at 50 km/h. The combines are part of this trend.” ■

Daily harvesting capacity has increased considerably over the last ten years, but the actual speed on the field has not changed much; 5-6 km/h is an optimal speed when balanced with the concentration needed to handle a harvesting machine

# WOMEN IN SOUND AND VIBRATION

"It's a man's world," they say, and looking at the statistics one would be tempted to agree.

Despite sobering statistics, women have contributed to the diverse fields of engineering throughout history. In fact, did you know that a woman, American toolmaker Tabitha Babbitt (1784 – about 1853) invented the first circular saw? And did you know that Englishwoman Sarah Guppy (1770 – 1852) patented her method for the safe piling of bridge foundations, but still gave Thomas Telford and Isambard Kingdom Brunel permission to use the design free-of-charge when building their respective suspension bridges – the Menai and the Clifton. And Lord Byron's daughter, Ada Lovelace (1815 – 1852), did not follow in her father's footsteps. At her mother's insistence, she was taught science and mathematics. Her achievements received little attention when she was alive, but her collaboration with Charles Babbage on a new kind of calculating machine, the Analytical Engine, has now earned her recognition as the 'first computer programmer' and founder of scientific computing.

So defying stereotypes and despite the odds, these women pursued their vision and proved that they were indeed a match for any man in their chosen profession. We celebrate five women who, with determination and talent, achieved success in a male-dominated industry.

## THE ENTREPRENEUR

**Dr Gabriella Cerrato**

President, Sound Answers Inc.

### AREAS OF EXPERTISE

Sound and vibration quality modelling, target setting and cascading, vibroacoustic modelling and correlation of CAE models, synthesis/prediction of products' noise and vibration performance

Gabriella Cerrato maintains that she does best when she follows her instincts. And that's exactly what she did when she accepted a job at a small consulting firm after getting her degree in Italy. "I could have gone to work for big labs, but for some reason I felt attracted to the small environment and the fast pace of consulting although I was a theoretical physicist and the job was really much more practical than what I was used to." It just so happened that the small company worked in noise and vibration and she has now been in that male-dominant field for over 25 years.

Annoyed by stereotypes, she believes that women bring thoughtfulness, less ego, stronger team and collaboration spirit to the workplace. "I still cannot understand and believe that people truly think that women are weaker, but it is sadly a reality. We also tend to be more patient, less vocal, and although in my opinion this may be a good thing, it may be seen as a sign of weakness." However, things are changing.

## STATISTICS

- Two thirds of the 774 million adult illiterates worldwide are women
- 54% of the 72 million children not attending primary school are girls
- Women's wages are 10% to 30% lower than men's wages in most countries
- When all work – paid and unpaid – is considered, women work longer hours than men
- Women in tertiary education are significantly under-represented in the fields of science and engineering
- Women constitute only slightly more than a quarter of all scientific researchers worldwide
- Only 13 of the 500 largest corporations in the world have a female chief executive officer ■

Source: UN report, 'The World's Women 2010: Trends and Statistics'



"FIGHT THE STEREOTYPES  
BY SHOWING HOW GOOD  
YOU ARE AT DOING YOUR  
JOB, WHATEVER IT IS."

DR GABRIELLA CERRATO



"It takes time to establish yourself as someone technical in a male-dominated environment," she says, "But a MAJOR milestone was achieved recently! For the first time in my 30 plus years of professional life, I walked into a meeting with a customer as part of an all-female project team. That was so special to me."

A self-confessed addict to the release of endorphins, it's not altogether surprising that a lot of Gabriella's inspiration comes from athletes and the amount of hard work they have to do to achieve their goals without whining. However, her greatest

inspiration comes from women in leadership positions: "It must have been tough, but they made it." Despite a sterling career, Gabriella does not hesitate when asked about her greatest achievement, "Obviously my daughter," she says, "and after that, becoming a successful entrepreneur." ►

## WOMEN IN SOUND AND VIBRATION

“GETTING AN  
ENGINEERING DEGREE  
WAS ONE OF THE BEST  
DECISIONS I EVER MADE.”

DORTE HAMMERSHØI

## THE SCIENTIST

**Dorte Hammershøi, MSCEE, PhD**

Professor, Aalborg University

### AREAS OF EXPERTISE

Binaural recording, synthesis and reproduction, noise from sources close to the ears, headphone calibration, temporary threshold shifts, oto-acoustic emission, binaural auralization

Dorte Hammershøi would not change a thing about the path of her career. “Getting an engineering degree was one of the best decisions I ever made. It has provided me with so much more than just a career.” With a vision to make a difference, she is unashamedly proud of her personal scientific results and for her contribution to the foundation of a company (AM3D) that commercializes some of her scientific findings.

Inspired by her mentor, Professor Henrik Møller, to become a scientist, she became fascinated by the need for interdisciplinary approaches to many of the challenges in the field, and so entered the world of acoustics.

She considers becoming a professor in a male-dominated scientific environment one of her greatest achievements, but still believes that, despite her own success, it will always be easier for most men to relate to other men. “Men don’t trust their ability to understand women. And probably vice versa,” she says.

A strong advocate for women to consider engineering careers, her advice is to “ignore possible barriers as they take attention and focus away from the things that matter.” She doesn’t believe that women have one common professional skill that no man has. “The fact that approximately half of the population is female suggests that our work environment will be stronger, if we recruit from both genders. We are all best challenged if our colleagues, male or female, bring unique skills and competencies to the workplace.”

Juggling career and family, Dorte is today the proud mother of “teenage children who never cease to amaze me”. Maybe, she took a leaf out of Dr Per Brüel’s book when she says, “He apparently decided early in his life that he would live a happy life, and he managed to remain happy through great challenges. This inspires me to focus on spending my resources constructively and not dwell on hurdles.”



Dorte Hammershøi on a family vacation



## "OUR NURTURING NATURE CAN MAKE US GREAT MANAGERS AND LEADERS."

ALYSE BORLA

## THE PRESIDENT

### Alyse Borla

President, Borla Performance Industries, Inc.

### AREAS OF EXPERTISE

Management, corporate branding (advertising and promotion)

"I began my career in advertising," states Alyse Borla, who went on to co-found an exhaust manufacturing business with her husband, and where the main focus was to suppress sound. In the early 80s, they moved to the mecca of car performance, Southern California, and switched focus to enhancing power and performance. "We evolved into the sound aspect, and now we offer several exhaust sound options for the same vehicle. Orchestrating the right notes is challenging and exciting, and we gain great satisfaction delivering the right sound quality to enable a driver to personalize the driving experience."

In the corporate world of the 70s there was nothing unique about the challenges Alyse faced as a working woman. "Being a woman mostly meant being a secretary," she says. "Over the decades since, in a male-dominated industry, I have had to fight to rise above being mostly considered 'the wife', even though I am the highest ranking officer."

"ORCHESTRATING THE RIGHT NOTES IS CHALLENGING AND EXCITING, AND WE GAIN GREAT SATISFACTION DELIVERING THE RIGHT SOUND QUALITY."

ALYSE BORLA

But with strong female role models growing up, and a husband of nearly forty years who she describes as "gender blind in every aspect of his life," she has paved the way for today's fiercely determined women. "A woman can elicit a receptive state of mind from a man as long as he doesn't feel emasculated. Our nurturing nature can make us great managers and leaders and if a woman decides she wants something, she can be relentless in the pursuit of her goal."

Her advice for women at the start of their careers? "Don't settle but rather strive for excellence in every aspect of your life because you can have it all if you are willing to take responsibility, confront obstacles and work hard."

"I am living my dream!" says Alyse, "Why waste your time and energy with excuses and roadblocks when there is so much happiness and fulfillment out there to grab and enjoy. My business and my family are my passions. Oh yes, and there must be dancing!" ►



Alyse Borla, second from the left



## WOMEN IN SOUND AND VIBRATION

"MY PHILOSOPHY IS, IF YOU WANT TO GET A TASK DONE SOONER, RATHER THAN LATER, YOU GIVE IT TO A BUSY PERSON."

DR HELEN ULE

## THE ACOUSTICIAN

### Dr Helen Ule, PEng

Vice-President and Business Manager,  
Akoustik Engineering Limited

### AREAS OF EXPERTISE

Psychoacoustics and sound quality, structural modal analysis, measurement and analysis of community noise impacts from airports, environmental noise and vibration analysis

As a child, intrigued by space and future exploration, Helen Ule wanted to be an astronaut. Realizing that this was unrealistic, she turned to maths and science, culminating in the highest echelon of her profession – a doctorate degree in engineering. "This opened up the opportunities for me to partner in my own company in the field of noise and vibration consulting."

An accomplished musician, Helen recalls that, "Music has always been part of my life. Going into acoustics was a natural transition." Part of the appeal was also the fact that there were less acousticians than, for example, automotive engineers. "This suggested to me that there is something very special about being an acoustician. I always like being on the fringe, of being a bit 'out there'."

Her dream is to expand her company in terms of the types of consulting jobs and number of employees, "While I very much enjoy the hands-on components of taking measurements and processing data, I realize that for the company to grow I need to mentor the younger engineers and pass my experience on to them."

For Helen, education is key, "I have encountered school guidance counsellors who have advised young women to not focus on science and mathematics... But they should not limit their education, and potentially close doors by not including maths and science in a well-rounded education." And as a female in the industry she has never faced barriers in her professional life. "Hard work, confidence and a positive attitude will allow you to achieve the goals that you set for yourself." She concludes, "Women play many roles in life, and have to juggle their time around... In other words, they can be more efficient in getting things done." She smiles wryly, "My philosophy is, if you want to get a task done sooner, rather than later, you give it to a busy person."



"I HAVE A MANAGERIAL ROLE, WEAR A SUIT AND LEAD A TEAM OF VERY CLEVER AND CHALLENGING ENGINEERS."

MARIA DEL MAR FRANCO-JORGE

## THE MANAGER

**Maria del Mar Franco-Jorge, MEng, AMIMechE**

Engineering Function Manager, HORIBA MIRA Ltd. (MIRA)

### AREAS OF EXPERTISE

Vehicle NVH subjective appraisals, human perception and subjective-objective correlation of NVH performance, modal analysis, vehicle ride and suspension refinement, R&D and engineering management

"I landed in noise and vibration by chance," says Maria del Mar Franco-Jorge, who on finishing her degree moved from Spain to the UK to join MIRA as an NVH engineer. "It was a good way to apply my 'theoretical' knowledge in a fun environment – driving cars on a proving ground or testing in a laboratory." Her dream job was to become a white-coated scientist working in a laboratory. "Instead," she laughs, "I have a managerial role, wear a suit and lead a team of very clever and challenging engineers." Her career has been full of opportunity including a secondment in China.

In 20 years at MIRA, Maria has never found significant barriers associated with being female despite the predominantly male engineering teams. Asked what advice she would give women, she says, "There is no need to give advice, women are doing well and there is no need to try harder to prove yourself in the work environment, just because you're a woman. Women should be confident of their own capabilities and do their best without trying to prove a point – that should be enough to make them shine!" She continues "Women tend to be able to step back and see the whole picture better than most men and, in general, are more capable of multitasking. However, this is sometimes detrimental as we miss some of the important details." "In fact," she adds, "being a woman has not made a difference to the path of my career. Being a mother has."

A good work-life balance is often one of the biggest challenges for women, and Maria makes time for friends and family, travelling, running and swimming – an accomplishment she's proud of. "At the end of the day, I guess my biggest achievement is to be able to juggle professional and personal life with reasonable competence." ■



"BEING A WOMAN HAS NOT MADE A DIFFERENCE TO THE PATH OF MY CAREER. BEING A MOTHER HAS."

MARIA DEL MAR FRANCO-JORGE



# VEHICLE NOISE TESTS ARE GETTING TIGHTER

The new pass-by tests coming in 2016 will help prevent 'noisy' vehicles from being able to satisfy legal sound limits in very specific test conditions – by broadening the scope of the tests.

But more driving runs at precise speeds and complicated calculations make the test engineers' life harder. Meet the Additional Sound Emission Provisions (ASEP).

#### Why do we need new test procedures?

To minimize the ever-present noise from cars and motorbikes in urban areas, manufacturers must ensure vehicles stay below pass-by noise levels. However, despite sound level limits having been reduced in the EU a number of times, European governments became concerned that limits were not translating into

reduced urban traffic noise. One reason was thought to be that the pass-by noise test procedure was not accurately reflecting real-world urban driving.

#### What was wrong with the old tests?

Test procedures define precisely how to drive and measure a vehicle while measuring sound – a wide-open throttle acceleration from 50 km/h, (ISO 362:2014). However, manufacturers have learnt to tune vehicles to keep noise below the legal limits during these tests, by installing devices or carefully mapping the engine





## WHAT VEHICLES FACE TIGHTER TESTS?

All two-wheeled vehicles, and all passenger vehicles with no more than nine seats, up to 3.5 tonnes. ■

control management system for that specific manoeuvre. But at other times during normal urban driving, the vehicle may still be perceptibly noisy.

### What do the Additional Sound Emission Provisions do?

The new type-approval procedures ensure the manufacturer also demonstrates that the vehicle's sound levels do not significantly differ from the ISO pass-by test result under typical on-road driving conditions, at a broader range of speeds.

### What do they add to the test procedures?

ASEP requires four additional runs past the microphones for every gear ratio. These are designed to capture the vehicle's noise at four different speeds for every gear, from the lowest – a 20 km/h entry speed (10 metres before the microphone), up to an 80 km/h exit speed (10 metres after the microphone).

### What challenges do they present for testers?

Precise speed requirements at entry, mid-point and exit past the microphones (a 20-metre track section) all require precise driving, and take several runs to achieve. This takes valuable test-track time. Test equipment needs to be easy to use on many consecutive runs, and with highly visible speed displays.

### What about the target speeds?

For two-wheelers, ASEP defines the entry speed for each run. For four-wheeled vehicles, however, it is more complicated because the entry speeds are not defined, apart from the lowest-speed run (20 km/h). For the highest speed run, the entry speed must be calculated back from the 80 km/h exit speed requirement. Then two more runs are required, which are designed to ensure the speeds between

those first two runs are well covered. The entry speeds of these subsequent two runs are calculated from the first two runs. This part can be very confusing.

### What does it take to achieve a pass/fail result?

During and after testing, there are many more calculations to perform than before. The 'A' in ASEP stands for 'additional', meaning they exist alongside the pre-2016 regulations. The ASEP results must be combined with the results from ISO 362:2014, and the only way is manually, such as by

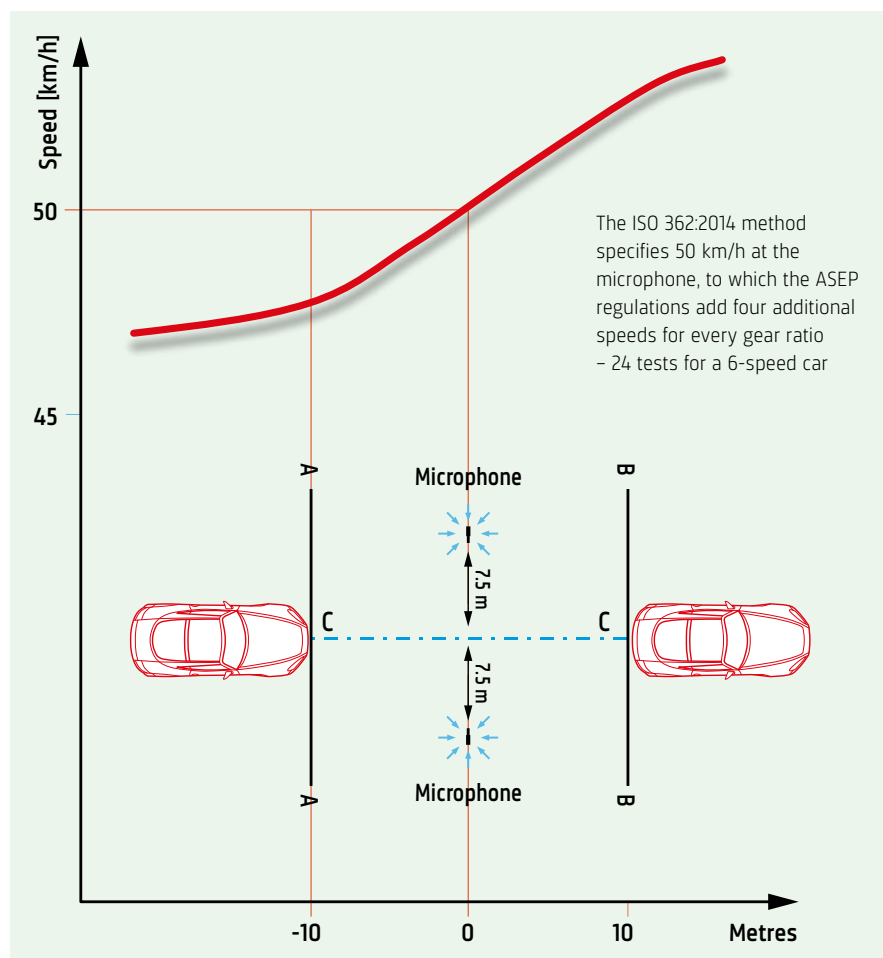
using a spreadsheet. However, solutions that build ASEP calculations into the pass-by testing software are under development, and will be released in early 2016.

### Where and when will ASEP be required?

They will be required on all new vehicle types (such as minor model changes) in Europe from July 2016.

### Where can people find out more?

In the UN Regulation No. 51, published by the United Nations Economic Commission for Europe. Or ask one of our experts! ■



# DIVING DEEPER

## INTO THE SOUND OF BLUE WHALES

Growing up to 30 m long and 180 tons, the blue whale is the largest animal in the world. In addition to its impressive size, its calls can be heard thousands of kilometres away and far below the ocean's surface. However, very little is known about these calls and how man-made noises can interfere with them – and what the implications really are.

### DR MARIANNE HELENE RASMUSSEN

As the director of the Húsavík Research Centre at University of Iceland, a leading centre of excellence for marine biology and the study of marine mammals, Dr Marianne Helene Rasmussen knows a thing or two about whales. Marianne started her marine mammal studies in Iceland for her Masters project before completing a PhD on the acoustic communication in white-beaked dolphins at University of

Southern Denmark in 2004. Since then, she has been involved in research projects worldwide that have revealed ground-breaking insights into the nature of humpback whales, blue whales, minke whales, killer whales, narwhals, and porpoises. ■





An adult blue whale can eat up to 3,600 kilograms (7,900 lb) of krill in a single day

Project Blue Whale was created to dive deeper into these issues. Thanks to the efforts of Dr Marianne Helene Rasmussen and her team, we are now beginning to understand more about how, why and when these majestic animals communicate and what we can do to help them survive and prosper.

#### **DISTURBING THE PEACE**

Blue whales (*Balaenoptera musculus*) are a peaceful species that live in many of the world's major oceans such as the Antarctic, Atlantic, Indian and the Pacific. However, populations have become scarce and fragmented, due partly to the mass whaling that occurred in the 17th – 20th centuries on one hand, and to more recent disturbances to their natural habitat on the other.

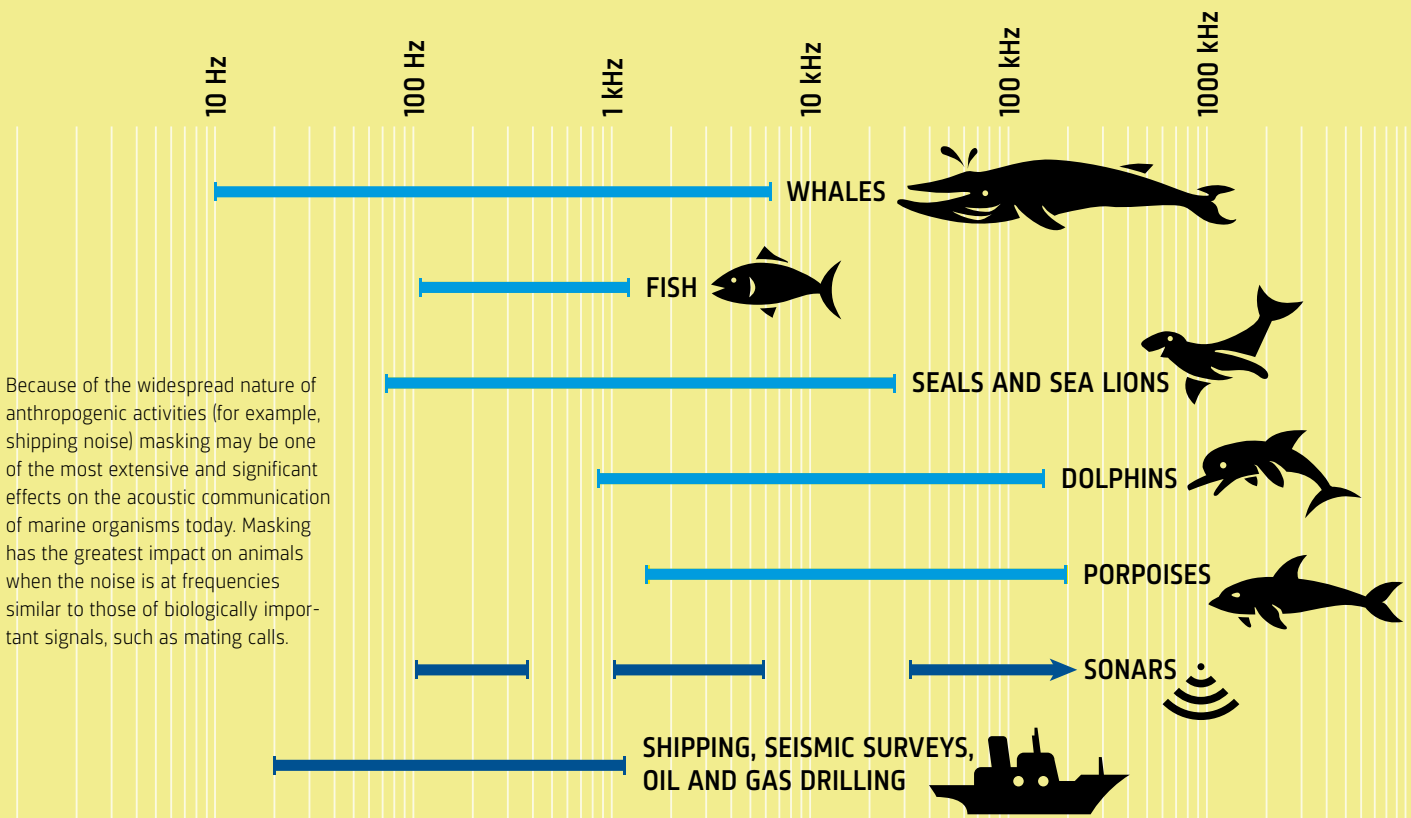
Blue whales communicate using the lowest frequency sound recorded among cetaceans with loud, low-pitched moans and whines that can be heard over very large distances. These 'down-sweep' calls have frequencies from 107 Hz to 21 Hz (or lower) and show an incredible variety with eleven different types of sound. Unfortunately, this is the same frequency range as a wide variety of man-made sounds, such as ship engines, low-frequency active sonar, seismic air gun array explorations and other oil exploration activities, to name but a few. The question this leads to is, what effect does this noise pollution really have on these highly intelligent and social animals? ►





## DIVING DEEPER INTO THE SOUND OF BLUE WHALES

### MASKING THE SOUND OF MARINE ANIMALS



Sources: [www.dosits.org](http://www.dosits.org), [www.cbd.int](http://www.cbd.int), Slabbekoorn et al. (Trends in Ecology and Evolution, June 2010)

#### A LOUD AND SERIOUS THREAT

By nature, blue whales are solitary creatures, often travelling thousands of miles alone or in small groups during migration. They are, however, in regular contact with each other but sadly, there is growing evidence that noise interference can disturb their vital life functions, such as feeding, breeding, navigation and communication. This is a very serious problem, especially for an endangered species.

To make matters worse, worldwide shipping traffic in sea areas used by blue whales is also on the rise. For example, during the Arctic Circle conference in Reykjavik in September 2013 and

October 2014 it was stated that 60 ships had gone through the Northwest Passage in the summer of 2013, with plans for several more shipping routes already in process. Furthermore, whale watching has become a popular tourist attraction, which has led to an increase in the number of vessels in areas where blue whales congregate.

The result is inevitable; more ships mean more underwater noise. To manage and mitigate risks to whales' survival, it is vital to gain a better understanding of how, why and where blue whales communicate as well as the level and effect of noise disturbance from ship engines.

“ACCURATE RECORDINGS ARE ESSENTIAL TO GET RELIABLE RESULTS. FOR THIS WE NEEDED JUST THE RIGHT EQUIPMENT, WEATHER CONDITIONS AND, OF COURSE, FOR THE WHALES TO BE IN THE RIGHT PLACE AT THE RIGHT TIME. ONLY ONE OF THESE WAS A CERTAINTY!”

DR MARIANNE HELENE RASMUSSEN



#### PROJECT BLUE WHALE

This issue was duly noted by the Húsavík Research Centre at the University of Iceland, a leading authority in the study of marine mammals. The centre is led by Dr Marianne Helene Rasmussen, who is the driving force behind ‘Project Blue Whale’ – a research initiative to get baseline data on ambient noise levels, the communication of blue whales and to study the effect that masking this low-frequency sound has on them.

The project has been financed by the Institute for Terrestrial and Aquatic Wildlife Research (ITAW) at the University of Veterinary Medicine Hannover, Foundation in Germany. The German

university had intended to do a similar project on blue whales in the Antarctic but technical problems had meant that they were unable to continue. Instead, they were happy to support Dr Rasmussen’s efforts, as she could provide the same or better results in Iceland at far less cost.

The objectives for Project Blue Whale fell into two parts. Firstly, the project aimed to gain a better understanding of the communications of blue whales. This would require the localization of individual blue whales and the recording of what sounds they were making at what times. ►

## DIVING DEEPER INTO THE SOUND OF BLUE WHALES



This would help to answer key questions such as whether it was always the same animal calling, what the difference is between animals and whether they are able to change the frequency of their calls to account for background noise (something other species of whales are able to do).

Secondly, the project would try to find out if and how underwater ship noises affect these communications. This would involve projecting noises at certain frequencies to mask the sounds created by blue whales and investigate their responses.

### THE RIGHT TIME, PLACE AND TOOLS

Such an endeavour required a large amount of planning. Dr Rasmussen chose Skjálfandy Bay in Northeast Iceland as the best area to conduct the research; it is easy to get to, close to shore and Iceland's round-the-clock daylight meant that the research team could go out very early in the morning, long before the whale-watching boats started up their engines.

There is also only a very small four-week window in June when blue whales are typically sighted in the bay (if at all). Blue whales move at their own pace and you can never predict when they will appear or for how long. As such, a two and a half week period was carefully chosen to make best use of this limited timeframe.

Fortunately, Dr Rasmussen has broad experience in marine research using hydrophone arrays to record beam patterns and sound levels, so she was well prepared for the technicalities involved.

## THE BLUE WHALE (BALAENOPTERA MUSCULUS)

- A healthy adult blue whale can live for 70 – 90 years
- Although the blue whale is called 'blue' it is actually a greyish blue (it isn't until the whale dives under the water that it appears to be a solid blue colour)
- The blue whale can eat as many as 40 million krill per day
- It is estimated that as much as 95% to 99% of the entire blue whale population was killed during the whaling era (17th – 20th century)
- Evidence shows that disturbances are having a serious effect on the communication, migration, reproduction and other behavioural patterns of blue whales
- Blue whales are now listed as a protected species ■





Three of the sailing vessels used for the project. Gogo from Iceland, Thoe from Belgium and Roxy from Denmark

In 2000, she had been part of a similar project in Andenes in Northern Norway that recorded the sounds made by sperm whales using Type 8101 hydrophones from Brüel & Kjær. The project had been a great success and so it was a natural decision to use the same equipment again for Project Blue Whale. To record the whales, a digital recorder was custom-made at Aarhus University and specially configured to be able to capture sound on one channel and to give an accurate GPS signal reading on the other for precise localization data.

#### FISHING FOR DATA

With everything ready in good time, 4 boats and 28 people set out at midnight on 19 June, 2015 to begin the first recording. The team included Dr Rasmussen, who was leading the project, and other specialists from the University of Southern Denmark, Odense University in Denmark, University of Veterinary Medicine Hannover, as well as some PhD and Masters students, whale-watcher crews and boat crews.

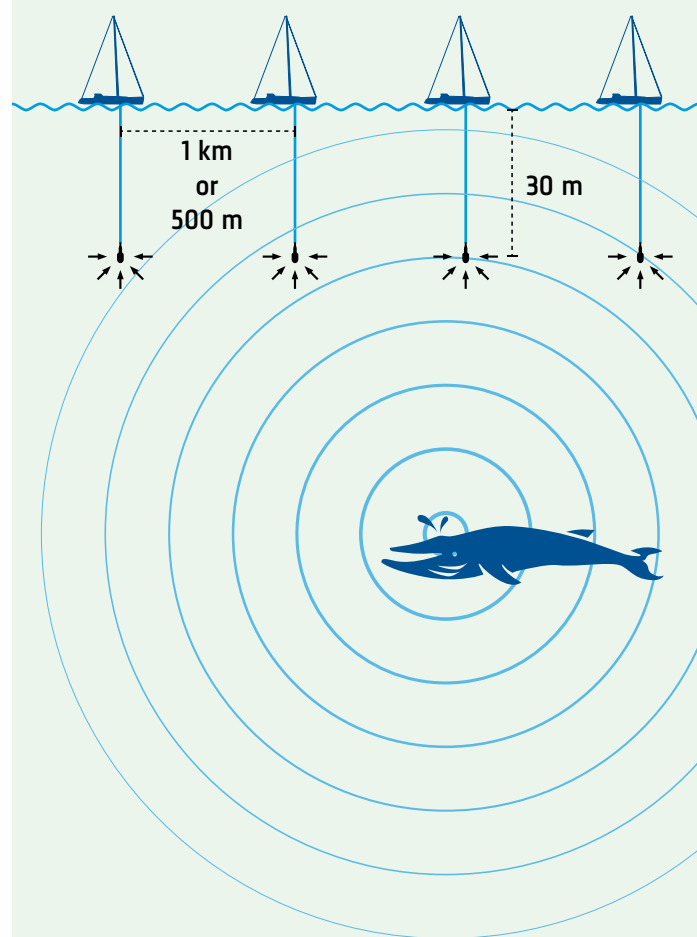
However, even with the most meticulous planning, the success of the project was still at the mercy of forces beyond anyone's control. Since 2008, acoustic tagging and photo identification research work had confirmed that blue whales go to Skjálfandy Bay in June but there were no guarantees at all that they would return. It was also essential for the weather to be on their side. To get accurate recordings, the team needed calm seas and no wind; otherwise the subsequent waves and 'cable strumming' noise from the hydrophone cables would cause additional noise interference that would render the results useless.

Blue whales communicate via low frequencies (for a 15 Hz signal the wavelength is around 100 m) so a special method was also needed to locate exactly where the whales were. This was achieved using all four boats 500 m or 1 km apart in a line, with the hydrophones at a depth of 30 m. Then, once a whale was sighted, all that was needed was for the boats to stay in place and record the whale sounds and locations for approximately one hour at a time.

#### THE BEST POSSIBLE RESULTS

Aside from a few days of bad weather and some minor technical glitches, everything went as planned and the team managed to gather over 100 whale calls and a wealth of good positional data. Now, all that is left for this part of the project is to analyse the recordings, which is done on shore and will be completed within the next six months. ►

## LOW FREQUENCY LOCALIZATION METHOD



The frequencies of interest are as low as 10 – 20 Hz. In order to achieve any bearing (directivity) the distance between the hydrophones must be far enough apart to secure a certain minimum angle

Using four hydrophones in a large hydrophone array, the distance between the hydrophones was either 1 km or 500 m and they were at a depth of 30 m

## DIVING DEEPER INTO THE SOUND OF BLUE WHALES

Of course, the project doesn't end there and the second part – examining how ship noises mask and affect the whales' communication – is still to be done. Nevertheless, the data so far has already revealed some interesting results about the nature of these fascinating sea mammals, how they communicate, what frequencies they use, why and when.

These findings are, in turn, giving rise to a host of new questions, such as whether or not blue whales can change frequencies when calling, if there is any inter-species communication and if this methodology can be used to study other types of whales (for example, the little-studied Baleen whale). Never one to sit still, Dr Rasmussen is already planning to apply for financial backing for a range of other projects next year to look more closely into these and other areas.

For a project like this to have gone so smoothly so far, with so many extraneous variables to manage and overcome, is a huge achievement. Now, thanks to Dr Rasmussen and her tireless team, we are not only forming a far deeper understanding of blue whales, but hopefully these results will be a catalyst for new dialogue with authorities about shipping lane regulations and what more we can do to safeguard the whales' natural habitat.

And if all this leads to more and better ways of protecting this enormous, endangered and enigmatic sea creature, then this is the best possible result for us all. ■

### LISTEN TO A BLUE WHALE



Mostly  
infrasonic  
calls (0:56)



Non-song  
communicative  
calls (1:02)



Geographically (California)  
distinctive song of the  
blue whale. Sea lion barks  
in background (1:44)

## RECORDING SOUND AT SEA

Hydrophone Type 8106 has a built-in amplifier which gives a signal suitable for transmission over long cables. It is usable down to 1000 m ocean depth. ■

### SOLID STATE RECORDING

The Brüel & Kjær NOTAR recorder allows underwater sound recording for hours at a time – even without the need of a laptop. NOTAR is a small and rugged solid state recorder that has no shock-sensitive moving parts (unlike tape recorders or PC hard drives) which means it can be used in locations where no PC-based recorder can operate. ■



## A NEW WHITE PAPER FROM THE STACKS

# SIMULATION OF REALISTIC BACKGROUND NOISE USING MULTIPLE LOUDSPEAKERS

Whether walking down a street, or multi-tasking with our phone on 'speaker', we expect clear voice transmission. Sophisticated signal processing enhances our speech above background noise, but which method is best to test this capability?

To pinpoint our voices in noisy environments, modern telecommunication devices use multiple microphones and algorithms to process the signals. Factors like the time difference between the signals allow the location of their origin to be triangulated. As designers continually refine these algorithms, evaluating them requires more realistic, spatially accurate reproduction of background noise, to create reflective test conditions.

Different methods exist for testing performance in background noise, using multiple loudspeakers that preserve the spatial sound field. They are the four-loudspeaker-based method as described in ETSI EG 202 396-1, higher-order ambisonics (HOA), and matrix inversion methods.

HOA optimizes the reproduced sound at a sweet spot in the centre of the array with the radius determined by a spherical microphone array, which is used to derive the spherical harmonics decomposition of the reference sound. The four-loudspeaker-based method equalizes the magnitude response at the ears of a head and torso simulator (HATS) for sound reproduction, while the matrix inversion method optimizes the local sound field around a few target positions.

This white paper documents an investigation contrasting the following five methods for the reproduction of background noise:

- 1) ETSI EG 202 396-1
- 2) Higher-order ambisonics
- 3) Matrix inversion method
- 4) ETSI TS 103 224
- 5) Matrix inversion method optimized for a specific device

For each method, the quality of the reproduced sound was evaluated both objectively and subjectively, at microphones close to a device under test and at the ears of the HATS. A listening experiment evaluated the perceived quality of the sounds at points where telecommunication devices would be placed, around the head. ■

## SEE MORE

Read the full white paper at

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





# UPLIFTING SOUND QUALITY



## UNDERSTANDING THE 'CROWN SOUND'

Our central aim was to find new and more efficient ways to improve our development process. This represented a perfect opportunity to adopt the latest methods and state-of-the-art tools within NVH and sound quality. ■



BY: RON ZIEGLER

Director – Compliance and  
Test Engineering  
Crown Equipment Corporation

Today, sound is being recognized more and more as an important parameter when defining product quality. With this in focus, Crown Equipment Corporation decided to explore how improving the sound of their forklift trucks could create a better product and, in turn, a more satisfying user experience. The result was better than they could have hoped for, with their newfound knowledge and skills leading to a more efficient and valuable development process – and the first of many new product designs.

Since our entry into the material handling industry in the 1960s, Crown has become known for exceptional product design, engineering and manufacturing of an award-winning line of forklift trucks. However, in an industry facing product parity, we understand all too well how important it is for our products to have as many 'quality defining' features as possible in order to maintain our leading market position and support our sales processes.

Even though our trucks have always had a reputation for delivering market-leading functionality and performance, at Crown we have also focused on maintaining the highest quality when it comes to ergonomic features, such as comfort, style and, naturally, noise – one particular area that we wanted to explore more deeply to augment our product development process.

The decision was therefore made to examine sound quality in detail. On one hand, this valuable knowledge would

help us to understand the factors that influence its perception; and on the other, it would also equip us with the right skills to engineer an even higher class of product. The big question was, how?

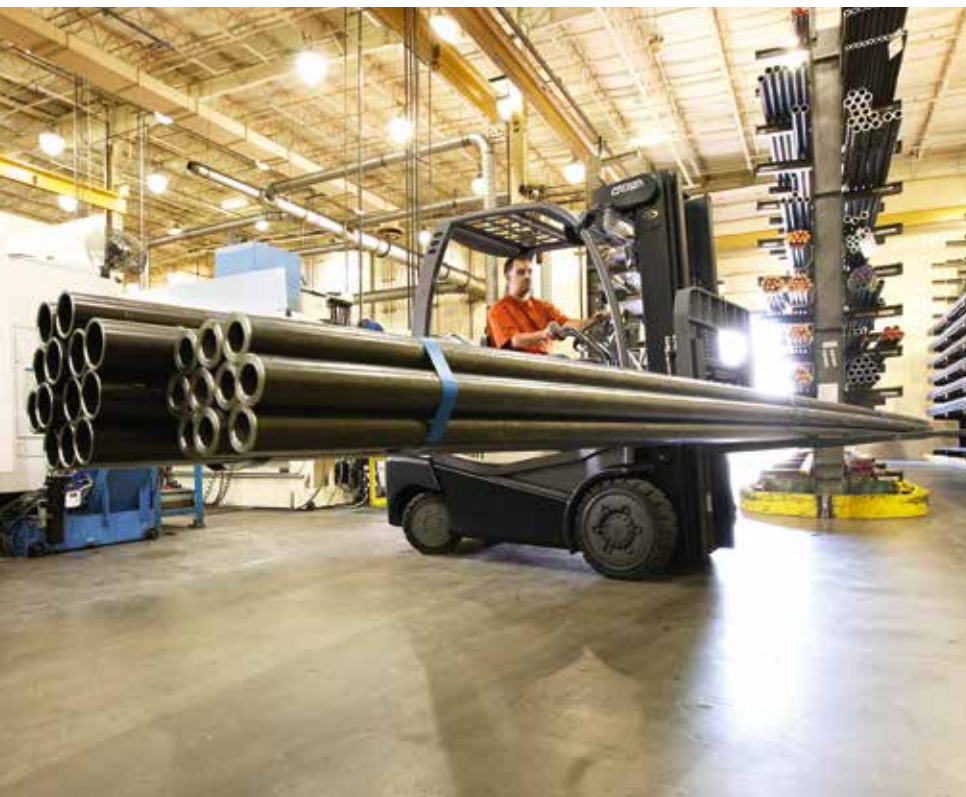
#### DEFINING PREFERENCE

In consultation with Brüel & Kjær, it quickly became clear that in order to create the 'right' forklift truck operating sound, we first needed to know what that sound actually was. To help clarify this, we brought on board Sound Answers, a sound and vibration consultancy company, who could help us advance our process and analysis abilities, and participate in design reviews based upon the analysis performed.

Sound Answers introduced the concept of a 'Jury Study' as one of the most effective ways of defining sound preference. This type of exercise involves a qualitative jury of end users who rate the sound of a particular class of motorized vehicles in order of preference. ►



## UPLIFTING SOUND QUALITY



## VIRTUAL PROTOTYPES

3D CAE models, like those created by Actran, enable engineers to validate and optimize designs using virtual prototypes. They are exceptionally valuable to reduce development time and cost by helping engineers to define and apply more precise results earlier in the design cycle. ■



Crown  
TSP 7000

These ratings are then correlated to highly specific sound quality metrics, such as sharpness, loudness and modulation strength.

To collect the required data and generate the most conclusive results, Crown worked with Sound Answers to assemble two Jury Studies; one in the US and another in Germany. The juries consisted of managers and truck operators who were asked to rate a series of sounds from our own and our competitors' equipment, which had been carefully recorded to eliminate any weighting or bias.

### MEASURING PREFERENCE

The Jury Study proved to be very productive and enabled us to understand users' sound preferences in more detail. In general, the results showed that people preferred forklift truck sounds to have a moderate level of low-frequency noise and be free of both high-pitched noises and excess modulation. The results also enabled us to pin down a specific combination that was the 'preferred sound'. This could then be used as a benchmark for developing other products.

This led to several interesting conclusions. It enabled us to build an immediate ranking of how the recorded Crown products were judged against our competitors' and to identify key opportunities, either for improvement or where we were already performing better. In addition to the recorded sounds, modified or synthesized sounds were included in the evaluation to help identify the dominant drive motor sounds that people preferred. Most interestingly – and usefully – these results enabled us to create a 'Sound Quality Preference Equation', a mathematical formula that could be used to



"I SEE A GROWING TREND TOWARD STRICTER MARKET REGULATION OF NOISE AND VIBRATION EXPOSURE GLOBALLY, PARTICULARLY IN THE EU AND INCREASINGLY IN THE US."

RON ZIEGLER

accurately define the objective metrics of our ideal forklift truck sound (known as the Sound Target).

This formula would help us to evaluate any of our trucks' sound against our competitors', reliably predict the impact of alternate designs and communicate these clearly to our internal engineering teams.

In short, the equation would enable us to predict, measure and make precise adjustments to the sound of all future product designs much earlier in the development phase and, crucially, based on actual user preference.

#### PUTTING THEORY INTO REALITY

With this initial goal reached, we were then able to leverage what we had learned about defining, measuring and analyzing sound quality and use it to support the development of a new sound quality model design; specifically, the exhaust system of our new line of LP Gas forklift trucks.

At this stage we were confident in our ability to put these new techniques into practice, with Brüel & Kjær and Sound Answers standing by to help us optimize the final design. Immediately, we were able to make full use of our new knowledge and tools; by running data through our Sound Quality Preference Equation, we could rank and analyze competitor products and set clear parameters for our own product's sound quality target and design.

Then, in order to correlate, visualize and audition the test data, a 3D CAE model of the new exhaust system design was built using MSC Actran® acoustics software. ►



Both indoors and out, sound can be an important customer consideration



## UPLIFTING SOUND QUALITY



In combination with Brüel & Kjær's NVH post-processing software, Actran was able to simulate a working 3D model of our exhaust system that could display the mechanical, acoustic and aeroacoustic characteristics of the system, along with its internal gas flow.

This enabled us to accurately predict and listen to how the final product would sound and behave under a wide variety of conditions.

Once we were satisfied with the CAE model design, we were able to move forward with a physical prototype. This allowed us to correlate the test results from the virtual and physical model and refine the design to bring the exhaust noise even closer to our Target Sound. As an important part of this, Brüel & Kjær's Low Frequency Sound Source tool was used to measure the transmission loss, which revealed how close our virtual model was to its physical counterpart. All this data could be correlated back to the Actran model to continue improving and optimizing the sound and, each time the model was updated, the results could be run through the Sound Quality Preference Equation to determine their impact.

A final prototype was then built using the improved design from the updated Actran CAE model. Once it had been installed on a forklift truck, the entire project team, including those from Crown, Brüel & Kjær, Sound Answers and MSC Software, each reviewed its performance in person for any final refinements. The unanimous decision was that the new exhaust system was a significant improvement over the previous design; an opinion that has since been widely affirmed across all our engineering teams.



TOGETHER WITH SOUND ANSWERS, WE HELPED CROWN TO DETERMINE WHERE THEY WANTED TO BE AND, BY IDENTIFYING THEIR TARGETS AND EQUIPPING THEM WITH THE RIGHT KNOWLEDGE AND SKILLS, HOW TO GET THERE."

GARY NEWTON, REGIONAL MANAGER,  
BRÜEL & KJÆR

#### A CROWNING ACHIEVEMENT

All of us at Crown have greatly valued Brüel & Kjær's and Sound Answers' roles in helping us to gain a firm understanding of how sound quality plays a vital part in product development – and how best to achieve it.

The entire exercise has had a major influence on how we conduct our development processes and now we are continuing to further develop our strong capabilities in acoustic modelling (along with other CAE tools). Previously, much of the important testing, evaluation and refinement phases were weighted to the end of project. Now, these can be conducted far more upstream, greatly shortening the development time, reducing the need for additional design build test iterations and thereby significantly lowering development costs.

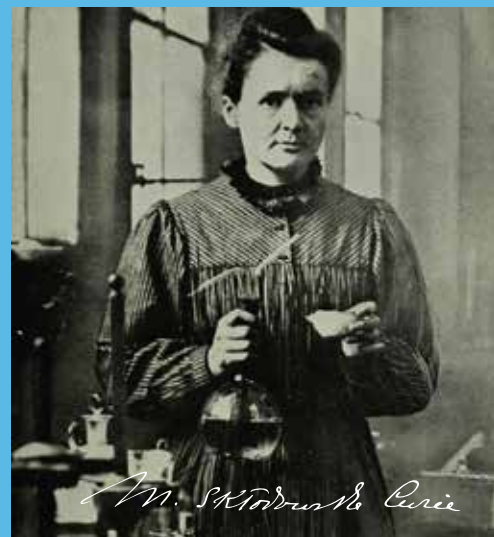
More importantly, this has enabled us to move from what was primarily a knowledge-based approach to one built

on actual metrics. The data captured and results generated enable a far more efficient and effective development process where new learning can be transferred from one project to the next. As a result, we are now well on our way to a point where sound quality methods and acoustic modelling will be the principal means used to specify and validate noise requirements.

These methods and tools also have broad application in many areas. We are conducting several projects aimed at reducing overall vehicle noise and vibration which will ultimately reduce operator exposure to noise and greatly enhance comfort and usability.

Crown's vertically integrated processes provide a level of control and consistency that brings unsurpassed results for our customers. And today, with this invaluable new understanding, we are now equipped to lift those results even higher. ■

## WHO SAYS WHAT?



"BE LESS CURIOUS ABOUT PEOPLE AND MORE CURIOUS ABOUT IDEAS."

MARIE CURIE (1867 – 1934)

Marie Skłodowska Curie was a Polish born physicist and chemist who conducted pioneering research on radioactivity. She was the first woman to win a Nobel Prize, the first person to win it twice, and the only person to win it twice in multiple sciences. She was also the first woman to become a professor at the University of Paris.

An increasing number of women are making their mark in the traditionally male-dominated fields of science, physics and engineering. On pages 16 – 21 you can read about five individuals whose expertise and way into the world of sound and vibration are very diverse. However, they have one thing in common. They are all women. ■



EXPERT PROFILE

# THE CONDUCTOR'S POINT OF VIEW



## CHESKY RECORDS

A specialist 'audiophile' record label focusing on high-definition recordings of authentic music captured intact, in atmospheric buildings. A single-point perspective records music as a person hears it, without later post-processing to balance it, mix it, or add artificial effects. You can try an HD record from [www.hdtracks.com](http://www.hdtracks.com) and get 20% off with this offer code: **BKCHESKY20** ■

"I WANT YOU TO HEAR THE ROSIN ON THE BOW, I WANT YOU TO HEAR THE PEOPLE BREATHING. I WANT YOU TO HEAR THAT WOODINESS OF THE VIOLIN."

DAVID CHESKY

At 58, David Chesky is a composer and musician whose commitment to sound is fanatic. After growing up among the Latin sounds of Miami, he moved to New York and found himself conducting orchestras in studios for films. His insights led him to set up a record label, and many Grammy award nominations later he's leading the audiophile world with 3D binaural records and a secret technique perfected in churches and jazz clubs.

#### Why do you do what you do?

Because most people get their art through an electronic medium, we want to really put people inside that virtual space. Most people don't live a block from a concert hall in a big city. So if you're living in the country and you can't go to the concert hall, we can take you there.

#### What is unique about your recordings?

We only record in real spaces: churches, concert halls, jazz clubs. Some pop musicians like Madonna create their album in a studio, in a mixing board. But our process is taking a really good photograph. We put real musicians in a real space and try to capture that moment. And because we don't add anything artificial like echo, it has to be a beautiful, great-sounding space.

#### How important is place to your own music compositions?

Art has to reflect time and culture, and I like to use the rhythms of the street. I don't live in the mountains, up in the Alps or by the seaside. I live in the middle of New York City, where it is fast-paced and hectic. So my music is very jarring, it's very rhythmic, it's very exciting – because New York is like that. That is what evolved naturally, because I come from the world of jazz.

#### Have your views changed over time?

When I first came to New York from Miami, I liked heavy metal. I guess it's just part of being a kid. My kids like Katie Perry and Taylor Swift. But when you grow up you change – it's a natural evolution. If you had told me I'd be writing operas and symphonies, I'd have told you that you were crazy!

#### What did you first do when you came to New York?

I played piano in a club. And I was a commercial orchestrator for movies and television. That was it; I made a living as a professional musician.

#### How did you learn about recording audio?

I basically lived in the studio, and got very interested in sound. It was like I was a kid in this big candy store. Every day I'd be conducting the orchestra and hear the playback, and where I stood on the conductor's podium was where the music sounded best. Everything was balanced. Yet, since it was for television and movies there would be like 50 microphones – one on each instrument – and when they mixed them together it never sounded the same.

#### Is that what drove you to set up your own recording company?

Yeah, I thought it would be very interesting to start a label that made music from the conductor's perspective. The great pianist Earl Wild was my music teacher. His albums had been issued on a budget label, and the pressings were not that good. When I heard the master tape, the sound was stunning, spectacular for the day. That's when my brother and I began to re-issue his old recordings with better definition. Then we did our first jazz record using single-point micing. That's what launched Chesky Records, in 1988.

#### When you started out, did you have the expertise you needed?

We had a lot of knowledge, but nobody had ever done this, so we were always experimenting, learning on the job. Take Lars (David's HATS). I guess he was made to test ... automobiles, or factories or whatever – it's a measuring microphone – but we found it so good that we use it for music. It's a non-stop learning process. And you can never feel 100 per cent sure of yourself; you're always nervous because you never know if the balance will come out right.

#### With a measurement microphone, you must be getting a better signal than anyone out there

Yeah, we are. We make records for people who are really into music, wanna hear every detail. And we use your mic because it gives us that. It reaches out and gives us every last ounce of resolution and tone and purity we can get. But you have to learn how to use it, there are some tricks to using the mic for music. But they're the recipe that we don't give out. They're our secret sauce! ►



## THE CONDUCTOR'S POINT OF VIEW



Chesky Records  
Binaural+ recording  
technique explained



Experience 3D  
audio on your  
headphones

### How critical is capturing tone and ambience?

You pay 10 million dollars for a Stradivarius for its tone. A great jazz musician practices his whole life to get a great tone out of his saxophone. Anyone can pick up a score and read it, but the tone is the poetry of the music. And by capturing it, you're able to be a magician in a way, to bring you closer to the experience. We want to bring you as close as we can to that musician. I want you to hear the rosin on the bow, I want you to hear the people breathing. I want you to hear that woodiness of the violin.

### What does the future hold for music recording and playback?

We'll evolve into virtual reality. We'll meld with virtual reality glasses to put us in a virtual space. When my children grow up they could live in Tahiti and stream a concert live from Berlin.

And they're gonna be in the concert hall; they're gonna look around, look up and down, and the music will track them wherever they are. People are gonna look at speakers like we do now at those wind-up gramophones. They're gonna think: this is ridiculous, two little boxes? I'm not in the event. People will want to be immersed in the sound field.

### Do you ever get away from music, or is it always there?

It's always there, but I do sports: I like hiking, and kayak racing and bike riding. When you do music all day it becomes a job and it's stressful. I still listen to music when I come home though – I like to put on my electrostatic speakers and listen to modern classical music. ■



Photo © Alan Nahigian



# THE FAUNA PHILHARMONICS

They howl, thump, bang, chirp and rumble. The sound and vibration repertoire of these animals would indeed make an interesting symphony. Key to their survival, these weird and wonderful creatures use sound and vibration to navigate, hunt, communicate, attract mates and ward off predators.

## CRAB DRUMSTICKS

Crustaceans communicate through vibration. During nocturnal courtship, the male sand fiddler crab uses its oversized claw to drum on the ground luring his mate into his burrow. ▶



## THE FAUNA PHILHARMONICS



Mole cricket

### THE SHOW OFF

The 2 cm long snapping shrimp does not sing, drum, head-bang or howl, but it is probably responsible for the loudest noise produced by any living being. Also known as the pistol shrimp, it stuns prey by snapping its claws together quickly to create a low-pressure bubble that, as it extends out from the claw, reaches speeds of 97 km/h and releases a sound reaching 218 dB. This mini-explosion stuns or even kills the shrimp's dinner. In colonies, the shrimps' noise is enough to hide submarines from sonar detection.



Slow motion pistol shrimp attack hits 4000° C

### SING YOUR HEART OUT

The male coqui frog, a Puerto Rican native, is thought to be the loudest amphibian. It might be tiny, measuring a mere 15 to 80 mm, but this tree frog has a big voice and its calls have been recorded at peaks of 100 dB from a metre away, which is equivalent to the sound of a jackhammer or a chainsaw.



Choruses of male coqui frogs can be heard from dusk until dawn all over Puerto Rica

### CHIRPY CHIRPY CHEEP CHEEP

The tiny male bush cricket 'sings' at frequencies of about 74 kHz by merely rubbing its wings (stridulation). However, the loudest insect is the mole cricket. Standing in its self-built megaphone-shaped burrow, it chirps so loudly that humans can hear it nearly 600 metres away. Microphones placed a metre from a cricket's burrow entrance have recorded peak sound levels of 92 dB – as loud as a lawn mower.

### THE HOWLER

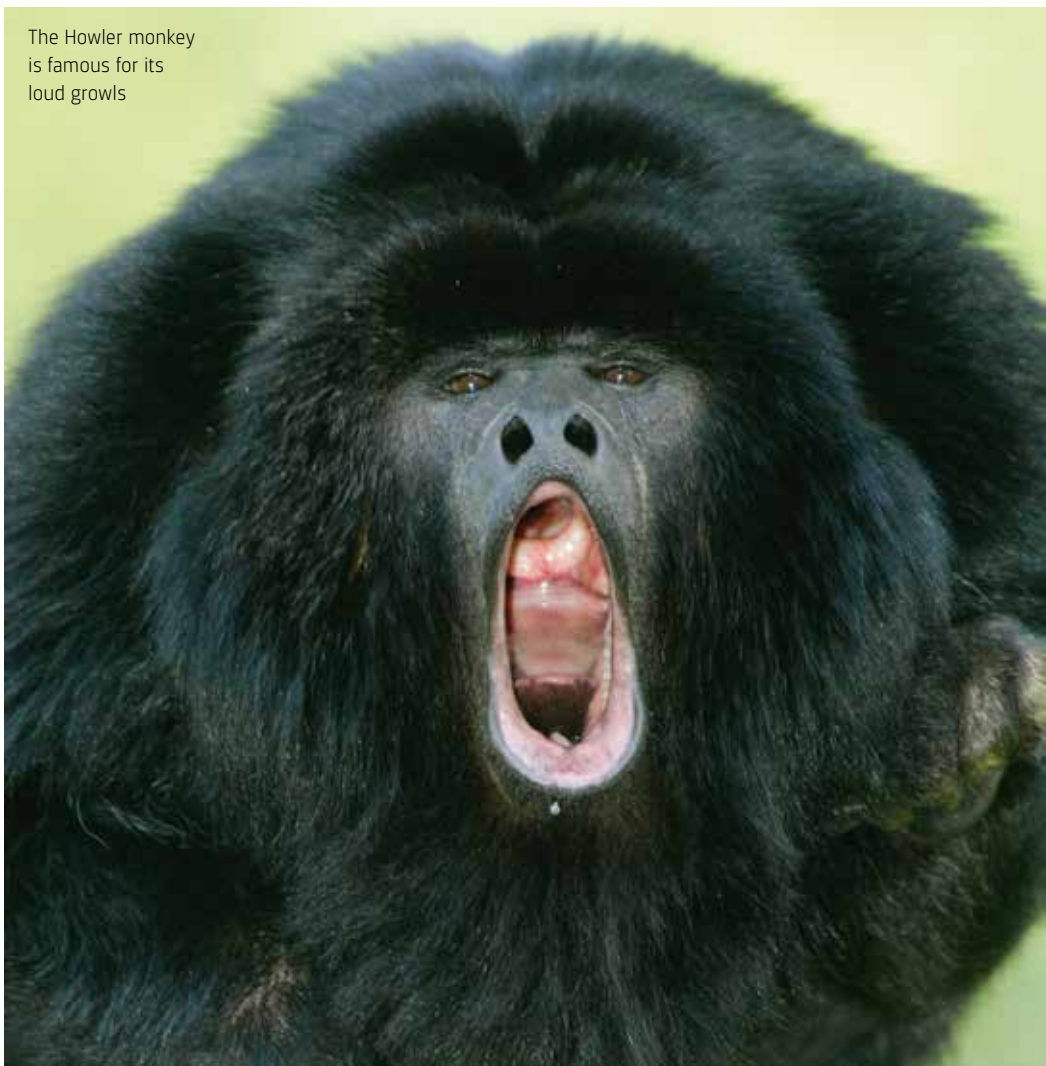
Famous for its loud howls (128 dB), the howler monkey of the South American

rainforests can indeed claim the title of loudest land animal. More of a growl than a howl, the sound can be heard up to 4.8 km away.

### LIVE AND LOUD AT THE CAVERN

Cave-dwelling oilbirds are deafening when gathered in large groups – a colony can contain up to 1000 birds. They use echolocation to navigate in completely dark caves, but, unlike most bats, their calls are well within the range of human hearing – each bird can squawk and click up to 100 dB at close range, making

The Howler monkey is famous for its loud growls





## ALL ABOUT THE BASS

Not only the largest mammal, the blue whale is also the loudest mammal on Earth, with vocalizations that reach 188 dB (a jet reaches only 140 dB). Its low-frequency rumbling sounds –

some below the range of human hearing – have been recorded more than 800 km away. We dive deeper into the sound of blue whales on pages 24 – 30. ■

them the loudest known birds. Bats, on the other hand, seem silent to us, but their calls can reach sound pressure levels greater than those emitted at rock concerts. Using echolocation to find prey, bats emit high-pitched sounds, which, at close range, can exceed 140 dB; a loud rock concert, by comparison, measures 115 to 120 dB – just under the threshold of pain for humans.

### BEAT IT

The male Caribbean white-lipped frog does more than just sing to attract mates. It likes to chirp when sitting with its rear end buried in the mud and its head and front legs just above the ground. With each chirp, its vocal sacs expand and contract, hitting the ground and producing an accompanying vibration. These thumps can be felt 3 to 6 metres away.

### STOMP

Vibrations created by a stomping elephant can travel 32 km through the ground. This social creature also receives messages through its feet – a warning, a greeting, or a “Let’s go”. And at 80 to 90 dB, this is louder than most humans can shout.

### HEAD BANGERS

Signals that rely on hearing and seeing aren’t much use in the dark, underground burrow of a mole rat. However, vibrations travel well through the ground so some species of mole rats, such as the African Demon mole rat, have taken to head banging. In fact, the first mammal documented for vibrational communication was indeed the Middle East blind mole rat, which knocks its head against the walls of its tunnels to signal to its rodent neighbours.



Elephants stomp louder than most humans can shout

### DRUMMING UP A FUSS

If a predator, for example an aardvark, approaches an African termite mound, chains of drumming termite soldiers will head-bang an alarm. Even though they bang their heads on the ground at a rapid 11 times a second, the vibration only travels around 38 cm but fellow termites close by will respond by drumming their heads too. This chain reaction raises the alarm throughout the colony.

### THE FOOT PERCUSSIONIST

Reminiscent of Disney’s Thumper, the solitary and nocturnal banner-tailed kangaroo rat foot-drums to communicate in a number of situations – during courtship, to signal territory and when encountering snakes. This could be to warn its vulnerable young of the approaching predator or simply to alert the snake to the fact that its attempt at an ambush has been foiled. ■



## BRÜEL & KJÆR NEWS

### Speed transducer setup and eliminate errors with Smart Setup



#### SEE MORE

about smart transducer setup at

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

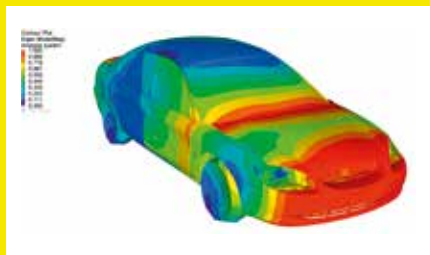
When making vibration measurements, it is often a challenge to link the transducers on the test object with the measurement software. Identifying each transducer and adding information about its alignment is a time-consuming exercise and easy to mix them up.

Smart Setup speeds this process while helping to eliminate errors. With Smart Setup, transducers are equipped with

datamatrix barcodes (much like QR-codes) that can be scanned using the Smart Setup smartphone app. The app has a patented algorithm that automatically detects the orientation of an accelerometer by scanning the code, and can be synchronized with your PULSE Reflex software.

Smart Setup is available for iOS smartphones and will soon be available on Brüel & Kjær transducers. ■

### Altair embeds Brüel & Kjær sound simulation in CAE



Noise, vibration and harshness (NVH) is perceived differently by individuals in a vehicle, so subjective NVH assessments are important to automotive designers. Now, Brüel & Kjær's NVH simulation software is bringing this capability to users of Altair's own 'Hyperworks' software. Automotive designers using Altair Hyperworks CAE software can now choose a module called Insight+ to listen to the sound a vehicle would make if it featured their design. This new Insight+

capability from Brüel & Kjær quickly processes CAE models into detailed sound models and allows designers to listen to them. Insight+ can auralize data from real-world NVH testing as well as allow mixtures of real and virtual data. NVH testing and CAE design have traditionally been separate domains, but are increasingly coming together as more comprehensive simulations are used instead of physical prototypes. Integrating test data and CAE in Insight+ helps unite these separate disciplines. ■

### PULSE 20 is here



The latest release of Brüel & Kjær's data acquisition and analysis platform includes new hardware, software and applications, plus updates and enhancements.

- New **LAN-XI hardware**: bridge and generator modules expand data acquisition capabilities, especially for aerospace and defence industries
- In PULSE Reflex **Structural Measurements**, geometry-guided measure-

ments enrich the platform's fully integrated measurement, analysis and test-FEA capabilities

- **Flyover Moving-source Beamforming** provides a high-resolution acoustic map of aircraft sound sources, using one, simple measurement procedure
- Software updates help testing to **new standards** for telephones and outdoor machinery noise assessment ■

## AIM, SHOOT AND MEASURE WITH THE ACOUSTIC CAMERA

Finding noises in aircraft cabins, cockpits and other areas where sound sources are difficult to locate can be a challenge, since they can come from small, local spots and may only appear at certain times. The new PULSE Reflex Acoustic Camera makes it possible to locate and view transient sound sources using a simple “aim, shoot and measure” procedure. The Acoustic Camera is a complete system for real-time noise source identification and data recording, which makes it easy to identify and measure non-stationary noise events in aircraft, vehicles, cargo bays and many more applications – with minimal training.

The Acoustic Camera includes both hardware and software and is completely portable, with a battery life of up to four hours. Recorded data can be exported for post-processing, where transient sounds can be replayed and speeded up, slowed down and adjusted for frequency, to help analyse them in detail. ■



## Measurement Partner transforms acoustical consulting



For users of sound level meters, Measurement Partner now supports you every step of the way, throughout the sound measurement process. With Wi-Fi capability now included in Brüel & Kjær's sound level meters, taking and storing data is more convenient than ever. Uploading data to Measurement Partner's cloud storage is straightforward, allowing acousticians with Measurement Partner's post-processing software to easily access it.

A new Measurement Partner field app for iOS/Android smartphones controls your sound level meter remotely, preventing users from disturbing the sound field. It also captures GPS position, location photographs and other metadata to document the measurements. Additionally, users can find help in the online Measurement Partner Learning Centre and connect with other users to share tips in the online Measurement Partner Community. ■

## CUSTOMER NEWS

# EUROFIGHTER PROJECT TO MINIMIZE NOISE NEAR AIRPORTS

Airbus Defence and Space needs to be certain that the Eurofighter jet generates minimal disturbance to local communities. To this end, the company has entered into an agreement with Brüel & Kjær, which will provide data acquisition equipment, software and specialist knowledge to create a model of the fighter jet's acoustic emissions during take off and landing. This model will support accurate estimation of the noise radiated in all directions for a wide variety of flight configurations and operating conditions. Airbus Defence and Space will use this data to update and validate their Eurofighter noise models, and will subsequently incorporate this information into the software model they use to compute noise-optimized take-off and landing profiles. ■



## Bobcat's structural analysis gets its machines purring



Bobcat is the leading provider of compact equipment for many industries, including construction, agriculture, government and mining. The company's compact track loader has become increasingly popular, but presented comfort challenges for operators, due to the vibration from its metal tracks. To get a fuller picture of vibration characteristics, Bobcat wanted to perform broader modal evaluations on larger components and whole vehicles.

Sound Answers, a consulting partner of Brüel & Kjær, helped to provide a solution with a 40-channel data acquisition and analysis system, accelerometers and PULSE

Reflex post-processing software. The team provided training to Bobcat's engineers, demonstrating the system in a project to characterize a T630 compact track loader. With the new system, Bobcat can now test its vehicles in a completely assembled condition, with the loader in a single orientation.

Bobcat engineer Patrick Stahl says: "Being able to test an entire machine has been helpful to determine the critical components. The project gave us the beginning that we needed, providing the spark that began the investigations we are now continuing on our own." ■



## Mecanizados Escribano complete dynamic testing capabilities

Mecanizados Escribano, based in Madrid, specializes in producing and analyzing complex parts for the aerospace and defence industries. When the company needed a high-end vibration test system to carry out sine, random and classic shock testing on the remote weapon station 'Guardian', it turned to Brüel & Kjær for help.

After installing an LDS V875 shaker system, Mecanizados Escribano was able to successfully carry out their tests on the military equipment. The shaker met their requirements, having been specially designed

for testing large, heavy equipment up to 600 kilos, as well as having low installation and running costs. ■



## Austin successfully manages noise of major entertainment events

Known as the 'live music capital of the world', Austin, Texas is home to hundreds of entertainment venues and thousands of musicians who keep them rocking. While the music is appreciated by its fans, the residents of the downtown area were starting to complain about the noise.

The city wants to capitalize on its reputation as a music capital, but it also needed to provide low-cost, effective noise monitoring to keep the noise complaints at bay.

Austin subscribed to Noise Sentinel – On Demand to monitor noise at its 'Fun Fun Fun Fest'. The monitoring was a success, with the city receiving immediate SMS alerts when noise levels got too high, so they could react to them quickly. Austin has now expanded its use of the service to numerous other venues in the city. ■



## Hepworth Acoustics creates a noise map for England

In 2015, the huge project of creating a noise map for an entire country fell to Hepworth Acoustics, an English consultancy specializing in acoustics, noise and vibration.

Using Brüel & Kjær's Predictor-LimA noise mapping software, Hepworth mapped thousands of miles of roads and railways, and 65 cities, using approximately 950 million assessment locations throughout the country.

The result was the world's largest noise map, created on time and on budget, and in compliance with the EU directive on environmental noise. "Without Predictor-LimA, we would not have bid for the project," says Peter Hepworth. ■



# FIVE QUESTIONS FOR MARTY

Senior Sales Engineer and Telecom Audio Solution Manager [Marty Alexander](#) hails from Brooklyn, NY. He joined Brüel & Kjær at the age of 32, having been a noise and vibration consultant until then. Passions include classic rock and old British sports cars. He lives with his wife, Gabriela, and their neurotic dog, Chance.

MOTTO:

**“SOMETIMES ALL IT  
TAKES IS HARD WORK  
AND A SENSE OF HUMOR”**

#### What are the challenges ahead?

In the digital world, solutions that were once an art to develop are now more easily achieved. However, knowledge of the underlying principles of the noise or vibration issues being addressed is necessary to develop the right solution.

#### What drives you in your work?

My motivation to help my colleagues and customers. I'm always questioning whether I could try harder to find the best solution to a problem.

#### What is the best advice you've been given?

My first manager shared some words of wisdom, including "people hate change" and "sell yourself, sell your company, then sell the product".

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

The ability to travel in time, to revisit the world I remember in my youth and see if it really was as I remember it. The ability to fly (without the hassle of airport security).

#### What's your favourite saying?

"It's the cable". I have found that, over the years, most issues with instrumentation systems can be traced to a bad cable. I have become famous with colleagues and customers alike who have found that, more often than not, I am right.

