CASE STUDY

GE Healthcare Systems

Waukesha, Wisconsin, USA
Medical
PULSE™ Platform, Transducers, Shakers, Service

GE Healthcare Systems is one of GE Healthcare's six primary units. Its industry-leading products are used for medical imaging and diagnostic purposes allowing clinicians to see inside the human body more clearly. Technologies include Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Positron Emission Tomography (PET) covering a wide range of medical requirements. These provide health care workers with the solutions to enhance the efficiency of medical care. Brüel & Kjær applications are used almost exclusively for product R&D, product life cycle testing, durability, reliability and fatigue testing purposes.

Photos courtesy of GE Healthcare Global Diagnostic Imaging

Brüel & Kjær

GE Healthcare

With Headquarters in Little Chalfont, Buckinghamshire, UK, GE Healthcare is a $17 billion unit of General Electric Company and employs more than 46000 people committed to serving healthcare professionals and their patients in more than 100 countries. GE Healthcare has a range of products and services that include medical imaging and information technologies, medical diagnostics, patient monitoring systems, performance improvement, drug discovery, and biopharmaceutical manufacturing technologies and enable clinicians around the world to find new ways to predict, diagnose, inform and treat disease so their patients can live their lives to the fullest.

Innovative Diagnostic Solutions

Fig. 1
GE Healthcare Systems Headquarters in Waukesha, Wisconsin, USA

GE Healthcare Systems has its headquarters in Waukesha (near Milwaukee), Wisconsin, USA and is one of GE Healthcare's six primary units – the other five being Life Sciences, Medical Diagnostics, Healthcare IT, Surgery and Performance Solutions. The technologies and methods used by the Healthcare Systems unit include X-ray, digital mammography, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Molecular Imaging, ultrasound, and Positron Emission Tomography (PET) and cover a wide range of medical requirements.

GE Healthcare's products provide health care workers with the tools to enhance the efficiency of medical care. Some are quite simple while others are complex and combine different technologies. However, they are all crucial for prevention, diagnosis and treatment of illness and disease. The positive impact that CT, PET and MRI technologies are having on, for example, cardiac, neurological and cancer diagnosis and care is indisputable. In today's health care environment, the focus is very much on early detection of disease states – in both diagnosis and treatment. As a result, diagnostic tools are becoming increasingly more sophisticated with emphasis on making new procedures less invasive and less risky for patients.

Trusted, Reliable and Tested Technologies

Fig. 2
Life cycle testing, durability, reliability and fatigue testing are all carried out using Brüel & Kjær products almost exclusively

For GE Healthcare, innovation goes hand in hand with empathy. From design to final product and beyond, it's all about understanding the end-user – the people who will interact with the equipment – technologists, clinicians and patients. High product quality, safety and comfort are, therefore, huge driving forces behind the company.

With a degree in Electronics, Advanced Mechanical Engineering Lab Manager and Test Engineer, Scott T. Mansell has been running the vibration and environmental test laboratory at GE Healthcare for 33 years of its 35-year existence and performs sound and vibration testing and analysis on GE Healthcare's medical products, systems and components. Life cycle testing, durability, reliability and fatigue testing are all carried out in Scott's laboratories and Brüel & Kjær solutions are used almost exclusively for testing purposes. Most recently, a 24 × 24 × 16 ft acoustic room, mounted on specially designed floor isolators and with a 30 dB(A) background noise level, was established specifically for sound power and sound quality analysis. Scott says, "In the near future we intend to buy an array system for use in our new acoustic room for noise source identification".

Brüel & Kjær and GE Healthcare's relationship goes back many years. Scott says, "We have tried many products in the past but, since 1977, we have almost always used Brüel & Kjær microphones, accelerometers and charge amplifiers." He continues, "When we looked around for data acquisition analyzers all those years ago, we decided that Brüel & Kjær's Dual-channel Signal Analyzer Type 2032 was the way ahead, so we bought four of them." He adds, "The Miniature DeltaTron® TEDS Accelerometer Type 4507-B is the general purpose accelerometer we use here at GE Healthcare, and apart from a couple of

other products along the way we have exclusively used PULSE, although we were initially a little wary about moving onto a PC platform. And, incidentally, our service contract these days is 100% Brüel & Kjær". The first PULSE system was purchased in 2000 and GE Healthcare globally now has more than 20.

The Acoustic Challenges

Getting the Noise Out of MRI

Fig. 3
An MRI unit is a large cylindrical tube surrounded by a circular magnet. The patient lies on a table that slides into the centre of the magnet

MRI is a non-invasive test that produces very clear pictures, or images, of the human body without the use of X-rays. MRI uses a large magnet, radio waves and a computer to produce these images. An MRI unit is a large cylindrical tube surrounded by a circular magnet. The patient lies on a table that slides into the centre of the magnet. As the MRI scanner begins, it makes thumping and humming sounds that last for several minutes. This is caused by the switching on and off of field gradients resulting in vibration that produces loud noises. The sound intensity can reach very significant levels. Understandably, this can make the MRI experience a very frightening one for patients and add to their overall sense of claustrophobia and anxiety. In fact, ear protection is required for anyone inside an MRI scanner room. An average MRI examination lasts around an hour with each scan lasting between two and seven minutes.

Fig. 4
Senior Mechanical Engineer, Dan Nemecek (left) and Scott T. Mansell, Advanced Mechanical Engineering Lab Manager and Test Engineer (right) standing in front of one of GE Healthcare's mobile engineering units

One of the challenges for Scott and his team is to find a solution that could drastically cut the noise level and improve the overall MRI experience for patients. Dan Nemecek works closely with Scott and is Senior Mechanical Engineer at GE Healthcare. He has a degree in Mechanical Engineering from the University of Milwaukee and has been at the company for 10 years. He and Scott carry out 90% of the sound and vibration testing. Dan says, "We make sound and vibration tests on an MRI unit's components and sub-assemblies. This is to help us to understand the noise before assembly". There are IEC standards for MRI systems and GE Healthcare meet the specified noise levels outlined. Dan continues, "The standards are static, but despite this, the specifications are getting tighter for us as customers, hospitals and industrial design groups demand quieter devices and constantly try to get the noise out of MRI". He adds, "We don't do benchmarking at GE Healthcare but we know that sound quality is a competitive parameter and of ever-increasing importance to our customers. We are actively looking for sound quality solutions for our products and the future might include jury testing". "There is no doubt," he concludes, "that a better sound would be a major selling point for operators".

Vibration – Shaking Up Components and Systems

Vibration testing is vitally important for all GE Healthcare's products. For example, can components and sub-systems survive being moved around or transported from place to place? How do they cope in different temperature and humidity conditions, etc.?

Using the PULSE platform, GE Healthcare performs CPB, FFT, octave analysis and modal analysis on its products in order to obtain a mathematical model of their dynamic behaviour. Understanding and optimising the inherent dynamic behaviour not only leads to stronger and safer products, but also leads to more human comfort and better product performance. The tests range from simple mobility tests with impact hammers to multi-shaker testing using a large number of response accelerometers. PULSE LabShop is used for the modal data acquisition as well as for real-time measurements. PULSE Reflex is used for post-processing time data. Scott says, "Reflex is particularly intuitive and easy to use".

GE Healthcare is currently in the process of migrating from Test for I-deas to the PULSE Reflex Core and Modal platform. And Scott foresees the need for ODS (Operating Deflection Shapes) analysis in the future to determine the vibration patterns of the devices under operating conditions.

Fig. 5
A GE Healthcare CT scanner

Life cycle tests simulate a product's expected lifetime in a compressed time frame. Some of these tests are already defined in standards and universally accepted within the industry. GE Healthcare's products and sub-components have, on average, a 10-year life expectancy. To represent this accurately, they carry out tests that accelerate product use and determine how different components and materials stand up. Scott says, "Our products typically undergo between 300 and 400 hours of continuous testing. We have a number of shakers, including four from Brüel & Kjær, and complete systems – for example CT tables – can be placed on the table of our largest shaker. We also carry out long-term vibration and humidity testing combining a climatic chamber with our vibration shakers".

Life cycle testing allows GE Healthcare to detect problems and defects quickly, allowing time for correction or enabling product design and specifications to be changed.

Innovative Technology with a Purpose

Fig. 6
The R&D Centre, Bangalore, India supports GE Healthcare's vision "to continuously develop innovations focused on reducing costs, increasing access and improving quality and efficiency around the world"

Although the majority of the world's population is denied adequate access to appropriate medical devices within their health systems, it is encouraging to know that the situation is slowly improving. The adoption of, for example, MR devices worldwide is encouraging. At the moment however, the average number of MR scanners per million people in the US is 25, while in China and India it is less than one per million people. So there is a huge need and business potential.

With offices around the world, GE Healthcare has major regional operations in France, Hungary, Japan, Finland and India. In fact, GE Healthcare's largest R&D centre is in Bangalore, India, and was built at a cost of $50 million. An important part of Scott's work involves travelling and visiting customers or other GE Healthcare facilities. From Saudi Arabia to Colombia to India, Scott travels the world with his laptop and LAN-XI data acquisition system performing a multitude of different tasks – ranging from troubleshooting at customer sites, to teaching and training GE Healthcare's Indian staff how to use PULSE, helping set up a laboratory in Bangalore or performing vibration testing using shakers in Beijing, China.

He is often asked for advice and recommendations and has inspired others to use the PULSE/LAN-XI platform. All this is part of GE Healthcare's commitment to taking the benefits of new technologies and methods to emerging markets where healthcare systems are still developing. And for Scott, it allows him to support all modalities, customers, and facilities worldwide. As he puts it, "Every day is different. I have the same job, but no two days or two jobs are quite the same".

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