



EPIQ

a new era in premium ultrasound

Best known from ante-natal scans for expectant mothers and heart exams, ultrasound enables doctors to see within the body without radiation. Aiming to make ultrasound scanning easier and quicker, Philips marked a new milestone for ultrasound technology with the launch of the EPIQ in late 2013. With the development of the new *n*SIGHT Imaging architecture, the usual trade-off between the quality of an ultrasound image and the recording of movement has been overcome. This major advance enables EPIQ to deliver both improved resolution and frame rate – resulting in incredibly sharp 3D moving images.

As well as offering higher image quality and more quantitative support in making diagnoses, equal attention has been paid to ensuring EPIQ is easy and intuitive to use, whatever system clinicians have used before. And addressing the issue that ultrasound can be heavy and straining for the people who use it regularly, the EPIQ system has been designed to be 'light as a feather and solid as a rock'. Creating the next generation of ultrasound systems was a monumental challenge that took the skills of hundreds of people from around the globe, but the resulting EPIQ systems are worthy of their name!

PHILIPS

The inside view

Many of us know of ultrasound from applications like ante-natal scans for expectant mothers or heart exams. It's a safe way of seeing inside the body by sending out high-frequency sound waves, which reflect (echo) off internal structures. These echoes are then transformed into images on a screen for doctors to analyse.

However, performing ultrasound exams is a skilled task, and the quality and consistency of results depends on the individual operator's level of technical expertise. Perhaps more surprisingly, ultrasound takes a big toll on sonographers, the specialists who operate the machines. They spend entire working days on their feet performing repetitive hand and wrist movements, and bending and twisting to reach the right position on patients. One study found that over 80% of sonographers experience work-related pain, and 20% develop injuries that end their career.¹

Hearing the customer

So when Philips started thinking about a next-generation premium system, one of the key objectives was to fully understand the needs of medical professionals and patients. The team went into hospitals around the world and Philips clinical specialists and ergonomics experts observed real exams and clinical workflows. They studied data from existing systems that showed which controls were most commonly used, and the patterns of hand movements.

"Customers talked to us about all kinds of issues. They wanted even higher image quality and more quantitative support in making diagnoses. They asked for systems that could scan heavier patients, and make scanning easier and quicker for everyone. They asked for ultrasound machines that were quieter and lighter to move around," says Dan Schmiesing, R&D Director for the EPIQ project.

It was a big wish list! But Philips was determined to create a platform that would revolutionize ultrasound for years to come. "We wanted to create a system with the performance, quality and design that customers would love to use," adds Dan.

Insight into nSIGHT

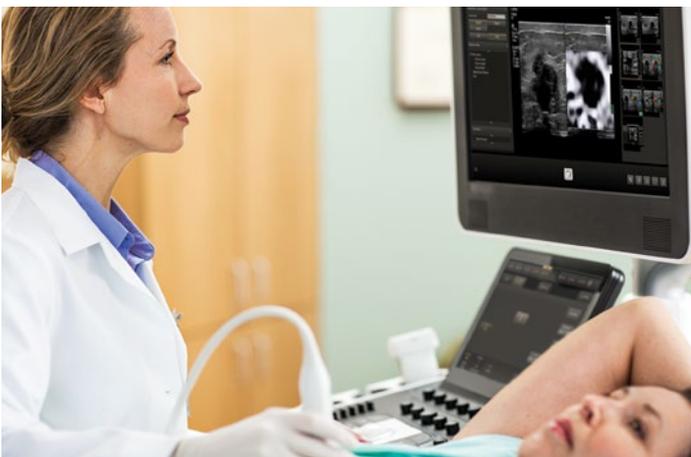
At the heart of any ultrasound system are the hardware and software that transmit and receive the sound waves, and transform them into images. Philips has pioneered many advances in this field, including real-time 3D imaging of the heart, and EPIQ's revolutionary nSIGHT Imaging technology marks a new level in ultrasound performance. Typically in ultrasound, you can have a faster frame rate (which shows movement) or greater image quality, but not both. With EPIQ, the technical team has developed algorithms able to deliver both, avoiding the usual trade-off.

Serendipity

With the significant upgrade of hardware in the EPIQ, the researchers were exploring how to make use of the new capabilities to make the most superb images possible. The system had much greater processing power, so more information could be extracted and processed at the same time. As Senior Researcher Jean-Luc Robert explains: "We were developing advanced algorithms to leverage this new information, with the aim of achieving the best resolution at any depth."

"But one day, while working on these new algorithms, we made a surprising discovery. We found that we could reduce the number of sound waves needed to produce a top quality image. This meant that we could produce more images in the time it would have taken to make one, and this enabled the quality of movement captured by a scan to also be improved." See box: 'nSIGHT Imaging – new realities'.

¹ Society of Diagnostic Medical Sonography, Industry Standards for the Prevention of Musculo-skeletal Disorders in Sonography, May 2003.





A step-change for ultrasound

“We were a small team of specialists, but as we shared ideas between us, it was amazing. We began to realize we were opening up undreamt possibilities,” says Jean-Luc. “We could improve the frame rate and the resolution at the same time. This was completely new and meant we could potentially enable major advances, like making a 3D image of the moving heart in a single beat.”

Karl Thiele, Principle Scientist R&D Ultrasound, explains its benefits. “Think of a bat using echo location to search for a tasty mosquito. Normally, the sound wave from his chirp would diffuse over a large area, making it hard to locate individual mosquitos. With our technique, it would be like giving our bat the ability to pinpoint his chosen meal, while still being able to see all the other mosquitos in the swarm.”

In addition, insights from workflow studies and discussions with doctors led to EPIQ being equipped with a raft of new and improved software tools. These guide operators efficiently and consistently through exams, and help to speed the physician with diagnoses by rapidly identifying and quantifying body organs and their movement in real-time 3D.

Making it easy to use

Tackling the huge challenge of translating these revolutionary concepts into new electronics required the expertise of dozens of electronics and acoustics

specialists. Meanwhile, industrial designers and engineers were working on the rest of the system. The user interface (UI), the screen and the ‘cart’ containing the electronics, battery and power supply – all came under their scrutiny.

“One of the biggest insights was just how physical the work is,” says UI designer Christopher Haverstock. “Sonographers are not only bending and reaching over to patients, their hands are constantly moving, and their heads bob to and fro as they look at the screen, then the controls and back again.”

All these observations led to small but important changes to Philips’ current control panels, from the color of buttons to the way they are grouped together. The team wanted to make using the controls tactile, so sonographers could find the right knobs by touch, even in darkened exam rooms.

‘Walk-up’ usability

As Wendy Yee, the usability lead for research and development, explains: “improving workflow for clinicians was a key objective for EPIQ. We wanted to make EPIQ easy and intuitive to use, regardless of whatever systems a person had used before.”

Having tested the system with over 150 clinicians worldwide throughout the development process, Wendy is confident that ‘walk up’ usability has been achieved. “This means that clinicians using EPIQ for the first time are able



to ‘walk up’ to it and carry out the key functions without any training. It is easy to work out – in the same way that most people can use an ATM in a foreign country, even if it’s in another language initially.”

To achieve this, the interface has been made as simple as possible. The team added the ‘swiping’ functionality, familiar from smartphones and tablets, to give quick access to advanced functions. And the entire screen, touch pad and controls were placed on an articulated arm that moves through 360 degrees, so it’s easy to position next to the patient.

Light as a feather, solid as a rock

Ergonomic design was another top priority. Ultrasound machines are frequently moved to patients’ bedsides, often by female staff, so the aim was to make EPIQ lighter and more mobile, while allowing it to remain steady during scans. It also needed to be easy to fine tune its position single handed at the bedside, so the user could focus on the patient and the exam at all time. “We all had one clear vision: to make a system as light as a feather, and solid as a rock, to make it effortless for users to perform an exam”, adds lead designer Daniel van Alphen.

Driven by this vision, the team looked at everything from how the system would be manufactured to how easy it would be to service. Working with internal teams and suppliers, they miniaturized the electronics to come up with a machine that was as light as possible. It is also as ‘quiet as a library’. “Noise is a big problem for ultrasound systems. Some customers said ours sounded like having a helicopter in the room which is very disturbing to patients and operators. We really wanted to fix that!” adds Dan Schmiesing.

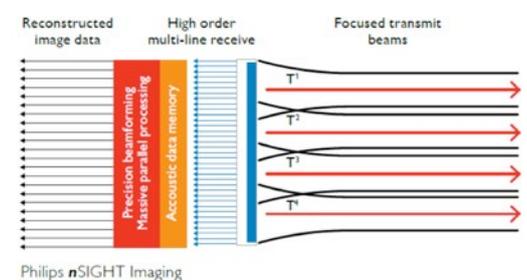
nSIGHT Imaging – new realities

Philips nSIGHT Imaging is a totally new architecture for premium ultrasound. The technique of retrospective beam reconstruction is entirely new and allows nSIGHT Imaging to focus right down to the pixel level.

The EPIQ hardware incorporates several new elements that enable nSIGHT Imaging:

- **Precision beamformer** – transforms the traditional hour-glass shape of ultrasound beams into a straight-edged, laser-thin profile, creating virtually perfect transmission beams throughout the depth of field.
- **High-order multi-line beam transmission and reception** – allows the system to acquire large numbers of ‘receive’ beams for each ‘transmit’ beam. This means more information is captured per transmission event, which adds speed. This enables nSIGHT Imaging to focus on every pixel with relatively few transmit beams – and it’s how it can achieve higher frame rates while still generating clear images.
- **‘Massively parallel processing’ capabilities** – provide the computing power to process all the acoustic data and deliver the exceptional image quality.

For more technical details see the [nSight Imaging background paper](#).



A higher frame rate and enhanced image resolution can be created without requiring more ‘transmit beams’. The new nSIGHT Imaging is able to virtually ‘reconstruct’ a great number of ‘receive beams’ (the ones that bounce back to the machine), from the relatively few transmitted beams.

Putting it all together

Combining so many innovations was itself an 'epic' task. Around 150 people worked directly on the project, but the total was close to 300 if you count functions like sales and marketing as well. What's more, this 'legendary 300' as they were nick-named, was located on both coasts of the US, as well as in Bangalore, India.

"I don't think I've ever worked on a product before that involved the input of so many people from every corner of the organization", says Eden Jordan, Senior Manager Manufacturing. "People kept working evening after evening, weekend after weekend, and believe me, morale hit rock bottom on more than one occasion."

Dan Schmiesing echoes Eden's comment: "There were definitely moments when we wondered whether it was all going to work – especially the new imaging techniques. But everyone shared the vision and we never lost sight of it. Throughout the development, we tested time and again with customers. And every time a doctor came to try out some aspect of the system we saw their excitement. Then, we knew it was all worthwhile!"



[Watch the EPIQ video](#)

Images as never seen before

Since its launch in August 2013, EPIQ has attracted enormous attention from medical professionals. "Doctors have been stunned by seeing anatomical detail never visible before; they love the way the system looks, and how easy it is to use. It allows them to offer superb patient care and make informed diagnoses quickly and with confidence," says Jim Brown, Senior Manager Marketing Ultrasound General Imaging.

And the innovation continues. Longer-term, some of what has been developed for the EPIQ system will be integrated into other Philips ultrasound systems. Moreover, the team believes that we have only just started to see the full potential of Philips nSIGHT Imaging technology, so EPIQ's revolutionary capabilities will continue to evolve for many years to come.



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