How GE Corporate Research & Development Led to the Success of GE Ultrasound Medical imaging

By Sharbel E Noujaim, PhD

Today, Medical Ultrasound Imaging is one of the key modalities if not the most dominant one of worldwide medical diagnostic Imaging and General Electric (GE) is a leader. However, this was not the case 30 years ago. Below is the story of how GE Corporate Research & Development made GE a leader.

Ultrasonography or Medical Ultrasound Imaging is a technique based on the propagation and reflection of sound waves in water and is used to map internal body structures and organs. It is very similar to the sonar technology developed to search for submarines.

At the end of WWII and during the 50s and 60s, Ultrasonography was becoming a reality with advances in electronics components and circuitry. Its small size, mobility, low power consumption, low cost, ease of use, minimum side effects and most importantly real time imaging made it very appealing to many radiologists. Above all, real time imaging was not the only paradigm shift. With other modalities such as X-Ray, CT, and MRI, the patient had to be transported to the machine. Now with Ultrasound, the machine could come to the patient. Its main drawback was still the poorer image quality compared to CT and MRI and limited imaging capabilities of body organs like the lungs, and brain to name a few.

In the 1970s the electronic boom in computer and consumer electronics brought a "sonic boom" to Medical Ultrasound Imaging. The image quality was improving at a fast rate and catching up to CT and MRI. Small entrepreneurial companies were making major in-roads in Medical Ultrasound Imaging while well-established companies like GE were having a hard time competing and it was not for lack of trying. GE Medical Systems (GEMS) had its own ultrasound program (headquartered in Rancho Cordova, CA), bought Sonicare from JNJ, CGR from France, and relied on its Japanese partner Yokogawa Medical Systems to provide medium to low-end products. So, there were lots of ideas competing for resources. However, it was not enough to be a leader and GE was a distant 5th or 6th player in the Medical Ultrasound Imaging modality.

To Jack Welch, the CEO of GE who was famous for coining the phrase "If you are not #1 or #2 in your business you should exit," the GE Medical System situation in Medical Ultrasound Imaging was totally unacceptable. How can GE Medical System be a leader in X-Ray, CT, MRI and not in Ultrasound a modality that had the potential to be the biggest imaging modality in the not-so-distant future? Something had to be done! GE needed a premium end-product and it needed it fast.

In January of 1988, Jack turned his attention to GE Research & Development (R&D) and challenged Walter Robb, Senior VP of GE R&D, to find a way to make GE Medical System a leader in Medical Ultrasound imaging. By leader, Jack intended that it will be a breakthrough technology, and not a "me too." To make the challenge a little bit more exciting, the time-line was 24 months or less. Can GE R&D perform an "encore" and come up with the "Fan Beam of Ultrasound" in reference to the famous GE R&D "Fan Beam of CT" that made GE Medical System a leader in CT scans a decade earlier?

In February of 1988 a major effort was launched. We had no idea how to meet the chairman's challenge. It seemed so daunting. The one thing driving us was our risk-taking GE culture…and risk we took! It is true that sometimes ignorance is bliss. We had no idea what we were getting ourselves into.

While lots of people played key really important roles, the actual architect of the CRD Ultrasound Program was Matt O'Donnell. Matt proposed to do something completely different which meant it was an uphill battle from the beginning.

At the time, two R&D scientists, Matt O'Donnell and Bill Engler, were working on the solution to "phase aberration," a problem inherent to most Ultrasound Images. Due to the variation of the velocity of sound in different tissues in the human body, most ultrasound images are blurred when constructed using the ultrasound machine time-delay beamformer. Phase aberration does to ultrasound images what out-of-focus lens does to films.

Matt and Bill had, through non-real time computer simulation, shown the potential of their "Phase Aberration Correction" technique. The potential was huge, however, it was not easy to convince most of the stakeholders especially GE Medical Systems that the technique would work in real time. A prototype had to be built in record time to prove it.

Phase Aberration Correction involved very complicated real time mathematical computations and it was very clear early on that it could not be done with analog circuitry, the main component of most ultrasound machines engine at the time. A new engine had to be built… a "powerful digital" engine. In 1988, digital electronics was in its infancy. Analog to digital converters were not fast enough and did not have enough resolution to capture ultrasound signals properly. To put a digital prototype with 128 digital channels expandable to 256 in a shoe box was starting to look like "mission impossible." However, we were all convinced that if such an engine could be built, it was the way of the future as digital was getting smaller, faster, cheaper and less power hungry.

Clearly, things needed to be done differently and thinking out of the box was paramount for the success of this project. In June of 1988, a dedicated digital ultrasound team was put together at GE R&D and GE Medical System under the leadership of Red Redington, the pioneer of the GE "Fan Beam of CT".

To make the digital prototype in record time, we borrowed whatever we could from existing GE technologies and concentrated on designing and building only the digital beamformer (the digital engine). Transducer probes were borrowed from our friends at Yokogawa Medical Systems and CGR, a back-end processor from the Rancho Cordoba team, transmitters and receivers from Yokogawa and CGR. Having a dedicated ultrasound team at GE Medical system, working hand-in-hand with the team at GE R&D, was a life saver and precipitated many things, mainly: 1) early buy-in, 2) need for engineering support to build the prototype in record time, and 3) a head start to product development. Parts of the prototypes flew back and forth between Schenectady, NY and Waukesha, Wisconsin at a fast pace, sometimes in an engineer's lap.

As the development of digital components was accelerating, we used GE clout to convince many manufacturers of digital components to not only accelerate their development cycle but to release their first samples to us. In other words, we pulled out all the stops. It was a global, round-the-clock type of effort and it bore fruit.

In the summer of 1990 the prototype was operational. However, it was big, it was power hungry, it was non-mobile, it was everything an ultrasound product should not be. It was nicknamed the "B-52"! But to the ultrasound team it was beautiful. It allowed us for the first time to show images in real time and to show the potential of the digital engine and phase aberration correction. It was not perfect but it was a good start.

In the winter of 1991, Jack came to GE R&D to get an update on progress. He got encouraged and excited and asked GE Medical Systems to accelerate product development and to report to him personally on a monthly basis. To this day, I still remember Jack's comments scribbled on the first monthly report of John Kese (the general manager of the Ultrasound division at GE Medical system), "John, great progress! Remember this project is your life! " And for the following 24 months we lived, ate, and breathed Ultrasound.

In the fall of 1993, the "LOGIQ 700" was born…the first premium GE Ultrasound system. It was introduced at the RSNA (Radiological Society of North America) in November 1993, as a work in progress, to big fanfare attended by Jack Welch, John Trani (CEO of GE Medical System), John Kese and Lonnie Edelheit (Sr. VP of GE R&D). At the press conference, Jack made it clear to the medical diagnostic community, and to the world, that GE was in Medical Diagnostic Ultrasound… and was there to lead. In March of 1994, the LOGIQ 700 was approved by the FDA.

The digital architecture of the LOGIQ 700 allowed GE to upgrade new features relatively quickly by using software upgrades. In addition it allowed GE to ride the advances of digital electronics, faster, smaller, less power hungry and lower cost. Today, GE Digital Ultrasound Systems can fit in the palm of your hand, a long way from the "B-52" prototype.

Phase aberration may not have worked as expected by the time I left GE in the winter of 1997 but in my opinion it was the catalyst that galvanized the best resources of GE R&D and GE Medical Systems to build the digital engine of the future in record time and to put together a world class ultrasound team. This in itself was a success.

Two special recognition ceremonies at GE R&D and GE Medical systems recognized the more than 70 staff members at GE R&D and GE Medical Systems that rose to the challenge that nobody thought was possible.

Omar Ishrak, the VP of R&D at Diasonics, a small ultrasound company in California, was hired in the Spring of 1995 to lead the Ultrasound business at GE Medical System after the retirement of John Kese. Omar's experience in patient unmet needs, technology, and market dynamics allowed him to see all the potential of the digital engine, mainly Color Flow Imaging which catapulted GE Medical system to become a leader in Medical Ultrasound Imaging. Today, GE Medical Systems has more than 17,000 units sold worldwide.

Looking back, it is likely that GE Medical Systems would have remained a second tier player in Ultrasound Medical Imaging if it weren't for the "Phase Aberration Correction" initiative and the bold risk-takers at GE Center for Research and Development a GE Medial Systems.

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Sharbel retired from Lifescan a Johnson & Johnson company in Jan 2012 where he has been the VP of Research and Development from Oct 2001. From 1997 to 2001 Sharbel was with Ethicon Endo Surgery (EES), a Johnson & Johnson company as the World Wide Vice President of Research & Development. Prior to joining EES Sharbel was with GE Medical Systems in Milwaukee, WI from 1994 to 1997 as a director of technology where he contributed to the development of a premium digital ultrasound imaging system. Prior to joining GE Medical systems, Sharbel was with GE Research & Development in Schenectady N.Y. from 1982 to 1994 working on different technologies including Ultrasound medical imaging. Sharbel holds a BS degree in Electrical Engineering from Cairo University in 1975 and an MS and Ph.D. in Electrical Engineering from Stanford University in 1978 and 1983 respectively. Sharbel holds 20 U.S. patents.