MRI pioneer wins national physics prize

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With its ability to obtain detailed pictures from the depths of the living body, magnetic resonance imaging (MRI) has saved many lives and dramatically increased knowledge of the human body, particularly the brain. There are now more than 22,000 scanners worldwide performing some 60 million scans annually. But without the ingenuity of an industrial physicist and his colleagues, magnetic resonance would not have made its sudden jump in the early 1980s from esoteric laboratory research to a widely available technology.

The American Institute of Physics (AIP) has named William Edelstein the winner of its Industrial Applications in Physics Prize "for his pioneering developments leading to commercialization of high-resolution Magnetic Resonance Imaging (MRI) for medical applications." Sponsored by the General Motors Corporation and the AIP Corporate Associates, the prize will be given to Edelstein at the 2005 Industrial Physics Forum, being held from November 6-8 at the National Institute of Standards and Technology in Gaithersburg, Maryland.

Edelstein's critical contributions to MRI began at the University of Aberdeen in Scotland from 1977-80 where he collaborated in constructing one of the first whole-body scanners and was the primary inventor of the "Spin Warp" imaging method that is still used in all commercial MRI systems.

In the fall of 1980, he joined the GE Corporate Research and Development Center in Schenectady, NY. At the time, GE was focused on CT scans, still widely used today, which makes images of the body's interior by using x rays. Nonetheless, his boss, Rowland "Red" Redington, encouraged Edelstein and a small group of GE scientists to investigate medical magnetic resonance technology.

The initial aim of the GE effort was to develop clinical MR "spectroscopy," which would obtain important biochemical information from inside the body. To pursue this application, they purchased a superconducting, 1.5-Tesla (T) magnet which was much more powerful than magnets used by others at that time for MR imaging studies.

Dr. Paul Bottomley, another new GE recruit, led the group to try making MR images of the human head at that high field. Although noisy, the MR images showed no degradation in quality for views deep inside the head, contrary to conventional wisdom. These images were displayed at the 1982 Radiological Society of North America meeting and brought the MRI industry to a halt.

GE management then made the bold decision to produce an MRI product using 1.5 T magnets with their very strong magnetic fields. This required the solution of a host of technical problems. Scientists and engineers in the GE Corporate R&D group and others at GE Medical Systems in Milwaukee, WI made rapid progress and the first 1.5-T product was available less than two years later.

During this period and later, Edelstein led or was a key part of physics-related projects producing important science, ideas or inventions that solved critical problems and noticeably moved the field forward. He investigated fundamental issues of signal-to-noise ratio and image quality. He helped design and improve the structures creating linear magnetic field variation ("gradients") that produce the MRI image information. He worked on developing MRI radiofrequency coils both for whole-body imaging as well as for localized regions of the body. He collaborated in devising the MRI Phased Array that produces images combining the superior resolution of localized coils with a large field of view.

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Edelstein's recent work at GE investigated causes of and possible remedies for the intense acoustic noise produced by MRI systems, a problem noted at the beginning of MRI commercial development, but exacerbated by the use of high-field magnets and increasingly strong pulsed magnetic field gradients. The high electric currents coursing through the machines exert powerful forces that create vibrations and consequent noise levels as high as 120 decibels, forcing patients to wear ear protection. In addition to vibration of the gradient assembly itself, Edelstein and coworkers found that eddy currents induced in metallic parts of the MRI system by the pulsed field gradients are a significant source of noise.

All of these technical improvements helped make MRI systems commercially viable and clinically useful.

GE profited greatly from the industrial physics work of Edelstein and colleagues at the research laboratory and GE Medical systems. In a little over a decade after the first MRI image was produced at their lab, GE went on to gross a billion dollars a year from the sales of MRI systems, and GE retains the largest market share for MRI. Siemens, Philips, and Toshiba, which are some of the other major manufacturers of the machines, also profited greatly from physics-based MRI research at GE, those companies, and elsewhere.

While Edelstein retired in 2001 from the GE Corporate Research and Development Center, he remains active as an independent scientist and consultant and a Visiting Scientist at nearby RPI. He is also a Senior Research Associate at Case Western Reserve University, with whom he has done theoretical research on shielding the pulsed gradient fields in order to reduce eddy-current-induced acoustic noise.

Edelstein is a fellow of The American Physical Society, the Institute of Physics (UK), and a GE Coolidge Fellow. He is a Fellow of the International Society of Magnetic Resonance in Medicine and a recipient of their the Gold Medal Prize. Edelstein retired in 2001 from the GE Corporate Research and Development Center. He was an undergraduate at the University of Illinois at Urbana-Champaign and did his graduate work at Harvard. Coincidentally, his Harvard advisor was Robert Pound, a pioneer in early magnetic resonance, though Edelstein did not pursue that area of research in his thesis.

Established in 1977, the Prize for Industrial Applications in Physics aims to encourage physics research in industry, publicize its value, and increase students' awareness of the role of physics in industrial research. Awarded biennially by the Corporate Associates of AIP, the prize consists of $10,000, a travel allowance for the recipient to attend the Industrial Physics Forum where the prize is awarded, and a certificate citing the contributions made by the recipient.

Source: American Institute of Physics