Earl Bakken made a better pacemaker, founded and led a major medical technology company and is leading the merger of high-tech and "high-touch" medicine in Hawaii.

Fascinated from childhood with all things related to electricity, Earl E. Bakken, along with his brother-in-law, started a medical equipment repair company named Medtronic, Inc. in a garage in 1949. Under Bakken’s leadership, that company grew into a leading medical technology company based on his belief that "failure is closer to success than inaction." This philosophy, which underscores Bakken’s life, took root in his Minnesota childhood home where his mother supported her precocious son’s tinkering.

Born in 1924, to Florence and Osval Bakken in Columbia Heights, Minnesota, in the northeastern corner of Minneapolis, Bakken recalls his mathematician grandfather Lars Bakken always sketching plans for mechanical devices. His own father, an avid reader, constantly worked crossword puzzles. His mathematically inclined mother, with a business training background, gave young Earl remarkable freedom to fool around with electrical gadgets, wiring, and batteries at home. His curiosity about the electrical wiring in his home led his electrician uncle to predict sternly that young Earl would electrocute himself someday.

A curious childhood

As a child, Bakken had the household to himself. (His only sibling is a sister 18 years younger.) In his autobiography, One Man’s Full Life, published in 1999, Bakken speculated that his mother may have been so tolerant because she shared his enthusiasms, including the Fourth of July firecrackers that Bakken wired to be set off electrically from his perch in the attic window. When he used wire from a sandpit blasting site to concoct a phone system, his amazed mother discovered she could use it to talk to his friend’s mother across the street.

Among Bakken’s favorite toys were an electric-eye kit, a chemistry set, a microscope, Erector sets, electric trains, and Lincoln Logs—all of which the innovator credits with developing his appreciation of electronics, chemistry, biology, physics, and engineering. To supplement these store-bought toys, Florence Bakken gathered used and castoff parts from hardware stores and radio shops—copper wire, vacuum tubes, switches, dials, knobs, and other items. In his basement workshop, Bakken experimented with electrical connections for devices he assembled, such as bells and buzzers, and built robots out of Erector set parts and plywood.

One elaborate robotic creation blinked its eyes, talked by remote-controlled loudspeaker, puffed on hand-rolled cigarettes, and gave Bakken a powerful incentive to eschew tobacco when its hot-water bottle lungs rotted from the inside out. And although tolerant
beyond reason, his parents did order him to dismantle one invention, a knife-wielding robot intended as a Halloween prank, after a neighbor’s child complained that the robot attacked him.

Following his grandfather’s example, the teenage Bakken relished drawing plans for inventions—from rocket ships to futuristic houses. In his autobiography, Bakken mentions by name brothers Russell and Rodney Sahlstrom, high school science teachers who encouraged his efforts. He expresses gratitude for Rodney’s assurance that "it was perfectly all right to be what kids today call a ‘nerd.’” Bakken found his niche as the guy who could keep things running, taking charge of the public-address system, movie projector, and other equipment. He also jumped in when difficult science experiments baffled a teacher. Always active, he lettered in track and traveled with football and basketball teams to operate the electric scoreboards and loudspeaker equipment. He vividly remembers modifying a radio and connecting it to the public address system in order to broadcast to the school President Roosevelt’s request for a congressional declaration of war against Japan, on December 9, 1941.

Bakken gives particular significance to Saturday afternoon science-fiction films, especially Frankenstein, in which a doctor used electricity to bring "a collection of inanimate body parts to life." At that moment, he realized that "when electricity flows, we’re alive. When it doesn’t, we’re dead." A deep awareness of the powerful potential of electricity stayed with Bakken for the rest of his life.

To that significant realization was added a weighty charge from his Lutheran pastor. Keenly aware of Bakken’s penchant for science and technology, the pastor counseled him, should he pursue a career in science, to use it for beneficial purposes rather than those destructive to humankind.

After graduating from high school, Bakken enlisted in the Army Signal Corps and received a commercial radio-operator’s license before basic training, eventually becoming an airborne-radar maintenance instructor.

Following the war, the G.I. Bill helped finance his bachelor of science degree. While pursuing graduate work in electrical engineering at the University of Minnesota, Bakken married his first wife, Connie Olson, a medical technologist at Northwestern Hospital in Minneapolis. Bakken often spent time at the hospital waiting for Connie’s shift to finish and became acquainted with doctors and technical personnel. Aware of Bakken’s electrical engineering background, they started asking him to fix malfunctioning electrical equipment.

When opportunity knocks, start a company

Bakken saw the need for a Minneapolis-based business to repair hospital equipment so he and Palmer Hermundslie, Connie’s sister’s husband, started Medtronic, Inc. in 1949. Officed in a garage, their tiny company struggled to survive, repairing and custom-
building equipment and serving as a regional representative for several companies that manufactured medical machines and instruments.

In the mid-1950s, the advent of the transistor along with various plastics and synthetic materials opened new doors in medical technology. The entrepreneurial Medtronic was well positioned, as it was already selling and servicing devices used in clinical animal labs and surgical suites. For example, if the company sold a multichannel recording device for the University of Minnesota Hospital catheterization lab, Medtronic would set up the device, train people to use it, and be on hand for troubleshooting and repair. Bakken spent so much time in the university hospital’s offices, surgery suites, and animal labs that he was given his own locker. He forged important and lasting relationships with young doctors who later became prominent physicians around the world.

One of those doctors was C. Walton Lillehei at the University of Minnesota, who had begun repairing congenital defects of the heart in babies with insufficiently oxygenated blood. To do this, Lillehei relied on big, alternating current-powered pacemakers—bulky boxes that had to be wheeled around on carts and plugged into wall sockets—to keep the tiny hearts beating after surgery until they healed enough to beat independently. These AC-driven pacemakers were not only traumatic for treating infants but vulnerable to power failures as well. In fact, a 1957 power failure did result in the loss of a baby’s life.

With experience as a radar maintenance instructor in the Army Signal Corps and graduate work in electrical engineering, Bakken found his niche in maintaining medical equipment. In this picture, taken in the early 1950s, he is at work at Medtronic, which he cofounded in 1949.

The following day, Dr. Lillehei asked Bakken to make a better pacemaker, and Bakken did. "I didn’t think I was doing anything out of the ordinary," he reflected in his autobiography. "Those lofty, idealistic notions of restoring life through electricity—sparked by the Frankenstein movies of my childhood—didn’t enter my head."

Medtronic pacemakers: from wearable to implantable

Medtronic’s first try involved an automobile battery with an inverter to convert the 6 volts to 115 to run the unwieldy AC pacemaker on its wheeled stand. Bakken declared that solution inefficient (since only a 10-volt direct-current pulse was really needed) and then thought about using a transistor. He found a back issue of Popular Electronics magazine in which he’d seen a circuit for an electronic transistorized metronome, with clicks transmitted through a loud-speaker and adjustable to fit the music.

Bakken modified that circuit, putting it minus the loudspeaker into a four-inch-square box that could be taped to the patient’s body. The result was a small, transistorized, battery-powered pacemaker free of cords and AC connections. Wires carrying the pulse could pass through the patient’s chest wall and be withdrawn when no longer needed without reopening the chest. Bakken took his pacemaking device to the University of Minnesota clinical animal lab, where it was tested on a dog and worked.
The next day, he was startled to walk past a University Hospital recovery room door and see one of Lillehei’s patients already wearing the new pacemaker. Thus, four weeks after the doctor’s initial request, the device was in use—almost unbelievable today, when such products are subject to extensive regulatory review.

Above: By 1959 the Medtronic family had grown and become more "corporate" in appearance. Bakken is on the far left in the sports jacket. Below: Building therapeutic devices as they were requested by doctors and only later evaluating the product’s profit potential, Bakken coined the company motto: "Ready, Fire, Aim."

Bakken observed, in his book, that since Medtronic was then such a small company with perhaps a dozen employees, necessity dictated its operating procedure; "We got the order, built the product, and only after rushing it to the customer debated its long-term possibilities for the company." He refers to this approach as "ready, fire, aim."

Soon orders started arriving at Medtronic from all over the United States and other countries for the battery-powered pacemaker, which served as a precursor to Medtronic’s first implantable pacemaker. The implantable device was the collaborative effort of surgeon William Chardack and electrical engineer Wilson Greatbatch in Buffalo, New York. "In October 1960, Palmer Hermundslie flew to New York and signed a license agreement to use their names and patent, giving Medtronic exclusive right to manufacture and market the Chardack-Greatbatch implantable pacemaker in exchange for 10 percent royalties on sales," recalled Bakken in his autobiography. Three months later, Medtronic had 50 orders for the device at $375 each. Today, roughly 690,000 pacemakers are sold worldwide each year, and Medtronic sells about 345,000 of them.

The design and concept of these early devices underwent numerous improvements and changes—including introduction of a rate-responsive pacemaker and polyurethane lead insulation—resulting in today’s tiny, sleek implantable pacers. By successfully mating transistor technology to a medical device, Bakken’s pacemaker helped launch a wave of innovation in medical electronics.

Growing a medical technology company

In addition to his scientific innovations, Bakken furnished the foresight and leadership Medtronic needed to become the prominent medical technology company it is today.

Bakken (left) and Wilson Greatbatch, an electrical engineer and codeveloper of the first implantable pacemaker, were collaborators and friends who shared an interest in using electricity to help restore patients to health. Photo circa 1970.

Medtronic’s gross sales for the fiscal year 1959–60 were $181,000, triple the gross sales of just five years earlier. During the 1960s, the company built new facilities; by 1962, sales from the 21 medical devices Medtronic manufactured exceeded $500,000. Bakken took a strong leadership role as chief executive officer and board chairman from 1957
through 1976, and senior board chairman until 1989. As the company grew, Bakken faced professional and personal challenges. Foremost was what he called "my transition from product-focused engineer to button-down chief executive."

Bakken found inspiration in meeting people who had been helped by his company's medical devices. In 1986, he visited this healthy five-year-old girl who had received a Medtronic implantable pacemaker when she was one month old.

At this point, Bakken noted, "I missed the hands-on activity—the day-to-day technical work—the engineering that brought me to the business in the first place—even more than I imagined." But to lead Medtronic, he decided to abandon the lab and turn his energies toward encouraging the company’s engineers, ensuring them the freedom to use imagination and follow their creative urges. "I learned to find great satisfaction in what others were doing at their workbenches," conceded Bakken, "to understand that what many of them had accomplished was far greater than anything I could have done myself."

Among Bakken’s personal challenges was a lack of time for his family. He credits Connie with doing the largest part of rearing their two sons and two daughters, stating that his extensive travel and business obligations no doubt contributed to the couple’s eventual divorce. Still, wrote Bakken, "I’m not sure I could have done it any other way. Unfortunately, I don’t think there’s any alternative when starting and building a business than to give it everything you have."

By 1974, Medtronic was marketing products in more than 70 countries, with pacing devices accounting for 80 percent of sales. With Bakken’s full support, the company’s engineers continued to innovate, developing a 10-year pacemaker and, eventually, programmable and rate-responsive pacemakers as well.

Disciplining operations and clarifying the mission

Along with growth, however, the 1970s brought troubles: For the first time, members of Medtronic left to form a competing company, and difficulties with Medtronic’s Xytron pacemaker in 1976 shook public confidence. Body fluids had infiltrated some units, causing a small number of them to short out. All physician customers and patients with Xytron pacemakers had to be notified, and Medtronic’s share of the worldwide pacing market dropped from 65 percent in the early 1970s to 40 percent by 1978.

In line with Bakken’s penchant for learning from failure, Medtronic made changes, bringing in additional materials scientists. Bakken, as chairman of the board most of that time, saw a need to tighten focus. He credits Medtronic presidents, particularly Dale Olseth and later Winston Wallin, with disciplining operations. Medtronic became one of the first manufacturers to mass-customize, allowing physicians to put together a pacing system to meet each patient’s specific needs. Among new pacemakers developed at Medtronic was the state-of-the-art Activitrax, with sensors to adjust heart rate to the wearer’s physical activity.
Medtronic achieved its $1 billion sales goal in 1991, and by the start of 1999 it had 20,000 employees and served customers and patients in more than 120 countries. By April 2003, the corporation had 30,000 employees and revenue of $7.7 billion. Although still active as founder and director emeritus, Bakken retired as senior chairman of the Medtronic board in 1989, the company’s 40-year anniversary. He remained on the board until 1994.

Today, Medtronic continues to deliver medical technology solutions to patients worldwide. Medtronic’s products include mechanical and tissue heart valves, pacemakers and implantable as well as external defibrillators, spinal surgery and cardiac surgery products, implantable drug pumps, brain implants, and electrical stimulation systems for chronic pain, chronic muscle spasms, incontinence, and gastrointestinal disease.

Museums and prizes

In the mid-1970s, Bakken founded the Bakken Library and Museum of Electricity in Life, housed in a renovated and enlarged Tudor mansion in Minneapolis. The Bakken collection comprises some 11,000 old and rare books and manuscripts and 2,000 scientific and electrical medical devices. At the same time, the museum offers science-based programs for children, with workshops and labs for hands-on inventing. Here, youngsters get encouragement to try and try again—as Bakken did in his childhood home.

Reflecting another part of his lifelong interests, Bakken acquired an amateur ham-radio operator’s collection of old radio equipment and started another museum in collaboration with the Minnesota Broadcasters Association. The Pavek Museum of Broadcasting, in St. Louis Park, a Minneapolis suburb, contains more than a thousand radios and is open to the public. It also has a working amateur station and is an important educational resource for schools and youth.

Over the years, Earl Bakken has received numerous awards. In 1984, the National Society of Professional Engineers recognized the cardiac pacemaker as one of 10 significant engineering achievements in the latter half of the twentieth century. The National Academy of Engineering, in 2001, awarded the Russ Prize along with $500,000 to Earl Bakken and Wilson Greatbatch for their achievements in bioengineering. Other awards of recognition accorded Bakken include two from the North American Society of Pacing and Electrophysiology—a Pioneering Award in 1999 and a Distinguished Service Award in 1985—and the American Creativity Association’s Lifetime Creative Achievement Award in 1996.

In his retirement from major responsibilities from Medtronic, Bakken has relocated to Hawaii, where he has continued his efforts to apply science and technology to benefit humanity. In 1999, with his wife, Doris, he celebrates his 75th birthday at a North Hawaii Community Hospital fund-raiser.
In 1982, Bakken married his second wife, Doris, with whom he resides in his retirement years on the big island of Hawaii. Of his family, Bakken remarked with characteristic candor: "Like Connie before her, and like my four beautiful and accomplished children, Doris has given me the grounding that has allowed me to do so much with my life ... I can never satisfactorily tell her and the rest of my wonderful family everything that they mean to me."

High tech meets high touch

As innovative in retirement as in earlier years, Bakken, who turns 80 in January 2004, quipped, "Clearly, there is no shortage of challenges and opportunities for a retired fellow in Hawaii."

In his years there, Bakken has followed his passion in yet another direction, having personally observed that Medtronic's high-tech products seemed more effective when prescribed and watched over by certain doctors and nurses. He noted that some professionals "would create in their patients the conviction that the technology was indeed going to make them feel better." By believing in the devices, these physicians and nurses were somehow able to transfer that belief to the patient, said Bakken. His observations led to a desire to link high technology with high-touch medicine, focusing on the patient rather than on the hardware, theory, and procedure.

Thanks in part to Bakken's leadership and substantial contributions, the new North Hawaii Community Hospital integrates advanced technology with the more patient-centered, high-touch therapies. Here, a patient in the hospital's critical care unit is receiving healing touch from the nursing staff.

Through his work with the North Hawaii Community Hospital, Bakken remains close to the leading edge of medicine today, just as he has been since 1957 when he made this first wearable pacemaker.

Bakken found this approach compatible with local Hawaiian healing traditions. He subsequently helped start the North Hawaii Community Hospital (and is president emeritus of the board) and Five Mountain Medical Community.

In Hawaii, Bakken is bringing to fruition his dream of a multifaceted health and wellness center for patients from all over the world. In appreciation of his efforts, he received the Kako’o ‘O Kalaniana‘ole Award in 2002, for outstanding service to the Hawaiian community, and the Living Treasure of Hawaii Award in 1999, recognizing his work on behalf of the culture of indigenous Hawaiians. Additionally, retiree Bakken has been involved in developing solar energy in Hawaii and in creating a four-year biomedical-engineering scholarship in conjunction with Tulane University in New Orleans. The scholarship goes to big island students who commit to returning to there.

Now, as throughout his life, Bakken takes action, continuing his lifelong mission to use scientific and technological advances for the benefit of humankind.
(Article written by Alice M. Vollmar and published in The World & I, December, 2003.)