EARL ELMER BAKKEN was born to Florence and Osval Bakken on January 10, 1924, in Columbia Heights, a northern suburb of Minneapolis. He passed away at age 94 on October 21, 2018, on the island of Hawaii. He had lived there for 30 years with his wife Doris in the dream retirement home they had built at Kīholo Bay.

As a child Earl had developed a keen and lifelong interest in the role of electricity in living things. This began in 1931 when he saw Universal Pictures’ classic Frankenstein “monster” movie at the neighborhood theater. He became fascinated with the idea of using electricity to (re)animate life. He built robots—including one that smoked cigarettes—and a phone system that connected his house to a friend’s house nearby. He also rigged the high school loudspeaker system so that students could hear President Franklin D. Roosevelt call for a declaration of war on Japan after the attack on Pearl Harbor December 7, 1941.

Immediately after graduating from high school, Bakken enlisted at age 18 in the US Army Signal Corps. Because in high school he had earned a US government license qualifying him to operate a commercial radio station, he was assigned to be an instructor of electronic equipment maintenance. His specialty became teaching technicians how to maintain precision
airborne radar systems. At the age of 20 he was promoted to become responsible for the training of all US Army Air Force technicians who maintained these systems.

Later in the war, a prototype of the world’s most advanced airborne navigation radar set was sent to Bakken’s unit for testing. He proposed several significant design enhancements, and subsequently joined the design team of that top-secret program—the only enlisted man asked to do so. He often said that his wartime experience instilled in him the certainty that he could accomplish almost anything in life.

After his military service he earned a bachelor’s degree in electrical engineering, with specialties in electromagnetic field theory and radio communications technology, from the University of Minnesota in 1948. He then enrolled in the graduate school for advanced work in electrical engineering with a minor in mathematics, applying his war-time experience to lead a team that successfully reflected a radar signal off the surface of the Moon.

In 1949 he cofounded Medtronic with his brother-in-law, Palmer J. Hermundslie, in a small garage in northeast Minneapolis. The company’s initial purpose was to provide repair services for electronic medical equipment at the University of Minnesota’s medical facilities. Use of electronic diagnostic equipment was rapidly expanding and Medtronic saw the market opportunity to maintain it. However, it was an inauspicious beginning; the first month’s revenue was reported to be eight dollars. Moonlighting in the repair of household radios and television sets kept the company afloat in its early years.

A confluence of events and circumstances in 1957 sharply altered Medtronic’s and Bakken’s respective business and professional trajectories. The backdrop was the transformative cardiac surgery advances being developed at the University of Minnesota in the 1950s.

Cardiopulmonary bypass machines that served as a patient’s temporary heart and lungs made it possible to surgically correct congenital heart defects through open-heart procedures. Prominent surgeon C. Walton Lillehei was pioneering
the surgical correction of anatomical heart defects that caused improper blood circulation and substantially reduced blood oxygenation levels in children.

Open-heart surgery as performed in that era could inadvertently damage the patient’s native conduction system, which is responsible for controlling the heart’s normal rhythm. To prevent dangerously slow heart rhythms in the postsurgical period, the patient was connected via wires placed on the heart and passed through the skin to a large, cart-mounted, line-powered external stimulator. The device served as an external “pacemaker” to deliver timed electrical stimuli to the heart until the natural system recovered.

Earl’s first wife Connie worked as a medical technologist in the same building as Lillehei’s operating theater. Earl would pick her up at the end of the day for the ride home, providing an excuse to be a frequent presence at the hospital. This gave him the opportunity to scrounge for equipment repair work (for example, he did repairs on the cart-based cardiac stimulators) and cultivate potential customers. As a result, he had established a working relationship with Lillehei, for whom he had built a few special-purpose devices and performed adaptations of hospital equipment.

A power outage in October 1957 knocked out service to the hospital complex—a catastrophic event for patients dependent on the external line-powered cardiac stimulator. Lillehei approached Bakken to implement a strategy for back-up electrical power for such events, asking him to install several automobile batteries on the cart holding the line-powered stimulator and, via a DC-to-AC converter, switch the power supply from the line power to the back-up batteries—the equivalent of today’s uninterruptible power supply.

While investigating this idea, Bakken conceived a different solution consisting of a portable, battery-powered, “wearable” cardiac pacemaker that employed recently available transistors rather than power-hungry vacuum tubes. He remembered having read an article in a recent issue of Popular Electronics magazine detailing the construction of a transistorized metronome. A metronome emits steady clicking sounds
to help rehearsing musicians keep time, and he realized that the circuit could be modified to mimic the steady beating of a heart. Within weeks, prototypes of the device were being used by Lillehei’s team to successfully treat surgical patients.

The wearable device was packaged in a box roughly the size of a paperback book. The new design not only provided the stimulation parameter adjustability of the old stimulator but also eliminated the mobility limitation for patients who were formerly tethered by the length of the extension cord to a wall outlet.

When word of this innovation spread through the cardiac surgery world, unsolicited orders followed. Medtronic, under Bakken’s leadership, set out to develop additional applications for therapeutic devices. The company he started in a garage and led for 40 years is now the largest therapeutic device company in the world, with annual revenues exceeding $30 billion. Its success spawned the emergence of the medical device industry, with an estimated worldwide market of $390 billion. A more important metric is the industry’s positive impact on health care and patients’ lives around the world. Bakken, who retired from Medtronic in 1989, is often credited as the pioneer of the medical device industry.

In addition to his technical leadership and innovation, Bakken was a firm believer that corporations have a purpose that extends beyond maximizing financial returns. In 1960 he published Medtronic’s mission statement, an aspirational basis for corporate comportment that remains essentially unchanged and has been espoused by the company’s subsequent leaders. It provides guiding principles to alleviate pain, restore health, and extend life. Until personal health issues late in life prevented him from doing so, he spoke to every new employee about the importance of adhering to the mission statement.

Earl Bakken was a mentor, futurist, historian, philanthropist, humanist, and advocate for science education. He founded the Bakken Museum of Electricity in Life (in Minneapolis), which originally focused on the role of electricity in medicine, a motivating lifelong interest of his. Today known simply as
the Bakken, it has expanded to offer dynamic exhibit experiences and STEM-focused educational programs based on the history and nature of electricity and magnetism. The Bakken also highlights Minnesota’s medical technology industry and features an “electrifying” Frankenstein experience.

Along with other educational and cultural endeavors, he founded the Pavek Museum (also in Minneapolis) to focus on another of his lifelong interests: the history and technology of electronic communications, including science and engineering applications of electromagnetic fields. Among the visitors to the Bakken and the Pavek Museum have been hundreds of thousands of children participating in educational activities.

He also developed a 100-year plan for medical technology that has remained relevant. For instance, he began in the early 1970s to advocate for greater consideration of the role of the body’s internal “clocks” in health and disease. Although once thought to be relatively unimportant, circadian rhythms and chronobiology have gained respect as marked by the awarding of the 2017 Nobel Prize in medicine to researchers who had laid the scientific foundation. These rhythms play a role in aspects of heart disease, diabetes, and overall patient health and well-being.

Perhaps paradoxically as an engineer of his era, Bakken advocated for a high-tech and high-touch approach to medicine. To further this concept, he founded the North Hawaii Community Hospital to better serve the medical needs of the community with state-of-the-art technology and at the same time enhance the patient experience by minimizing the emotional stresses of being away from home in a bustling, unfamiliar environment. He engaged Hawaiian spiritual leaders to assist in defining the physical design of the hospital to incorporate the spiritual beliefs and customs of the local population.

In recognition of his impact on an integrated and interdisciplinary approach to technology and medicine, the University of Minnesota in 2017 renamed two of its centers in his honor: the Earl E. Bakken Medical Devices Center and the Earl E. Bakken Center for Spirituality and Healing.
He also received numerous honorary degrees, professional society awards, government medals, and lifetime achievement awards acknowledging his impact, inspirational leadership, and role as an exemplar. In 1990 he was elected to the NAE and in 2001 he shared with Wilson Greatbatch the first NAE Russ Prize for the development of the implantable cardiac pacemaker. He was named an honorary fellow of the American Institute for Medical and Biological Engineering, and he received the Eli Lilly Award in Medical and Biological Engineering (1994) from the Institute of Electrical and Electronics Engineers, the Laufman-Greatbatch Award (1998) from the Association for the Advancement of Medical Instrumentation Foundation, and a Trailblazer Award (2002) from Scripps Center for Integrative Medicine. And in 1999 Medtronic provided a grant to the Society of Thoracic Surgeons to establish the Earl Bakken Scientific Achievement Award to honor individuals who have made outstanding scientific contributions that have enhanced the practice of cardiothoracic surgery and patients’ quality of life.

Earl Bakken fully lived his mantra: “Living on, giving on, dreaming on.”

His first marriage, in 1948 to Connie Olson, ended in divorce in 1979. He is survived by Connie and their four children: Wendy Watson and husband Warren (New Brighton, MN), Jeffrey Bakken and wife Linda Shaw (Orono, MN), Bradley Bakken and wife Mary (Orono), and Pamela Petersmeyer and husband Jeff (Prior Lake, MN); eleven grandchildren; and four great-grandchildren.

In 1982 he married Doris Marshall. He is survived by Doris, stepchildren Ramona West (Waikoloa, HI) and David Marshall and Linda (Rice, MN); three step-grandchildren; and eight step-great-grandchildren.