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Peter Henry Rose

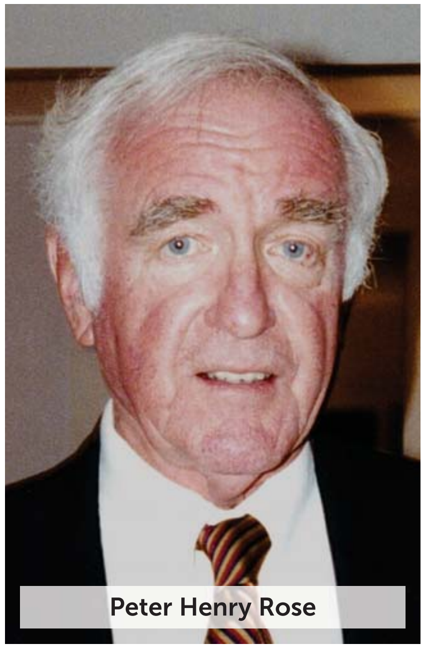
Known as the father of ion implantation technology, Peter Henry Rose died peacefully at his home in Rockport, Massachusetts, on 23 March 2017.

Peter was born on 16 January 1925 in Lincoln, UK; his father was a ship builder. For many years he and his family lived on the Isle of Wight off the UK's south coast. That introduction to country life, with water as a central part, greatly influenced his life and lifestyle. He was for many years an avid sculler on the Charles River in Boston; later he loved sailing his 18-foot catamaran at high speed and on one hull across Lake Sebago in Maine. He also was an enthusiastic skier; on one occasion, while giving a technical paper to an international audience in the Alps, he wore his ski boots so that he would not lose a single moment on the slopes.

Peter received a PhD in nuclear physics from the University of London. Without any instruction, he also was given an adjunct divinity degree, which gave him great amusement throughout his life.

Peter's first job after graduation was at Frank Whittle's innovative turbojet-engine research laboratory. Then, as a Fulbright scholar and research associate, he spent two years at MIT. Peter returned to the UK in 1954 before emigrating permanently to the US in 1956 to join a new and innovative company, High Voltage Engineering Corp. HVEC was dedicated to building large particle accelerators for fundamental nuclear structure research. During his 15-year tenure there, he worked closely with one of its founders, Robert Van de Graaff, and rose to be director of its research laboratory. As well as improving the performance of the machines, Peter was author or coauthor of more than 50 peer-reviewed technical papers.

In 1968, while at HVEC, Peter was asked to build a much smaller accelerator to be used for semiconductor device development at Fairchild Semiconductor. At that time, the desired junction doping of a transistor was achieved by thermal diffusion of dopants into the substrate. That resulted in devices with a distribution of threshold voltages from which those with the desired operating voltage were sorted, and it led to a low



Peter Henry Rose

product yield. Using ion implantation made the threshold voltage precise and resulted in a 100% yield. Unfortunately, the HVEC machine used the existing technology, which had the dopant-ion selection magnet at ground potential after the ion acceleration stage. That configuration resulted in a machine that was nearly 11 meters long; although useful for research, it was quite unsuitable for a production setting.

That experience was the inspiration for Peter's invention of a radically different compact accelerator design, with the selection magnet placed prior to acceleration. Almost no one in the scientific or technical community believed the arrangement could work. But the ion implanter design continues to be used worldwide by semiconductor factories.

In 1971 Peter chose that risky design for the product of his first start-up company, Extrion Corp, which grew to employ 1500 people; it was acquired by Varian in 1975 and still exists today as a division of Applied Materials. The repetitive reproduction of the ion implanters required standard manufacturing procedures that were not in line with Peter's entrepreneurial talents, and he left Varian in 1976 to form his second start-up, Nova Associates (now Axcelis Corp). The company grew rapidly and created an innovative high-current ion implanter. Peter also contributed to the start-up and operation of a subsidiary, Sumitomo Eaton Nova, because sales to semiconductor fabrication factories were particularly strong in Japan at the time. Additionally, he helped colleagues found or agreed to serve as a director of several other start-ups, including Ibis Technology and Passport Systems.

Peter was a superb leader, which contributed to his being an outstanding entrepreneur. People loved to work with him because they trusted and believed in him. He created a wonderful environment that didn't seem like work because it was so much fun. Customers knew he would make good on his promises. Because of his integrity and reputation, Peter was often able to sell complex ion implanters based on just a simple concept sketch. For the same reason, he was also able to convince investors to support the development of his numerous innovations.

Among Peter's many honors, he received the National Medal of Technology and Innovation in 1996. His most cherished award was from the City of Gloucester, Massachusetts, which recognized Peter for helping turn the city into a high-tech center from a one-industry fishing town, to the benefit of residents in the city and surrounding areas.

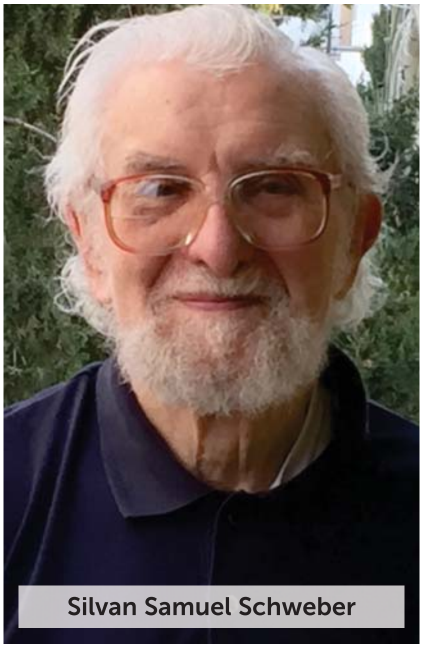
Peter was a gentleman who worked hard and played hard. Rather than raise his voice in anger, he would raise a glass in celebration. He was great fun to be with, both in and out of work. We and the semiconductor community miss him.

Andrew Wittkower
Soitec USA Inc
Rockport, Massachusetts
Geoffrey Ryding
Neutron Therapeutics Inc
Danvers, Massachusetts

Silvan Samuel Schweber

Silvan Samuel Schweber, who died on 14 May 2017 in Cambridge, Massachusetts, was a theoretical physicist by training and an accomplished historian of physics who contributed major works on the evolution of theoretical physics from James Clerk Maxwell through Richard Feynman.

Born in Strasbourg, France, on 10 April 1928, Schweber grew up in a Jewish family that soon felt the approaching



Silvan Samuel Schweber

danger of Nazism. Fleeing to Vichy, the family found temporary and fragile respite; his mother succeeded in rescuing several family members and some unrelated Jews who had been arrested by French police.

After October 1940 the family situation deteriorated as the race laws descended into Vichy. Schweber and his family moved to Marseille and eventually made their way through Spain, Portugal, and Cuba before finally settling in the US in 1942. Largely self-taught through years on the wing, Schweber was fascinated by literature and music. In 1944 he enrolled in the City College of New York, where he began studying chemical engineering but eventually shifted to physics. From there he moved to the University of Pennsylvania and continued in physics with Walter Elsasser and Herbert Jehle. With his 1949 master's degree in hand, he began his PhD work at Princeton University under the supervision of Arthur Wightman; he received his degree in 1952.

Without a doubt, the single greatest influence on Schweber was Hans Bethe, with whom he worked as a postdoc at Cornell University between 1952 and 1954. Along with Frederic de Hoffmann, Schweber and Bethe published *Mesons and Fields* (1955), one of the earliest textbooks to treat postwar developments in quantum field theory and renormalization. Schweber expanded on that material in his 1961 textbook *An Introduction to Relativistic Quantum Field Theory*; a 2005 edition remains in print today. Following his work with Bethe, Schweber joined the physics department faculty at Brandeis University in 1955, where he spent the rest of his career and served three times as department chair.

Building on his experience as a theoretical physicist and textbook author, in the early 1980s Schweber began to explore the history of science. His first forays examined relations among 19th-century astronomers, economists, and naturalist Charles Darwin, but soon he began to investigate the history of quantum field theory. From the start of his work in the history of science, Schweber sought to understand technical developments within broader intellectual and institutional contexts. Those developments include the first successful efforts in the late 1940s to "renormalize" the infinities that had long plagued field-theoretic calculations. Schweber's investigations culminated in his masterful 1994 book *QED and the Men Who Made It: Dyson, Feynman, Schwinger, and Tomonaga*, which remains the most thorough account of one of the great successes of modern physics.

In Schweber's telling, young physicists like Julian Schwinger and Feynman succeeded because their intense efforts were embedded within a particular infrastructure. For example, unlike prevailing traditions in other countries at the time, physics departments in US universities housed theoretical and experimental physicists together, an arrangement that fostered close interactions between them. Those close ties were buttressed by massive World War II military projects such as radar and the Manhattan Project, which reinforced many American physicists' pragmatic approaches and underscored the need for theorists to "get the numbers out" rather than get distracted by formal niceties. Members of Schwinger's and Feynman's generation, joined by émigrés like Freeman Dyson from the UK, further benefited from strong postwar government support, including for new conferences and postdoctoral opportunities, to nurture and grow the nascent community of US-based theoretical physicists. In Schweber's reconstruction, original ideas about virtual particles and recalcitrant integrals thus unfolded against a specific historical backdrop.

After *QED and the Men Who Made It*, Schweber roamed across several domains of the history of physics. Much of his historical work centered around Bethe. Schweber's 2012 biography, *Nuclear Forces: The Making of the Physicist Hans Bethe*, captures Schweber's two favorite expressions of profound admiration: "off-scale," referring to individuals' intellectual capabilities, and "inner moral compass," about their ethical sense.

In an earlier study, *In the Shadow of the Bomb: Oppenheimer, Bethe, and the Moral Responsibility of the Scientist* (2000), Schweber contrasted J. Robert Oppenheimer's and Bethe's responses to the weapon they helped create. (Oppenheimer headed the wartime Los Alamos laboratory; Bethe led its theory division.) In Schweber's eyes, the contrast was profound: Bethe led a life of moral integrity, whereas Oppenheimer perpetually had to compromise to maintain as best he could his insider status in the halls of power. Schweber's book *Einstein and Oppenheimer: The Meaning of Genius* (2008) sketches a different dyad, this time setting Einstein's remoteness from postwar meson and quantum electrodynamics physics against Oppenheimer's engagement.

Schweber received the American Physical Society's Abraham Pais Prize for History of Physics in 2011. Members of several generations of historians of science, who worked closely with Schweber, recall him as a deeply committed mentor. He encouraged immersion in the science and never hesitated to speak out when he felt that history of science was straying from its best self.

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