

*At a meeting of the FACULTY OF ARTS AND SCIENCES on November 2, 2021,
the following tribute to the life and service of the late Richard Ernest
Kronauer was spread upon the permanent records of the Faculty.*

RICHARD ERNEST KRONAUER

BORN: August 5, 1925
DIED: October 18, 2019

Richard Ernest Kronauer, Gordon McKay Professor of Mechanical Engineering, *Emeritus*, was a highly productive and renowned scholar of mathematical biology, gifted teacher and mentor, and valued colleague with a Harvard career that spanned more than six decades.

Born in 1925 in Paterson, New Jersey, he was a precocious high school student and was admitted to Harvard when he was 15, but his family thought he was too young to go away to college, so he attended the nearby Stevens Institute of Technology instead. His studies were interrupted by a two-year stint in the Navy before he earned a bachelor's degree in mechanical engineering in 1947.

He then achieved his original goal of coming to Harvard, receiving his master's and Ph.D. degrees and staying as a faculty member and groundbreaking researcher for the rest of his illustrious career.

Though experienced with research in both fluid mechanics and applied mathematics, he is primarily recognized for his pioneering work in mathematical biology, especially research on human circadian rhythms. Professor Kronauer's 1982 paper "Mathematical model of the human circadian system with two interacting oscillators" outlined a new method for elucidating the biological circuits that underlie circadian rhythms in physiological processes such as blood pressure or body temperature. His research also has direct implications for the causes and possible treatments for many types of sleep disorders, contributions for which he received the Peter C. Farrell Prize in Sleep Medicine from the Harvard Medical School Division of Sleep Medicine in 2008. He was co-inventor on six process patents relating to circadian rhythms.

In the late 1960s, MIT considered opening a medical school but ultimately decided to partner with Harvard to create a program in technology-based medicine. Professor Kronauer represented Harvard Engineering in the deliberations and became a founding faculty member

of the Harvard-MIT Division of Health Sciences and Technology, today a leading producer of research-focused M.D.s and Ph.D.s in biomedical engineering.

He also led the creation of biomedical engineering education at Harvard. He taught classes in mathematical modeling of physiological systems, biological fluid mechanics, and bioelectricity, which attracted a broad range of students and inspired generations of Applied Mathematics concentrators to work on medical and biological problems.

He stood out among faculty of his stature and accomplishments for his willingness to spend seemingly unlimited time with his students, including undergraduates, discussing the science about which he was so passionate. One felt as though this incredibly busy and productive man always had time to meet, to discuss, debate, and explore ideas.

His career was in its latter stages when personal computers came into widespread use. A precocious undergraduate once came to Professor Kronauer with a problem after running a complex computer simulation. Almost instantly, he pronounced the results to be faulty, seeing with X-ray vision the hidden mistake embedded in the commercial software and writing the equations out in chalk on the blackboard, occasionally pausing to pull out his trusty slide rule, to prove his point. Other former students recounted races between themselves, with calculators, and their advisor Professor Kronauer, with the slide rule, to solve a particular mathematics problem. They always came to the same result, and Professor Kronauer frequently worked it out first.

On another memorable occasion, a statistician on an NIH site visit team questioned whether his analytic and modeling core could conduct time series analysis on unequally spaced data collected in human studies, as all the algorithms available at that time required equally spaced data. Without missing a beat, he stood up and, while explaining each assumption, covered the six blackboards surrounding the conference room with equations until he completed a mathematical proof demonstrating that he could do so, ending the proof with a flourish and then sitting down. After an ensuing silence, the chair of the study section pronounced, "Clearly, they have the math under control." Shortly thereafter, the review committee awarded the proposal a perfect score, funding human circadian research for decades to come.

Professor Kronauer had a tremendous respect for data and understood, long before the emergence of the field of data science, the value of thinking deeply about how to harvest it. He was also an early pioneer in what we today refer to as quantitative biology. He recognized earlier than most how mathematics could unlock biological mysteries, presaging the development of a branch of inquiry in which Harvard today enjoys global leadership.

Harvard is home to brilliant researchers and amazing teachers; Professor Kronauer was both. In his office, at the most heated points in impassioned debates about mathematical models and theories, he was known to raise his hands and say, "Peace . . . we will test both theories."

He appreciated and mentored students with intellectual rigor, both men and women, at a time when women's contributions were not universally valued in his field. Professor Kronauer's own curiosity remained undiminished throughout his career. Weeks before he died at age 94, he published, with longtime collaborator Charles Czeisler and colleagues, a paper describing new findings on photic resetting of circadian rhythms, which he considered the most important result of his career.

When he embraced something or someone, a line of intellectual inquiry, a professional colleague, or tending to his gentleman's farm or his love of opera, he did so wholeheartedly. And he embraced no one more than his childhood sweetheart, soulmate, wife, and life-long partner, Joanne, who predeceased him.

He taught by example how to live and work with dignity, integrity, humility, kindness, and a rich sense of humor.

This legendary sleep researcher went to sleep for the final time at his home in Tucson, Arizona, on October 18, 2019. He is survived by his three children, Karen Edwards Kronauer, Charles Richard Kronauer, and Anne Kronauer Saetren, and six grandchildren.

Respectfully submitted,

Frederick H. Abernathy
Charles A. Czeisler
Robert D. Howe
Francis J. Doyle III, Chair

Portions of this Minute were previously published in "Memorial service set for Richard E. Kronauer," *Harvard Gazette*, December 4, 2019, <https://news.harvard.edu/gazette/story/2019/12/harvard-professor-richard-e-kronauer-dies-at-94/>.