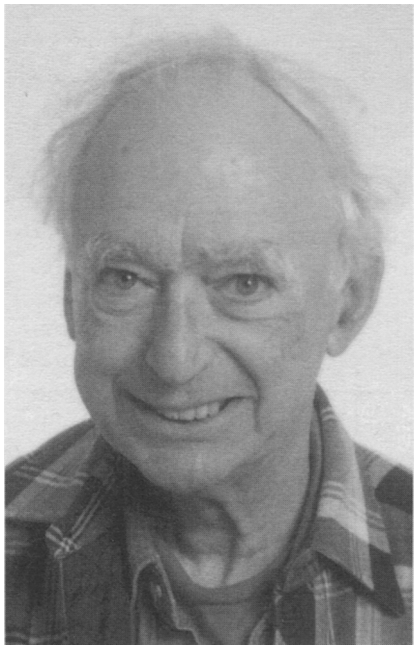
WILLIAM B. JOYNER



I still vividly remember meeting Bill Joyner for the first time. I was attending a symposium at Harvard in 1970 honoring Professor Francis Birch. During one of the coffee breaks, an elfish fellow with a twinkle in his eye introduced himself and proceeded to tell me all about the wonderful research we were going to do together in Menlo Park. My first reaction was, "Who IS this guy?" Not only did he seem ancient (40, at that time), but I had never heard of him before. In the arrogance of youth and as a freshly minted Ph.D. from MIT, I thought I knew by name, if not personally, all the seismologists who really mattered. Even if I had known that Bill had received an A.B., A.M., and Ph.D. from Harvard, or that he had spent five years working in seismic exploration, two years working for a Beltway consulting company, and six years working as a researcher and administrator at the national headquarters of the U.S. Geological Survey, I would not have been impressed—his Ph.D. thesis was a gravity survey of New Hampshire, for Pete's sake, and he had never published a paper in a seismological journal! If you had told me that that meeting was to be the start of a 30-year collaboration with one of the smartest and most inspirational persons I've known, I would have wondered what recreational drug you were using. But I held my tongue and was polite, one of the smartest things I've ever done.

It turned out that Bill and I were headed for the USGS in Menlo Park at the same time—he to help in the fledging earthquake hazards program, and I to start a postdoctoral fellowship. Bill quickly retooled himself as a seismologist, including learning to program in Fortran, and started to fill critical gaps in data and analysis methods. He accomplished an incredible amount of work in his first decade at Menlo Park, most of it dealing with site response. He created the ongoing program to obtain downhole velocities for site response. To date, data from about 300 holes have been collected. Many of the early holes were 30 m in depth, because that was the usual depth reached in one day's drilling. This number has taken on a life of its own, because it is now the depth over which shear-wave velocities are averaged to characterize sites in recently proposed building codes (we currently collect data to a bit less than 100 m depth).

Bill also spearheaded the installation of a downhole array of seismometers in the soft sediments near the margin of San Francisco Bay (the Ravenswood array). This array recorded a number of earthquakes, including the 1971 San Fernando earthquake. A paper analyzing the site response from these data was published in 1976.

The Ravenswood array recorded only weak motions, but Bill was fully aware of the potential for nonlinear effects from stronger shaking. For this reason he wrote computer programs for truly nonlinear wave propagation in one and two dimensions. The calculations are simple and efficient, and utilize a characterization of nonlinearity that allows considerable freedom in incorporating laboratory results on soil behavior. His codes were decades ahead of their time, and they are now finding increased use worldwide.

In perhaps his most well known and enduring work, Bill produced a series of papers in which he introduced and applied a novel regression method for the derivation of equations from which ground shaking can be predicted as a function of magnitude, distance, fault type, and geologic site conditions (including the first use of average shear-wave velocity to characterize the geologic conditions at a site). Researchers throughout the world have copied his methods, and the equations have become both the standard for predicting ground motions for engineering design and a benchmark for comparing equations developed from other parts of the world. In particular, the equations are widely used by federal and California agencies, as well as private industry, in developing building codes and in evaluating the design of critical facilities such as nuclear power plants, dams, hospitals, schools, and waste disposal sites. Although my name is associated with those papers, I more or less went along for the ride—Bill made the fundamental decisions and innovations regarding the methods, and I helped implement those decisions.

Recognizing that the ground-motion prediction equations suffered from a lack of data at distances close to earthquakes, Bill turned to theoretical predictions of motions based on extensions of the stochastic method published by me and others. He used modern concepts of fault mechanics and seismic source theory to derive a spectral scaling law appropriate for events so large that they rupture the entire width of the seismogenic zone. He followed this work with the development of methods for the prediction of ground motions close to large earthquakes, for which the source can no longer be considered a point in space.

In his last sole-authored paper, published in the December 2000 issue of *BSSA*, he analyzed data and developed equations for predicting the ground motion from long-

period surface waves generated at the edge of deep sedimentary basins, such as the Los Angeles basin. These surface waves dominate the long-period ground motion and control the seismic response of high-rise buildings, storage tanks, and long bridges constructed in basins.

Bill's scientific stature was recognized by the numerous invitations he received to present papers and keynote addresses around the world, as well as by the students and professionals who sought his advice. He served as a co-advisor for two Ph.D. students at Stanford University. He also served on a number of USGS teams reviewing seismic design of dams, nuclear power plants, a waste disposal system, and a rapid transit system. In addition, he was asked by the Panama Canal Commission to provide design ground motions for the seismic retrofit of the Panama Canal.

Bill was particularly effective at bridging the gap between seismologists and engineers, working on various influential committees that contributed to earthquake hazard mitigation. Internationally, he was one of the longest serving members of the U.S.-Japan Joint Panel on Wind and Seismic Effects, and he was a member of the Working Group on Effects of Surficial Geology of the International Association of Seismology and Physics of the Earth's Interior's Committee on Earthquake Hazard Assessment. Nationally, from 1987 to 1991 he was a member of the prestigious National Research Council Committee on Seismology, and he twice served on the Strong Motion Instrumentation Committee of the California Seismic Safety Commission. He served on the Seismology Committee, Foundation Design Subcommittee, and Zonation Subcommittee (Chairman from 1982–1986) of the Structural Engineers Association of Northern California, and he was a member of the Building Seismic Safety Council Technical Sub-Committee No. 1 (ground motion) and Technical Sub-Committee No. 3 (site conditions), as well as the Seismology Committee of the Structural Engineers Association of Northern California. His committee work had significant impact on the design spectral shapes and site factors for the various versions of the Uniform Building Code, the NEHRP building code, and the 2000 International Building Code.

In the year before his death, Bill added the direction of the USGS National Strong-Motion Program to his list of responsibilities. He employed a rare combination of skill, wisdom, and tact in managing the program at a critical time in its history, when the boundaries between engineering-oriented and seismologically oriented data collection and archiving have become blurred.

In recognition of his contributions and service, he was awarded the Department of the Interior's Meritorious Service Award in 1986 and its highest honor—the Distinguished Service Award—in 2000.

Bill's depth of knowledge may not have been too apparent on first meeting him, but that impression was soon dispelled. As one of many examples, I accompanied him to visit an internationally famous statistician whose paper Bill had reviewed. Bill's incredible intuition about things statistical told him that the calculations in the paper must be wrong, but he wanted to discuss it personally rather than through an anonymous review. The interaction between Bill and the famous professor was fascinating—the famous professor started off in a condescending explanation of basic statistics, but Bill quickly cut to the chase, and in short order convinced the famous professor that in fact the calculations were wrong.

Bill's intellectual curiosity was apparent in that he attended all seminars at the USGS, no matter how boring or irrelevant to earthquake hazards, and no matter how busy he was; this often meant that he would work during weekends to make up for lost time. In addition, Bill always found time to speak with any visitor and to answer questions from scientists and engineers inside and outside the USGS and from the lay public. He always brought enthusiasm, wisdom, and humor to those conversations. He also adored using aphorisms to impart his wisdom, as in, "Never wrestle with a pig; you'll both get dirty, but only the pig will enjoy it."

When he decided he needed something, he simply went out and learned it. This included topics as diverse as Fortran 90 programming, matrix methods in regression analysis, touch typing (from a local community college), and photography so that he could take portraits of his beloved dogs.

To many, particularly those who only saw him at meetings, Bill probably seemed to be a polite, even-tempered, and even shy person. His personality seemed to be anything but blustering and domineering. But as I had the pleasure of having an office adjoining his for years, I know that was only part of the story. Even after 30 years of collaboration, I would sometimes be afraid to discuss some research ideas with Bill, for I had to endure his icy stare and body language that clearly said, "This is the dumbest thing I've ever heard." But if I could resist the impulse to bolt from his office, Bill always melted and we would have a wonderful and stimulating conversation. He liked nothing better than an intellectual challenge, no matter how mundane. It didn't matter whether it was why I was getting divide-by-zero errors, or whether it was the best strategy to do regression analysis of sparse and unevenly distributed strong-motion data, or even whether it was a good time to buy or sell stocks—he always had a sound reason for the advice he gave.

Bill seemed to have a love-hate relationship with modern technology, particularly personal computers. I always dreaded the days after he got a new piece of software or a new computer. The walls in our new office are very thin, and the profanity-laden outbursts from Bill were downright scary—Bill Gates would have feared for his life if he had happened to be nearby during one of Bill's outbursts. I coped by acquiring an extensive collection of CD's and a good pair of headphones. There were times when I wanted to consult with Bill, but after those outbursts I would be afraid to enter his office. The miracle was that he could put his frustrations behind him in an instant, giving me or any other visitor his complete and friendly attention.

In the last few years I would tell Bill that I didn't think that the outbursts were good for his health. His response was typical of Bill—he said I should worry when he DIDN'T get

upset. Sadly, that day came early this year. In the summer of 2000, Bill was diagnosed with anaplastic thyroid cancer. He underwent several rounds of chemotherapy, providing temporary relief and giving us false hope that he was in remission. He was productive almost to the end, traveling to meetings as the interim head of the National Strong-Motion Program and learning Fortran 90 in order to rewrite his maximum likelihood regression subroutine more elegantly (his last research accomplishment). His health deteriorated rapidly in March, and he died at home on March 24. His technical contributions, wisdom, and humor will be missed by all who knew him.

David M. Boore
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025