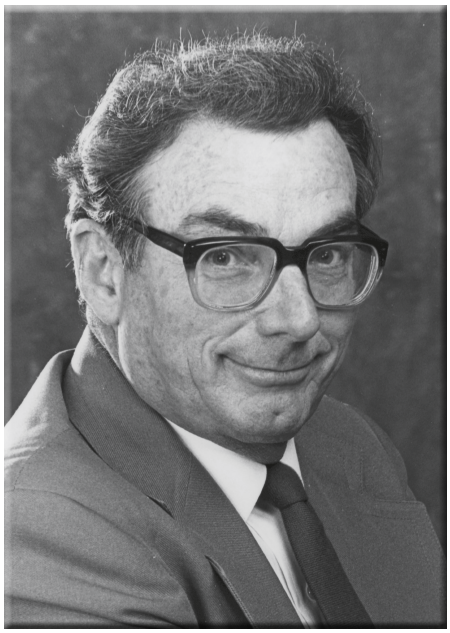

William H. Guier (1926–2011)

Three days after the USSR launched Sputnik I in October 1957, William H. Guier and George C. Weiffenbach,[1] "listened" to the 20-MHz Sputnik signal using a radio-wave analyzer and tape recorder, capturing the Doppler frequency shift from frequency-versus-time data. By early 1958, Bill and George had broken new ground, demonstrating that a complete and accurate set of orbit parameters for a near-Earth satellite could be inferred from Doppler shift data. In March 1958, Frank T. McClure,[2] then Chairman of the Research Center and later Deputy Director of the Laboratory, suggested that Bill and George apply their results to the inverse problem: from orbit parameters and Doppler shift of a signal from a satellite, derive the position of an Earth-bound observer. From these origins came the APL Space Department and the world's first satellite-based navigation capability, Transit, more formally known as the Navy Navigation Satellite System. Through his curiosity and pioneering efforts in those early days, Bill Guier had a profound impact on the future of APL.

David M. Silver, Editor-in-Chief

AN APPRECIATION

I first met Bill Guier in late fall 1957. I was invited to a meeting of "The Space Committee" to hear Bill talk about his and George Weiffenbach's discovery that a satellite orbit could be determined from measuring the Doppler shift. There were approximately 20 people in a small conference room in Building 1. As I recall, among the people there were Frank McClure, George Weiffenbach, Bill Avery, Art Leak, George Bush, Bob Newton, and the Committee chairman, Bob Rich. Bill's talk stretched my mind. The things he had done I would have previously thought to be impossible. He talked of a mind-boggling concept called "vector filtering on scalar inputs," to determine satellite positions (vectors) from scalar (frequency) measurements. True to form, I asked some questions and received answers that I could understand. I remember coming away with a feeling of exhilaration, because what Bill described was very important and certainly beyond the state of the art. George Weiffenbach then talked about the design of the data-gathering instrumentation and mentioned that if he had about $37K, he could put together a *good* tracking station. He needed a high-quality frequency standard because he had scrounged the one he was using out of a communications receiver.

I really did not get to know Bill until 1960 when we started to work together intensely on the Transit software. It was an exciting time, but it did not seem so; the fear of failure pressed hard on us all. The problems were very difficult, and the timescales seemed impossible. On a superficial level, Bill and I maintained a Mutt and Jeff relationship: he voiced boundless enthusiasm at every turn, whereas I was fond of understatement. We worked crazy hours for 2 or 3 years, many nights until 2 or 3 in the morning. I remember Bill asking me—he was wide

awake—to check his Taylor series coefficients when I could hardly read my watch. With his certain analytical ability, annoying enthusiasm, and unfailing physical intuition, the monster computer program slowly came together, the effort spanning 5 years. The effort seemed to have no definite beginning or end. Many people contributed: Guier, Holland, Hopfield, Hook, Marvin, Monahan, Newton, Pryor, Weisert, Welty, Yingling, and Yionoulis. We had frozen the design to get on with the programming but Bill's thoughts and analysis and his insistence on changes did not stop. He usually won out in the ensuing battles because his ideas were compelling. Some of his insight was overwhelming: In one analysis, which strongly affected the receiver design, Kershner[3] called Bill's insight and mathematics[4] "skullduggery."

What kept us going was that the Transit effort, based on the Guier/Weiffenbach discovery, was really worth doing—"worthy of the human spirit." For the success of the effort, Kershner, Guier, and Weiffenbach were absolutely indispensable people. The Transit program was certainly the peak experience of my professional life and similarly so for many people. Later, events proved that a meeting in the fall of 1957 was where the APL Space Department was born: I heard McClure tell Guier and Weiffenbach that they probably had to go through the "eye of the needle." He meant that they would have to join the satellite effort full time and give up their positions in the Research Center.

Transit was an incubator of space technology. Not only did it provide a globally-available navigation and positioning system, putting the world on a single coordinate system—"a global datum"—it also provided a means of propagating universal time and yanked the hoary arts of surveying and geodesy to a new level of global consistency and accuracy. Guier and Newton[5] derived the gravity field description (the geopotential model[6]) that was used to certify the accuracy of the overall Transit system to ensure that it met the specifications.[7]

The literature on Transit is vast. Entire issues of the *Johns Hopkins APL Technical Digest* have been devoted to Transit,[8,9] as well as an issue of the *Philosophical Transactions of the Royal Society London*.[10] The Guier–Weiffenbach announcement of their discovery was published in *Nature*.[11]

Around 1966, Guier returned to the Research Center and worked the rest of his career on biomedical engineering under a joint appointment with the Medical School, where he became an associate professor of biomedical engineering and contributed to advances in echocardiography and cardiovascular magnetic resonance imaging. After 40-plus years, Bill retired from APL in 1992 but continued his appointment in Biomedicine for some time thereafter.

Guier and Weiffenbach received a number of honors related to Transit. For instance, in 1986, they shared, with McClure and Kershner (both posthumously), the Pioneer Award of the International Aerospace and Electronic Systems Society of IEEE for the Transit system invention and development. This award recognized their singular roles in developing, demonstrating, and implementing the Transit satellite navigation system, which ultimately served both the military and civilian communities. In 1988, Guier and Weiffenbach were awarded the Magellanic Premium of the American Philosophical Society, Guier for "the highly precise system, the Transit Satellite Navigation System."

I owe to Bill's memory gratitude for rescuing my professional career from mediocrity and for sending me on a wild and exciting ride. The Laboratory owes to Guier, Weiffenbach, McClure, and Kershner the memory of the Space Department beginning, and what a "beginning."

Harold D. Black

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