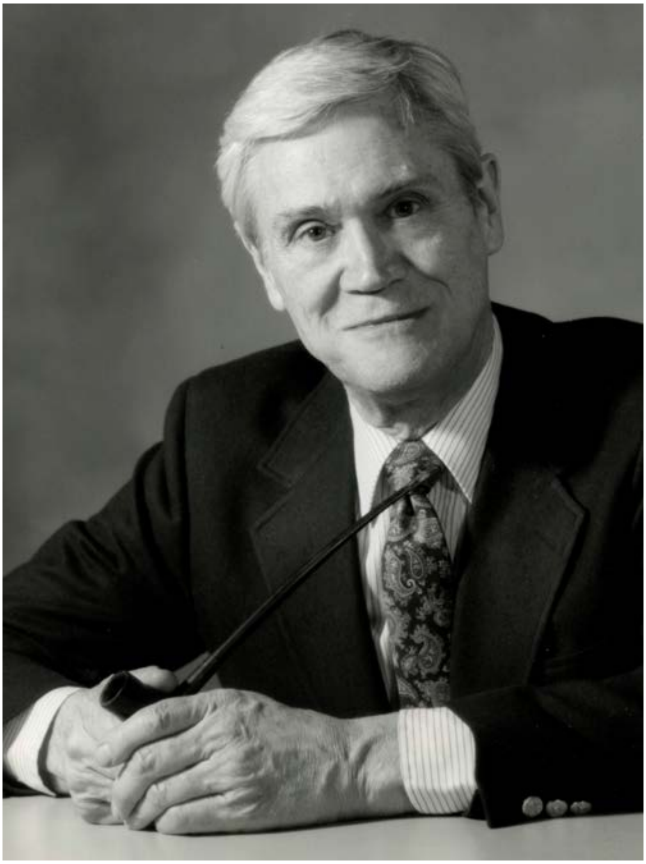

Louis Fabian Bachrach

WESLEY A. CLARK

1927–2016

Elected in 1999

"For the design of early computers."

BY IVAN E. SUTHERLAND, MARY ALLEN WILKES,
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WESLEY ALLISON CLARK passed away at his home in Brooklyn, New York, on February 22, 2016, at age 88. He was a pioneering architect of several revolutionary computers in the 1950s and 1960s, all motivated by his early, and at the time heretical, conviction that computers should be designed to enhance the productivity of the user, not the efficiency of the machine.

Long before the word "ergonomic" came into popular use, Clark's computers were outstandingly well human-engineered and thus highly interactive. They include the first computer with a ferrite-core memory (the Memory Test Computer), the first all-transistorized computer (the TX-0), the first computer with a million-bit memory (the TX-2), and the LINC (laboratory instrument computer), widely recognized as the world's first personal computer, the great-granddaddy of all the personal devices in use today.

The revolutionary nature of Clark's work is best understood by recalling the computing environment of the 1950s. Computers were then so massive and expensive that maximizing their efficiency was the paramount goal. The orthodox view therefore was that a computer had to be shared by multiple individuals. Initially this took the form of sequential sharing through batch processing via decks of punched cards, but by the late 1950s people were exploring time-sharing that promised multiple users "simultaneous" interactive access. However, interactivity was limited both by the access mechanism (typically teletype-like terminals) and by the fact that the increasing number of users quickly swamped the capacity of even the most powerful machines.

Defying the time-sharing orthodoxy, and influenced by his early 1950s experience with MIT's Whirlwind computer (where single users were given long periods of complete access to and control over the computer), Clark became convinced that complete individual "ownership" was vital.

He also recognized the power of graphical interaction with the computer. Thus, in the mid-1950s he designed the TX-2 at MIT's Lincoln Laboratory with a light pen and large display—and, although it was the most powerful computer in the world at the time, he insisted that it be dedicated to individual users. He resisted attempts to time-share it, ruffling some feathers at MIT in the process, and instead, despite the cost, made sure that an individual could take complete control of the computer for extended periods. His philosophy permitted Ivan Sutherland, for example, to develop Sketchpad, thereby laying the foundation for today's computer graphics. Years later Clark told Sutherland, "You know, I designed the TX-2 just for you. I just didn't know who you were at the time."

By the early 1960s Clark recognized that hardware size and costs were about to shrink dramatically, further facilitating individual ownership. He foresaw, at least a decade before anyone else, that computers would become personal devices with which one would interact through graphical means.

He had also spent some time in the early 1950s working with Belmont Farley on the use of computers to simulate neural activity of the brain. By the early 1960s he had developed a deep appreciation for how a real-time, interactive computer in the hands of a single researcher could advance biomedical research. In 1961 he addressed the first symposium of the Brain Research Institute with these words:

> Ideally the researcher would have the general-purpose computer in his laboratory for use "on-line," enabling him to observe and act on the basis of the calculated results while the experiment is in progress.

By 1962 this vision had become the LINC.

Before the LINC, for medical researchers to use the analytical power of a computer, they first had to reduce experimental data to a stack of punched cards that were transported to the computer center for processing behind closed doors by a "computer operator." It took hours, even days, to get results. It was not possible to interact with an experiment in real time or watch it in process on a display.

With the LINC, the computer moved into the laboratory as an instrument that could be integrated directly with an ongoing experiment. It was developed under Clark's leadership at MIT's Lincoln Laboratory and first used in a research experiment in April 1962 to analyze a cat's real-time neural responses at the National Institute of Mental Health (NIMH) in Bethesda, Maryland. It created a sensation. Robert Livingston, scientific director of the NIMH, said later, "It was such a triumph that we danced a jig right there around the equipment. No human being had ever been able to see what we had just witnessed. It was as if we had an opportunity to ski down a virgin snow field of a previously undiscovered mountain."

The National Institutes of Health (NIH) quickly embraced this development by funding the LINC Evaluation Program, which placed LINCs in a dozen selected biomedical research laboratories around the country in the summer of 1963. Within two years the LINC had revolutionized biomedical research.

Faculty at the University of Wisconsin, where one of the LINCs was placed, said in 2003, "Not only did it speed up data analysis by more than two orders of magnitude, but it also provided rapid, 'on-line' feedback of processed output that enabled hitherto impossible experiments to be carried out." The recipient of that LINC, neurophysiologist Joe Hind, went on to establish in 1965 a Laboratory Computer Facility at the university, making laboratory computers available to all in the Medical School. In so doing, he contradicted the university's policy that the university's main computer could handle all of the campus's computing chores even though it required carrying punch-card programs and specially processed data tapes to the Computing Center.

The LINC demonstrated that a small computer could exist with sufficient harmony and integrity to be a productive tool in the hands of a single person. It was the first of what came to be known as "minicomputers" (at that time the term "personal computer" was not much used), and it heavily influenced the design of subsequent DEC machines, including the PDP-4 and PDP-5, the direct forerunner of DEC's highly successful PDP-8.

Of course, the LINC was huge by today's personal computer standards: the electronics alone, all transistor logic, occupied a refrigerator-sized cabinet. Clark was fond of pointing out, swiping his hand like a paintbrush in the direction of the LINC, that "someday you'll be able to just paint all this on any handy flat surface." He believed that computers should be fun to use, and his were. He was a great admirer of the Honeywell-Emett Forget-Me-Not Computer, an engaging monument to invention and whimsy.

Clark's courage in bucking the centralized computing and time-sharing orthodoxy of the day was risky. It put him at odds with MIT's governing policies on more than one occasion and led to his parting ways with the institute. Although he had obtained a $30 million commitment from NIH, the largest grant it had ever awarded, to establish an interuniversity Center for Computer Research in the Biomedical Sciences, he and MIT disagreed over how the center was to be run and in 1964 Clark declined the grant and left MIT. He would often say in later years that he had had the distinction of being the only person in the world to have been fired from MIT for insubordination three times.

Clark and his team found a welcome home at Washington University in St. Louis, where he was appointed Research Professor of Computer Science and, with new funding from NIH, founded the Computer Systems Laboratory and continued the LINC Evaluation Program. He led the design of "macromodules," computer building blocks that spurred interest in asynchronous logic.

He made a crucial contribution to the design of the Arpanet, forerunner of the Internet. Interconnecting different models of computers in a network was a formidable problem. Clark suggested that a "small computer" be installed at each site that wanted access to the Net, with the small computers all interconnected and each site then needing to cope with just the one interface to its own small computer. This "small computer," now called a router, became, and remains, a central part of the design of the Internet.

The fact that Clark was able to make such a significant move to a different state, and have the core of his team join him, was remarkable and attests to people's dedication to him and his vision. He was an enabler and quiet mentor to all who worked with him. He was witty and engaging, humble, charismatic, and compassionate, and everyone who worked with him became a lifelong and loyal friend. One of his colleagues at Washington University, Warren Littlefield, captured the experience:

> Wesley opened a door for me to adventure and discovery. By inviting me into his magical kingdom I enjoyed the great good fortune of playing a small but exhilarating part in the evolution of computing. . . . Every day in the Computer Systems Lab was an exciting day. . . . You quickly became convinced that the center of the computing universe lay, at least while [Wesley] was there, in St. Louis, Mo.

He was active outside the laboratory too. He was a national lecturer for the ACM (1966) and a lecturer in the IEEE Distinguished Visitor Program. Three of his engaging presentations are available on YouTube. In 1972 he was one of six computer scientists invited to visit and lecture in China for 18 days as guests of the Chinese government. They were the first American scientists to visit China in nearly 20 years. He authored or coauthored over 25 publications.

For his extraordinary contributions, he received the ACM-IEEE Computer Society Eckert-Mauchly Award for Computer Architecture in 1981, and in the same year was a charter recipient of the IEEE Computer Society Computer Pioneer Award for the "First Personal Computer." He was awarded an honorary DSc by Washington University in 1984 and elected to the National Academy of Engineering in 1999. In 1977–1978 he was the Sherman Fairchild Distinguished Scholar at the California Institute of Technology.

He served on the National Academy of Sciences' Computer Science and Engineering Board (1968–1971) and its Committee on the Use of Computers in the Life Sciences (1961–1973) as well as the NAS Committee on Scholarly Communication with the People's Republic of China (1974–1976).

Clark was born in New Haven on April 10, 1927. He attended the University of California, Berkeley, where he received a degree in physics in 1947 and pursued graduate studies, which included two years with the Nuclear Reactor Dynamics Group at Hanford, Washington.

In his spare time he taught himself Chinese, built a working Turing machine (which he dubbed "The Only Working Turing Machine There Ever Was, Probably," or "TOWTMTEWP"), and designed and built lovely things such as an elegant aviary that harbored several pairs of finches and graced his home in St. Louis for many years.

He is survived by his wife, Maxine L. Rockoff; sons Douglas, Brian, and Peter and daughter Alison Eleanor Clark; a sister, Joan Murphy; and five grandchildren.