In Memoriam | DOI:10.1145/3572995 Simson Garfinkel and Eugene H. Spafford

In Memoriam: Frederick P. Brooks, Jr. 1931–2022

GENERATIONS OF COMPUTING professionals may remember Frederick P. Brooks, Jr., as the author of the seminal text on system engineering, *The Mythical Man-Month: Essays on Software Engineering*[a] and his essays such as *No Silver Bullet—Essence and Accident in Software Engineering*.[b] Those who worked with Brooks, winner of the 1999 ACM A.M. Turing Award "for landmark contributions to computer architecture, operating systems, and software engineering," may also remember him as the lead designer of IBM's System/360, as an innovator in graphics and virtual reality, and as the founder of the University of North Carolina's computer science department.

Brooks was born on April 19, 1931, in Greenville, North Carolina. He received his A.B. in Physics from Duke University in 1953. As a freshman, he saw an article in the January 23, 1950 issue of *Time Magazine* entitled "The Thinking Machine" that sparked his interest in computing. Brooks went on to complete his Ph.D. in applied mathematics at Harvard University, where he studied with computer pioneer Howard Aiken. After graduating in 1956, IBM recruited him to work on the "Stretch" 7030, IBM's first transistorized supercomputer, and on Harvest, a one-of-a-kind code-breaking computer that was being built for the U.S. National Security Agency. While working on the Stretch, Brooks is credited with coining the term "computer architecture."

Following his work on Harvest,

PHOTO BY JERRY MARKATOS, COURTESY OF U.N.C. DEPARTMENT OF COMPUTER SCIENCE

Brooks led the engineering effort to create IBM's 8000-series computer, a high-performance system designed to be the successor to IBM's successful 7000 series. Brooks' team produced a single 8000 machine in 1961. Bob Evans, then a senior executive in the Data Systems Division who was backing a different and incompatible computer architecture, canceled the project. In those days, practically every computer system that IBM sold had its own instruction set and operating system.

MARY WHITTON

Fred was interested in helping others. He saw computing as providing tools. He was an incisive scholar, but also humble and kind. Those qualities were evident in all he did.

After that setback, Brooks reportedly offered his resignation to Thomas J. Watson Jr, then IBM's Chief Executive Officer. According to Brook's former student and ACM fellow Steve Bellovin, Watson replied, "I just spent a billion dollars educating you; I'm not letting you go now!"

Later that year, a committee led by Watson and IBM's vice president T. Vincent Learson, and including Brooks and Evans, concluded that to remain dominant IBM would need to create a single computer system that would obsolete every other computer on the planet—including those currently being sold by IBM. Eventually called System/360, the goal was to have a single instruction set running on every IBM computer from the smallest workgroup system to the largest mainframe. Thus, moving software from machine to machine would require minimal or no modifications.

System/360 was a "bet the company" project for IBM. The project cost more than five billion dollars and required fundamental innovations in microelectronics, hardware, software, and manufacturing. System/360, more than anything else, made IBM the world's most successful computer company for decades to come.

Bob Evans, who had overall management responsibility for System/360, asked Brooks to serve as project manager. For the first three years, Brooks managed the development of the computer's hardware architecture; in 1964, he became manager of the delayed Operating System/360 effort.

a Brooks, F.P. Jr. *The Mythical Man-Month* (anniversary ed.). Addison-Wesley Longman Publishing Co., Inc., USA, 1995.

b http://worrydream.com/refs/Brooks-NoSilverBullet.pdf

Brooks often said the achievement he was most proud of related to System/360 was the 8-bit byte. That change allowed for lower-case letters to be represented—something that had not been the case with prior systems—leading to the development of EBCDIC and, eventually, ASCII. Other manufacturers did not complete their transitions to 8-bit bytes until the 1980s.

In 1964 the University of North Carolina at Chapel Hill invited Brooks to join the faculty as the founder and first professor of what would be the Department of Computer Science. He accepted but delayed his arrival by a year to finish the work on OS/360. Brooks, who was deeply religious, viewed the UNC leadership opportunity as his own calling. He would lead the department as its chairman for the following two decades.

Brooks's first research topic: what had gone right—and wrong—on System/360. "After leaving IBM in 1965 to come to Chapel Hill as originally agreed when I took over OS/360, I began to analyze the OS/360 experience to see what management and technical lessons were to be learned. In particular, I wanted to explain the quite different management experiences encountered in System/360 hardware development and OS/360 software development," he wrote in the preface to *The Mythical Man Month*, first published in 1975.

One of Brook's many lasting observations in the book is that tasks with sequential constraints cannot be executed faster by adding more people. "The bearing of a child takes nine months, no matter how many women are assigned," he wrote. With deeper analysis, he articulated what he named Brooks's Law: "Adding manpower to a late software project makes it later." Improved productivity only happens when the added people come up to speed—and provided the project can be sufficiently partitioned to accommodate the additional workers. Brooks had learned this lesson the hard way—adding more programmers to the OS/360 project had put a late project even further behind schedule.

IBM offered Brooks a grant to start the new department at UNC, which he insisted be shared with Duke University and North Carolina State University. This generosity and vision eventually led to IBM and other companies to invest in the Research Triangle area, benefiting all three universities and the field more generally.

According to his long-time collaborator, Mary Whitton, shortly after joining UNC, Brooks sought out people working on difficult problems for which computing might help. That led to a 30-year collaboration with protein chemists; the systems developed for them led to innovations in interactive 3D computer graphics, visualization, and virtual reality. Whitton stated in email "Fred was interested in helping others. He saw computing as providing tools. He was an incisive scholar, but also humble and kind. Those qualities were evident in all he did."

In a call, Turing Laureate Pat Hanrahan said that Brooks's approach made UNC "the center of the universe" for computer graphics. Hanrahan added, "Fred influenced my own work, not only in graphics but in how I approached design overall. Furthermore, Fred was always highly positive and very supportive. He was deeply insightful—not only focused on his work but looked at the broad aspects of the field. He had very wide-ranging interests. I think the best characterization is he was 'wise' in a broad sense of the word."

Whitton stated that Brooks also believed in service. He required that UNC graduate students teach an undergrad course as part of their studies, to help create well-rounded academics. Brooks also included professional practice in the curriculum. "And he taught people to be kind to each other," she added.

Brooks remained an active faculty member at UNC until his retirement in 2015.

In 1994, Brooks's fellow Turing Award winner and ACM Fellow Ivan Sutherland convinced him to co-chair a National Research Council study on high-performance computing. U.S. leadership in computing was in question at the time, as was the role and purpose of continued federal funding for computing research.

"Every senior researcher we approached to participate said 'yes.' I've never seen such a positive response from such a senior group," recalls Sutherland.

The committee met six times starting in March 1994, producing its final report[c] in February 1995. The report showed how U.S. government funding in computing research created "new ideas and trained people," creating multiple billion-dollar businesses—although typically, the payoff took roughly 15 years.

"Fred was a statesman in the best sense of the word, as well as a great leader, a very kind man, and a fine engineer. I am proud to have been his friend and colleague. Everyone should read his *Mythical Man Month*," Sutherland concluded.

Brooks was awarded the ACM Distinguished Service Award in 1987 and named an ACM Fellow in 1994 "for outstanding innovations in computer architecture, including pipelining, instruction look-ahead, and cache memory." That same year he was awarded the ACM–AAAI Allen Newell Award for his work on the System/360 architecture and "contributions to visualization methods for Biochemistry."

Brooks was also awarded the IEEE John von Neumann Medal in 1993 and the ICM-IEEE CS Eckert-Mauchly Award in 2004 for his work on computer architecture, instruction sequencing, and interrupt systems.

Among many other awards, Brooks was elected to membership in the National Academy of Engineering, the National Academy of Science, and the American Academy of Arts and Sciences.

Brooks died on November 17, 2022. He is survived by his wife Nancy, children Kenneth, Roger, and Barbara, nine grandchildren, and two great-grandchildren. C

c National Research Council. *Evolving the High-Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure.* The National Academies Press, Washington, DC, USA, 1995; https://doi.org/10.17226/4948.

Simson Garfinkel is an ACM Fellow.

Eugene H. Spafford is a professor of computer science and the founder and executive director emeritus of the Center for Education and Research in Information Assurances and Security (CERIAS) at Purdue University, W. Lafayette, IN, USA. He is an ACM Fellow.