RESEARCH ARTICLE | JANUARY 01 1995

Math Professor Turns Classroom Program into Successful Business FREE

David I. Lewin

Comput. Phys. 9, 8–9 (1995)
https://doi.org/10.1063/1.4823379

An Interview with

Cleve Moler

Math Professor Turns Classroom Program into Successful Business

If he had not written a matrix-calculator program while he was a professor at the University of New Mexico, Cleve B. Moler would not now be chairman and chief scientist of a multi-million dollar software company, The Mathworks Inc., of Natick, Massachusetts.

A mathematician whose career has been devoted to numerical analysis and computation, Moler was cofounder of the company, despite the fact that he did not work for it for its first five years and lived in California while the company grew in Massachusetts.

Though listed as chairman and chief scientist, he told *Computers in Physics* that he mostly serves as a technical advisor. "Companies have chief operating officers and chief executive officers. I'd call myself chief scientific officer—except that it sounds too much like [Mr.] Spock."

The program, MATLAB, has evolved far from the days when it was just an easier way to access linear-algebra subroutine libraries, Moler says. "We've been doing a lot more with graphical user interfaces within the last few years, but when you get back to the heart of it, it all still goes back to EISPACK and LINPACK."

While an undergraduate student at the California Institute of Technology, Moler majored in mathematics "because it had the most electives." Though at one point tempted by science writing (both his parents were journalists), when he took an undergraduate course in numerical analysis from John Todd, he found that this was his forte.

"My first computer was a Burroughs 205 Datatron at Caltech in 1958. We programmed it in absolute numeric machine language—we punched things on paper tape and fed it into the machine," Moler said. "Around that time, IBM contributed a computer to UCLA, to something called the Western Data Processing Center that was supposed to handle all the computing needs of all the universities in 13 Western states." At UCLA, on this IBM 704, Moler found his first opportunity to use Fortran.

As a graduate student at Stanford University, he worked for George Forsythe, a mathematician who established that university's computer-science department in 1965. "My last year at Stanford, I was a graduate student in math and an acting instructor in computer science," Moler said.

> *"Numerical analysis is not at the center of computer science— nor is at the center of mathematics. It's sort of a black sheep for both areas."*

"Forsythe was interested in numerical analysis and the beginnings of mathematical software," Moler said. "He was an early editor of the "Algorithm" series of the *Communications of the ACM* (which later became *Transactions on Mathematical Software*), and he got me interested in that kind of thing."

They taught numerical analysis, but there was no good book available at the time for teaching matrix computation. In 1967, Forsythe and Moler published *Computer Solution of Linear Algebraic Systems*, which dealt solely with matrix computations. "It was one of the first books to have any programs in it," Moler noted, and the book contained Fortran, Algol, and PL/1 programs for solving linear equations.

"I like to say we use computers for what God intended them for—to do arithmetic," Moler said.

Moler continued to have close associations with Stanford, first as a visiting professor, and then as an adjunct faculty member, when he moved back to northern California in the late 1980s. Over this period, the department's emphasis shifted to artificial intelligence and the theory of computation.

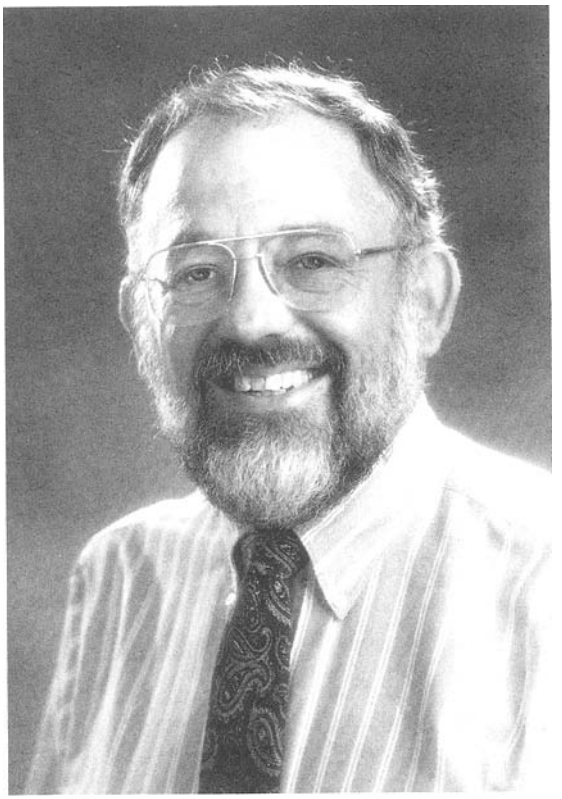
"One of the guys who succeeded Forsythe as head of the department said that numerical analysis was the mother of computer science, but now it's acting like an anxious grandmother," he said. "It's certainly true today that numerical analysis is not at the center of computer science—nor is it at the center of mathematics. It's sort of a black sheep for both areas."

In the 1970s, Moler was involved in the projects developing EISPACK and LINPACK, Fortran subroutine packages for matrix computation. "That started while I was at the University of Michigan and continued after I moved to the University of New Mexico," he noted. "It was centered at Argonne National Laboratory. Every summer we used to go to Argonne and work on the software projects, initially EISPACK and later LINPACK."

He became a familiar face around the laboratory during these summers. "It got so that I'd walk into Argonne and someone would say, 'Moler's here. It must be June!'"

In New Mexico he was teaching numerical analysis and linear algebra. "I wanted my students to have access to LINPACK and EISPACK without having to write Fortran programs. So I wrote the first version of MATLAB in Fortran as just a matrix calculator on top of LINPACK and EISPACK."

The Fortran version, which he calls "Classic MATLAB," was distributed



from the University of New Mexico to perhaps several hundred places worldwide in the early 1980s. "People found it useful for other things that I didn't know anything about, particularly (in electrical engineering) control theory and signal processing," he noted.

While Moler was a visiting professor at Stanford, he taught a course using MATLAB. Some of the university's electrical engineers got interested in the program, and two spin-off companies from the Stanford electrical-engineering department built commercial products for automatic control, using MATLAB as a base.

"About 1983 one of the individuals who worked on one of these commercial products, John Little, an MIT and Stanford electrical engineer, came to me and said he would like to do a serious commercial version of MATLAB," Moler recalled. "Little wanted to do this right: start a company, redo the program, and make this the basis for providing mathematical products to the engineering community."

Little quit his job, "went into the hills behind Stanford," and, together with another colleague, Steve Bangert, rewrote MATLAB. "They threw all my code away, started from scratch, and wrote it in C," the mathematician said. "They added a whole bunch of things, including MEX files and graphics, and the basis for the Toolboxes that are an important part of our product."

The company was formed in 1984 with Little as the only employee. Little, who remains The MathWorks's president, moved the company back to the Boston area in 1985, where the privately held company has since grown to 240 employees.

Moler himself stayed at the University of New Mexico only until 1985, moving first to Intel Scientific Computers in Beaverton, Oregon, to work on the Intel Hypercube. He then returned to California's Silicon Valley, where he went to work for a company that for most of its life was Ardent Computers.

"But there were close connections with MATLAB there," he noted. "We had MATLAB bundled on the Ardent computer, and much of the work I did at Ardent was MATLAB-related." Moler was involved in the software side of the computer—benchmarking, demonstrations, and software libraries.

When Ardent and its competitor Stellar merged in 1989, "many competent people left, including me," Moler said. At that time, he went to work for The MathWorks, which was already in Massachusetts. "I lived in California for a couple of years and commuted back here, spending half my time here and half my time working out of my home in California," he said. "Then I wanted to be where the action was, so three years ago I moved back here."

MATLAB has gone way beyond matrices—or even mathematics. "We're doing a lot of graphics and graphical user interfaces; we're a high-level language," Moler noted.

Asked to contrast MATLAB with Mathematica, he notes that the latter does both symbolic and numeric computation. "As a result," he claimed, "the numeric computation [in Mathematica] is really pretty inefficient. We only do numeric computation." The MathWorks now provides a symbolic computation add-on package that calls MAPLE.

The reason for MATLAB's dominance in a number of engineering areas lies in its provision of field-specific libraries of programs written in the MATLAB language called Toolboxes. These libraries exist for such applications as control systems, signal processing, neural networks, image processing, and statistics. Some are written by MathWorks staff, others (the Spline and Systems Identification Toolboxes), by outside experts.

"Certainly, in the areas of mathematics and physics, we and Mathematica are rivals. But if you go to some engineering disciplines, we're much stronger there," Moler asserted. All the Toolbox disciplines involve working with arrays of numbers, even if they are not normally thought of as matrices.

"We have users in a number of research disciplines, even physics—although we don't have very many there, yet," Moler said. "Geophysics is strong for us, interestingly. We have a couple of geophysicists on our staff."

One of the few things that Moler misses now that he has moved from academia to industry is the prestige of being a professor. "When I see one of my old Caltech friends on NOVA or something like that, I'm a little jealous. But I don't miss the drudgery of grading homework and of fighting for resources."

He notes that the graduate math and computer-science programs at New Mexico focused mainly on the needs of people at Los Alamos and Sandia National Laboratories. "Compared to graduate research work at the University of New Mexico, places like Intel, Ardent, and The MathWorks are actually much more academic and much more stimulating."

While he does no more formal teaching, he still considers himself a teacher. "I write, I give occasional lectures, I still help people learn about numerical analysis. But not in a formal academic setting."

David I. Lewin