

by changing the BIOS. Other manufacturers clamored to license CP/M. By 1981, an estimated 200,000 machines were running the system in around 3000 different hardware configurations. Kildall rapidly became a multimillionaire.

Success brought rewards for Kildall in the form of a California ranch, fast cars, and private planes. Like many programmers, he was motivated more by the challenge of writing elegant software than by running a growing business, and even though Digital Research was a casual, collegiate company, he rapidly grew bored with the business side. This explains the partly apocryphal story that he was out flying his plane when IBM executives came calling in 1980, keen to buy an off-the-shelf operating system for their proposed PC. That deal, famously, never happened, although not because Kildall was flying his plane, but because IBM had wanted to purchase CP/M outright for U.S.\$200,000, whereas Kildall had demanded ongoing royalties. IBM turned instead to **Microsoft** for a cheaper and more user-friendly operating system called **DOS** (substantially inspired by CP/M and, according to Kildall, copied from it). CP/M continued to sell steadily for several years (grossing annual sales of around U.S.\$44 million in 1983), but fell into disfavor once the IBM **personal computer** (PC) appeared and its **killer application**, Lotus 1-2-3, was released only on the **DOS** platform.

But Gary Kildall continued to develop innovative products. GEM was a **Macintosh**-like **graphical user interface** for PCs, years ahead of **Windows**, that was defeated by threats of legal action from **Apple**. Another product, called DR Logo (a version of the LOGO programming language), was conceived by Kildall as a more effective way of teaching children how to program computers than the then-prevalent BASIC language. In 1989, Kildall even attempted to market a direct competitor to DOS called DR DOS. Although widely recognized as technically superior to Microsoft's product, it made no impression on its market share.

In the last decade of his life, Kildall branched out into other projects. In 1985, he started a company called Knowledge-Set that pioneered multimedia **CD-ROM** publishing and launched the innovative *Grolier Encyclopedia*. After selling his remaining holding in Digital Research to **Novell** Corporation, he set up a

commercial and video production company called Video Design Group, followed by a company called Prometheus Light and Sound. He also became involved in charity work, notably devoting his time and money to helping children with AIDS. Kildall died under mysterious circumstances in Monterey in 1994, three days after suffering head injuries in a barroom brawl.

Gary Kildall has often been criticized for failing to turn Digital Research into the omnipotent corporation that Microsoft became. But CP/M and BIOS live on inside Windows-based computers, and his many other contributions to PC design will ensure that he is remembered, in the words of one colleague, as "a pioneer among pioneers."

BIOGRAPHY

Gary Kildall. Born 19 May 1942 in Seattle, Washington. B.S. and Ph.D. in computer science, University of Washington. Taught computer science at Naval Postgraduate School, Monterey, California. Developed CP/M, 1973. Founded Homebrew Computer Club, 1974. Founded Digital Research, 1976, and sold company to Novell Inc., 1991. Awards include Dr Dobb's Journal Excellence in Programming Award, 1997. Died 11 July 1994 in Monterey, California.

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—Chris Woodford

Killer Application

Engineers know that **hardware** drives **software**, in the sense that faster electronic equipment and larger memories allow more complex programs to be written. But economists know that software drives hardware: the volume production of computers can reach profitable levels only if popular programs are written and sold by the millions. In the computer industry a killer application (or *killer app*) is a program that transforms an electronic device into an electronic appliance—a consumption article for the masses.

There are several famous examples of killer applications. The first personal computers, such as the IMSAI or even the **Apple II**, were difficult to program and had a reduced memory capacity. They were products from the technically minded for the technically minded. However, a short time after the introduction of the Apple II, many applications were being written. The one program that made the Apple II very popular among nonexperts was VisiCalc, a spreadsheet program. Dan Bricklin (1951–) started writing the first version of this spreadsheet software at the Harvard Business School in 1978 and later recruited Bob Frankston (1949–) to make it more user friendly. In 1979, VisiCalc was ported to the Apple II and later to some other microcomputers. More than 1 million copies of the program were sold, and a market for packaged, off-the-shelf software had been established.

Another killer app was the legendary **Lotus 1-2-3** program, the spreadsheet developed by **Mitch Kapor** (1950–) in the early 1980s for the newly introduced IBM PC. Not only was 1-2-3 easier to use, but it included graphing and database capabilities. The pictures produced by 1-2-3 could also be used for business presentations. Millions of copies of Lotus 1-2-3 were sold in a few years and the package has gone, with different names, through many releases.

The **Internet** itself has had two main killer applications: **electronic mail** and the **browser**. When the **ARPANET** was created in the 1960s, e-mail immediately became one of its main applications and continues to be one of the major attractions of its replacement, the Internet. But ultimately, what brought millions of users to the Internet was the ease of use made possible by the **World Wide Web** and its first popular browser, NCSA Mosaic, developed by **Marc Andreessen** (1972–) in the early 1990s. Instead of typing commands, the user could now click his or her way through the net and retrieve text, pictures, audio, and video.

It is the dream of computer entrepreneurs to identify the next killer application, found a company to develop it, and see it become the next success story on Wall Street.

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—Raúl Rojas

Knuth, Donald

1938–

U.S. Computer Scientist

Don Knuth has had a remarkably productive career as a computer scientist. His major contribution is his magnum opus, entitled *The Art of Computer Programming*, planned in seven volumes, of which three volumes are extant. Knuth also designed the **TeX** program, for the preparation of documents, and the associated **METAFONT** system for designing typefaces, and has produced many novel research papers, mainly concerning **algorithms**.

As an undergraduate, Knuth studied mathematics at the Case Institute of Technology. In 1960, he was awarded a master's degree together with his B.S., an unprecedented move by the Case faculty. He studied as a graduate student at the California Institute of Technology (Caltech), where he received a Ph.D. in mathematics in 1963, and subsequently remained there as a member of the mathematics faculty. While at Caltech he was involved with **software** development, acting as a consultant for **Burroughs** Corporation (1960–68) and as editor of *Programming Languages* for the **Association for Computing Machinery** (ACM) (1964–67). In 1968 he became a professor of computer science at Stanford University where he has spent most of his career, and nine years later was appointed to Stanford's first endowed chair in computer science. He introduced several new courses into the curriculum, including courses dealing with data structures and concrete mathematics.

Knuth received the 1971 ACM Grace Murray Hopper Award for publication of the first volume of his mammoth treatise, *The Art of Computer Programming*. In 1974 he received computer science's ultimate prize, the **ACM Turing Award**, given for major contributions to the analysis of algorithms and the design of programming languages, and in particular for his contributions to the "art of computer programming" through his series of books under this title.

Knuth spent a decade or so away from this project to work on **digital** typography, developing the **TeX** system for document preparation and the **METAFONT** system for typeface design, which he issued in