livre = 20 sols and 1 sol = 12 deniers. A calculator for this number system has a 12-tooth sprocket for the least significant (denier) position, a 20-tooth sprocket for the second (sol) position, and 10-tooth sprockets for the more significant (livre) positions. With monetary machines calculating the complements is a bit more difficult than for a pure decimal machine, as the diminished radix complement of $x$ is $11 - x$ for the first (least significant) digit, $19 - x$ for the second digit, and $9 - x$ for the remaining digits. Some of the Pascal calculators have a small ring inside the sprockets with the diminished radix complements for each digit position. This feature was probably added to facilitate subtraction for the mixed radix (monetary) adding machines. Pascal made machines to accommodate the currency (livre, sol, and denier), where the two least significant digits have special sprockets with more teeth (20 for the sol digit and 12 for the denier digit). The book by Mourlevat includes photographs of several surviving Pascalines; about half of them are for currency calculations with the modified two least significant digits, and the other half have 10-tooth sprockets in all positions.

Pascal was not the first to design and construct an adding machine (that distinction goes to **Wilhelm Schickard** [1592–1635], who built a mechanical adding machine in 1621 that used a single gear tooth as the carry mechanism). Pascal was probably the first to build multiple copies of an adding machine, although each was handcrafted and the details of the design varied over time. The Pascal adding machines were not mass produced as we understand the term today.

In the twentieth century several adding machines that appear similar to Pascal's machine have been developed and mass produced. Early in the century the Calcumeter was developed and at least 60,000 were claimed to have been produced, although the serial numbers would indicate that over 100,000 were produced. The Calcumeter uses a spring-assisted carry mechanism. Later, the Lightning Calculator (a misnomer since it is in fact an adder) was produced initially in Grand Rapids, Michigan and later in Los Angeles, California. The Lightning Calculator used a simple gear-driven carry mechanism that requires significant force to effect a carry over several digits, but was apparently quite simple to manufacture.

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*—Earl Swartzlander*

# Patch

A patch is a quick-fix for some piece of **software** that is malfunctioning or whose security has been compromised. In the early days of computing, users reported software errors to the manufacturer, who programmed a "quick and dirty solution" before the problem could be solved definitively with the next software release. The patch was distributed in tapes to all customers. Usually, the patch was a binary file that substituted ("patched") some portion of the program binaries. The system administrator had to keep track of all patches, which in the case of complex operating systems, could run up to the hundreds. **IBM** reserved an unused portion of the binary file specifically for patches, called patch space.

In some cases the patch is distributed as source code, which has to be recompiled with the original program. This is done with **Unix** systems, which are usually delivered together with the source code.

One of the fastest patches in history was produced to stop the "Internet Worm" that infected computers connected to the **Internet** in 1988. The program used a **back door** in the software used to send **electronic mail** from one computer to another. It installed itself in the host computer, created a new process, and

looked for new computers to infect. Programmers in Berkeley and at other places in the United States disassembled the binary code (i.e., recuperated the original source program), wrote a fix, and started distributing the patch for the mail system just a few hours after the worm had been detected.

Patches are still a common tool for programmers. The **Apache** server, used to deliver **World Wide Web** pages from a Web server, was originally a replacement for an older, public-domain Web server. Because it contained many patches, it was referred to as "a patch-y server, " which eventually became Apache.

Today, software companies distribute patches via the Internet. Users can search the company's Web site to see if a patch is available to fix the particular problem they are having.

—*Raúl Rojas*

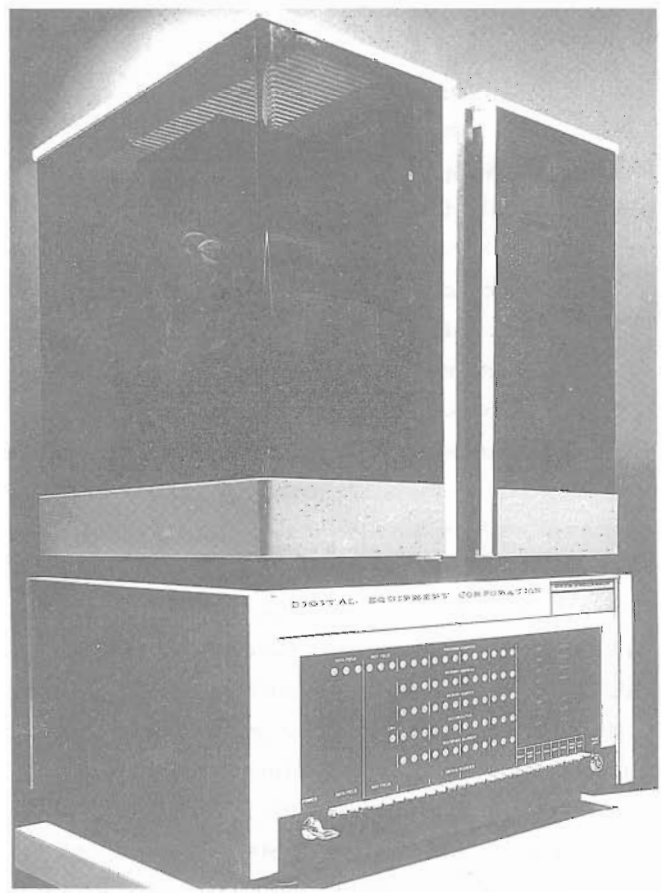
## PDP

PDPs (*programmed data processors*) comprise a remarkably successful line of small computers from **Digital Equipment Corporation**. The machines, built from 1960 to the present, had a major impact on the computer industry; they are often referred to as *minicomputers*.

Digital Equipment Corporation (DEC) was founded in 1957 in Maynard, Massachusetts by three former research engineers at the Massachusetts Institute of Technology (MIT): Harlan Anderson, Stan Olsen, and **Kenneth Olsen** (1926– ). The company's first facilities were located in an old woolen mill (often referred to as simply "The Mill"), which became the scene for many new developments in computer technology. In the late 1950s, DEC produced transistor-based *system modules*, plug-in circuit boards with simple logic functions, which were used as building blocks for laboratory or demonstration systems.

The explicit goal of constructing a stand-alone computer system surfaced in 1959, when another former MIT engineer, Ben Gurley, was hired to design and build the PDP-1. The machine was small, elegant, and inexpensive compared to other computers of that era, which is why it was called a programmed data processor rather than a computer. The name was then used for various other small computers, until Digital changed its naming conventions.

The design of the first PDP was influenced by three earlier MIT machines: the Whirlwind (1951), constructed at the MIT Computer Laboratory, and the TX-0 and TX-2 (1956 and 1957), built at the MIT Lincoln Laboratory. These three computers were all considered small at that time, and had simpler input–output (I/O) structures than those of contemporary computers. The word length of the PDP-1 was 18 bits (shorter than that of other commercial computers), it had 4 to 64 kilowords of ferrite **core memory**, a 16-channel interrupt mechanism, and a high-speed communication channel (called **Direct Memory Access** [DMA]). Processor and memory occupied four 19-inch cabinets. The typical base price was U.S.$120,000. The success of the PDP-1 helped establish Digital as an important computer company.



*Digital Equipment Corporation's PDP-8, 1965. (Courtesy of the Computer Museum History Center)*