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**The Development of Computer Operating Systems**

***Overview***

For most people, understanding their computers extends no further than needing to know how to be able to install programs. However, there are a number of essential elements that allow a user to make use of the computer hardware. This essay will explore the history of one of these elements—the operating system. An operating system is a program that serves as an interface between the user of a computer and the hardware. It sets up an environment in which a user can run programs conveniently and efficiently. Examples of operating systems include DOS, UNIX, and Windows. There are four main components of a computer system: the hardware, the operating system, programs, and users. The operating system manages the hardware and software resources of the computer to best meet the diverse and sometimes conflicting needs of programs and users.

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***Background***

The earliest computers did not have operating systems. Programmers interacted directly with the hardware through switches, tape, or punched cards. Because the computer could operate much more quickly than the programmer could load or unload tape or cards, the computer spent a great deal of time idle. To overcome this expensive idle time, the first rudimentary operating systems (OS) were devised. They were simple programs that were always in the memory of the computer and that ordered user programs by type and then automatically ran them one right after the other. The next step came about with the introduction of disk systems. Because disks are [random access](https://www.encyclopedia.com/science-and-technology/computers-and-electrical-engineering/computers-and-computing/random-access) devices, the information on them can be accessed in any order. Disks were used to hold user input and output until the central processing unit was ready to use it. As soon as the CPU finished one task it could jump on the disk to another job that was ready to run. Time-sharing was the next logical progression. In time-shared operating systems the CPU handles many jobs at the same time by switching in between them so quickly that it is unnoticeable. Thus, while one user is typing in a command, the CPU is executing another user's program.

**MULTICS and UNIX**

One of the earliest formal operating systems was MULTICS, designed between 1965 and 1972 at the [Massachusetts Institute of Technology](https://www.encyclopedia.com/social-sciences-and-law/education/colleges-us/massachusetts-institute-technology). MULTICS was a time-shared system running continuously on a large complex mainframe computer with a vast file system of shared programs and data. In 1969 Ken Thompson (1943- ) and Dennis Ritchie of the Research Group at Bell Laboratories began to work on UNIX, an operating system for minicomputers. Ritchie had previously worked on the MULTICS project, and UNIX was strongly influenced by MULTICS. (The name UNIX is a pun on MULTICS.) For this new OS, Ritchie and Brian Kernhagan developed the systems-[programming language](https://www.encyclopedia.com/science-and-technology/computers-and-electrical-engineering/computers-and-computing/programming) C to replace the assembly language previously used. By 1978 UNIX had become a product sold by AT&T (the parent organization of Bell Labs.) The size, simplicity, and clean design of the UNIX system encouraged programmers at sites other than Bell Labs to experiment with UNIX development. The most influential of these was a group at the [University of California](https://www.encyclopedia.com/social-sciences-and-law/education/colleges-us/university-california) at Berkeley. The advances made by this group convinced the defense department to fund further research, leading to the development of 4BSD (Berkeley Software Distributions) UNIX. 4BSD proved to be fundamental to the development of [the Internet](https://www.encyclopedia.com/science-and-technology/computers-and-electrical-engineering/computers-and-computing/internet). UNIX is a simple, highly flexible system designed to let the user build a more complex system if desired. It can run on mainframes, workstations, minicomputers, supercomputers, and even personal computers. Research and development of UNIX continued throughout the 1980s and 1990s, with special focus being placed on standardizing UNIX applications.

**Apple and Microsoft**

While UNIX was spreading beyond Bell Labs, the development of the Intel 4004 microprocessor in 1971 allowed the concept of a [personal computer](https://www.encyclopedia.com/science-and-technology/computers-and-electrical-engineering/computers-and-computing/personal-0) to emerge. The Intel 4004 was an entire CPU on a single microchip. Intel and other companies continued to refine the microchip, and [personal computer](https://www.encyclopedia.com/science-and-technology/computers-and-electrical-engineering/computers-and-computing/personal-0) (PC) kits that users assembled themselves became popular among computer hobbyists. Unlike mainframe computers, personal computers were not intended to have more than one user at a time and therefore were not concerned at first with time-sharing or multitasking. Instead, as the PC market grew, emphasis was placed on convenience and ease of use for the user. In 1976 Steve Jobs (1955- ) and [Steve Wozniak](https://www.encyclopedia.com/people/science-and-technology/computers-and-computing-biographies/steve-wozniak) (1950- ) designed and built the Apple I, which consisted of little more than a circuit board. However, by 1977 they had incorporated Apple Computer and announced the Apple II, which established a benchmark for personal computers. The Apple II had a simple operating system that came on a disk and accepted basic commands from a command line. In the same year [Bill Gates](https://www.encyclopedia.com/people/social-sciences-and-law/business-leaders/bill-gates) (1955- ) and Paul Allen (1953- ) founded Microsoft Corporation.

In 1980 a computer programmer named Tim Paterson developed an operating system called 86-DOS (Disk Operating System.) Like the Apple II and the other personal computer operating systems of the time, it was a command-line interface between the user and the PC hardware. Also in 1980 IBM decided to make a personal computer and chose Microsoft Corporation to provide the operating system for the new PC. Paterson joined Microsoft in April 1981, and by July Microsoft had bought all the rights to DOS. In August IBM sold its first PC, complete with MS-DOS 1.0. In less than a year reverse engineering had allowed competitors to produce clones of the IBM personal computer. Microsoft sold MS-DOS 1.25 to these clone makers. Throughout the 1980s MS-DOS continued to develop and advance, gaining more capabilities and meeting the needs of more powerful hardware and more advanced programs.

During the Super Bowl in January 1984, Apple introduced America to a completely innovative computer in an Orwellian-themed advertisement. The Macintosh was the first commercially successful computer with a graphical user interface (GUI). The GUI style of operating system allowed users to interact with the computer through click buttons, pull-down menus, and other image options on the screen rather than through a command line. In addition to the graphical interface, the Macintosh had more advanced hardware than IBM-style PCs. Apple continued to offer both the Apple II and the Macintosh throughout the 1980s. By the end of the decade, the Macintosh offered multifinder properties that allowed it to do more than one task at once. The Macintosh proved extremely popular, especially within educational facilities. Despite the Macintosh's popularity, Apple lost ground in the PC market throughout the 1990s until its introduction of the Powermac G3 in 1997. This was followed in 1998 by the highly successful iMac computers, aimed at a low-end market.

In order to compete with the Macintosh, Microsoft produced Windows 1.0 in 1985, which brought the GUI interface and Macintosh-style features to DOS-compatible computers. In developing Windows, Microsoft signed an agreement with Apple that Windows 1.0 would not use Macintosh technology. When future versions of Windows did utilize Macintosh ideas, Apple took Microsoft to court for copying the "look and feel" of the Macintosh. Microsoft argued that the agreement only applied to Windows 1.0, and the court ruled in favor of Microsoft. In the meantime, between 1985 and 1987 Microsoft and IBM collaborated on creating a new operating system. Microsoft pulled out of the collaboration and released Windows 3.0 based on technology that had been developed jointly. IBM continued working on the new operating system and released OS/2 in 1987. Although it was a technologically advanced system, it was not a great commercial success. In 1993 Microsoft produced Windows NT, an entirely new operating system written from the ground up, designed to compete with the server market that was dominated by UNIX. The GUI on this new operating system had much the same look as Windows but with different programming underneath. Meanwhile, Windows continued to develop, with the next major advance coming with the release of Windows 95 in 1995. It included a major overhaul of the GUI, some changes to the underlying DOS, and was tested by over 50,000 individuals and companies before being released.

Microsoft was quickly taking over the PC market, and some of its practices were drawing criticism. In 1997 Microsoft was ordered to make Windows 95 available without the applications software Internet Explorer. The argument was that by automatically including Internet Explorer on Windows 95, Microsoft was using its monopoly of the PC operating system market to destroy competition in other markets, such as internet software. Microsoft appealed the order. An appeal court ruled that the 1995 injunction did not apply to Windows 98, released in 1998. However, in May of that same year the U.S. Justice Department and 20 states filed an antitrust suit against Microsoft, charging it with abusing its market powers to destroy competitors. In November 1999 Judge Thomas Jackson issued his Findings of Fact, stating that Microsoft is an illegal monopoly and that it had abused its market power in anti-competitive practices.

**The Emergence of Linux**

While Apple and Microsoft were battling for space in the PC market, Linus Torvalds (1970- ) at the University of Helsinki in Finland was developing a freely distributed version of UNIX for personal computers called Linux. Linux began as a hobby for Torvalds, inspired by Minix, a small UNIX system developed by Andy Tanenbaum. In October 1991 Torvalds announced the first official version of Linux, 0.02. The system was still very rudimentary, but Torvalds put it out on [the Internet](https://www.encyclopedia.com/science-and-technology/computers-and-electrical-engineering/computers-and-computing/internet) for UNIX programmers and wizards to aid in its development. Hackers, programmers, and users of every flavor contributed, and by 1994 it had become a viable operating system, capable of running almost all UNIX programs. By 1996 Linux was a complete UNIX clone, capable of running X-windows—the UNIX version of a GUI. Because Linux was developed completely from scratch, it contains no code from AT&T or any other proprietary source. Much of the software available for Linux is from the GNU project at the Free Software Foundation in Cambridge, MA. In 1999 it was still possible to obtain Linux and a sizeable number of programs completely free of charge. Because of its flexibility, its price, and the fact that it is adaptable to most PC hardware, Linux became quite popular in the late 1990s as an Internet server. The growing interest in Linux convinced commercial software manufacturers to make their packages compatible with the Linux system. As this trend continues Linux will become even more viable and popular.

***Impact***

The pace of change in the computer industry makes it impossible to predict future developments in operating systems. However, this article has attempted to show that the evolution of operating systems in the second half of the twentieth century depended on a number of factors, including programmer interest, market pressures, hardware advances, and government oversight. Operating systems will continue to develop to meet the growing and changing needs of users and new hardware. It can only be hoped that the competition that gave rise to the PC revolution, the innovation that brought about GUI systems, and the free exchange of ideas that gave rise to Linux will all continue into the twenty-first century.

**DANIEL BONGERT AND REBECCA B. KINRAIDE**

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