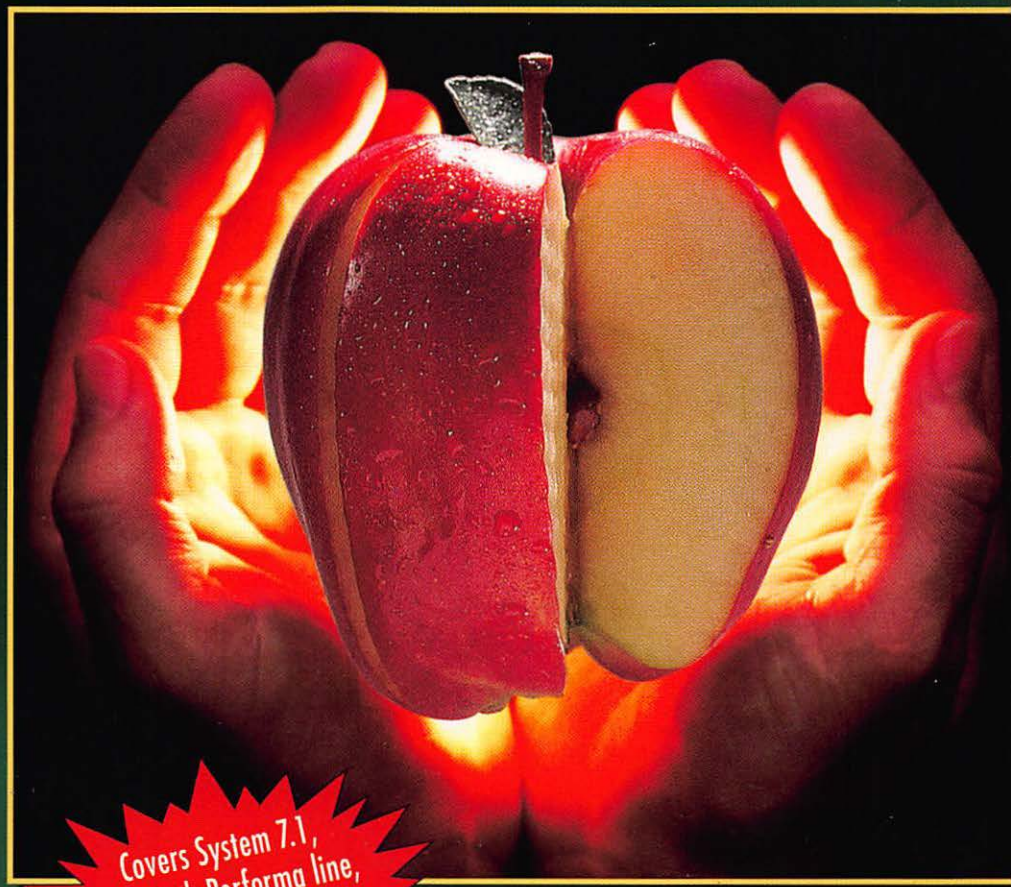
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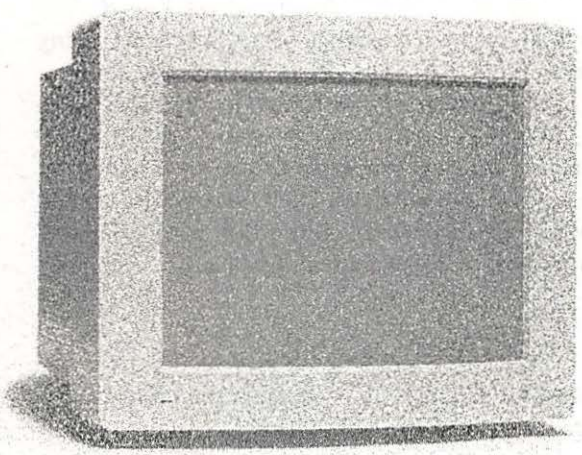
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Peter Norton & Jim Heid

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Preface

Time doesn't stand still, nor does the Macintosh world. Since the first edition of this book appeared in 1989, Apple has released more than a dozen new Mac models and almost as many new add-ons, as well as major revisions of the fundamental software that enables all Macs to run. Many of these new Macs and add-ons are more affordable than the machines they replaced—this new low-cost strategy has helped Apple ship millions of machines and earn a larger piece of the personal computing pie. And companies that make products compatible with the Macintosh haven't exactly been dormant, either. There are more ways to expand and enhance your Mac than ever before.

Although much of the basic information in this book's first edition still applies to today's Macs, a great deal has changed. That's why we're excited about this second edition—it gives us a chance to bring the book up-to-date with the latest developments in the Mac world.

If you read the first edition, you will find that we have changed our approach a bit. We still concentrate on giving you the fundamental background you need to understand, master, and appreciate the Mac, but we have tried to include more hands-on information, too—little tips and tricks that will streamline your work or enable you to tinker with some of the technical aspects of the Mac. Be sure to read the introduction that follows this preface to get a feel for what's inside.

In the end, our goal is the same: to provide the ultimate guided tour of Macintosh technology and concepts. If you took the first journey with us, welcome back! We hope you like the return trip. If this is your first time around, come on in and have a seat. The Macintosh world is a remarkable place, and we think you're going to have fun exploring it.

We'd like to express our gratitude to Scott Clark for his help in evaluating the manuscript and coordinating the project.

Jim Heid

Peter Norton

CHAPTER

1

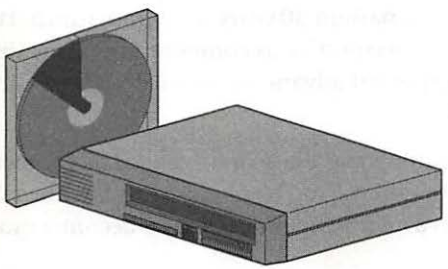
COMPUTERS 101: A SHORT COURSE

WHAT'S INSIDE

- Hardware and software—what they are and how they work together
- Memory and the jobs it performs
- Storage devices
- The devices we use to interact with the Mac
- The differences between system software and application software

The computer world has its own jargon, and if you're just starting out, a sentence filled with it can sound like a foreign language. Hardware, software, data, memory, RAM, ROM, CPU—it's enough to make you want to call for a translator.

The basics behind these terms aren't all that difficult. In this chapter, we lay the foundation of your computer knowledge by examining basic computing components and concepts. We examine these concepts in detail in later chapters. If you're familiar with the terms we have used so far, feel free to just skim this chapter.





A Joint Effort

The Mac is the result of an expertly choreographed joint effort between *hardware* and *software*. The common definition of hardware is the stuff you can touch—and that breaks when you drop it. Hardware is the physical components of the computer—its circuitry, disk drives, keyboard, screen, and so on.

Software is the less-tangible member of the duo, but it is what brings the Mac to life. Software is a series of detailed, stepwise instructions that programmers assemble in order to control the hardware and turn it into a tool for specific tasks, such as writing memos, drawing pictures, creating publications, and zapping aliens. Software is *stored* on the hardware (on disks, for example), but the instructions themselves are invisible. You cannot look at a disk and tell whether it contains software any more than you can determine what someone knows by looking at a brain.

The Central Processing Unit

Software and hardware work together much like your brain and body. Your brain handles the cerebral work—assimilating information and making decisions—and uses the body to interact with the outside world. In a Mac, the *central processing unit*, or *CPU*, follows the software's instructions—shuttling information, performing calculations, making decisions—and uses the hardware to interact with you, receiving your instructions from the keyboard and mouse and supplying responses using the screen or a printer.

In *minicomputers* and *mainframe* computers, the workhorses of business and scientific computing, central processing units are comprised of many separate electronic components—often more than exist in an entire Macintosh. In a personal computer like the Mac, the CPU is a one-piece affair. The Mac is built around a *microprocessor*—a single component that performs the same basic jobs as a multi-part CPU in a large computer.

A microprocessor is an *integrated circuit*, also called an *IC* or *chip*. The latter term is a tribute to the substance from which ICs are made—minute wafers, or chips, of silicon. A single IC contains the electronic equivalent of thousands—in many cases, millions—of separate electronic components. It's an entire circuit that would have filled a gymnasium 30 years ago—miniaturized to fit on a head of a thumbtack. From our perspective as computer users, the development of the IC was the most significant advancement in electronics since transistors replaced vacuum tubes.

From the outside, an IC chip looks like a multi-legged bug; a rectangular piece of plastic that contains between 4 and 80 or more legs. Remove the plastic case and put what's left under a microscope and the view becomes more interesting.

Suddenly, you're looking at an aerial view of a midwestern city, with myriad streets and avenues running in straight, precise lines, interconnecting infinitesimally small components.

The CPU chip in most Macs is called a *68030*—the number bestowed on the chip by its designer and manufacturer, Motorola Corporation. The Mac Classic and the PowerBook 100 uses the slower and less expensive Motorola 68000. Like most microprocessor manufacturers, Motorola groups related chips under the umbrella of a "family" number, and then numbers the members within that family. Macs use the 68000 family of microprocessors, sometimes referred to as *680xx* because those final two numbers change with each new generation of CPU chip. The 68030's successor (the chip used in top-of-the-line Macs) is the 68040, for example.

Bits and Bytes

Because a CPU makes decisions and performs calculations, it's often described as the Mac's brain. But technically speaking, it's more accurate to refer to a CPU as the central switching station of the Mac. In addition to performing calculations, the CPU enables the Mac to store, retrieve, and manipulate information. It does so by reading and changing the on-off settings of millions of electronic switches in the Mac's *memory*.

Each of these switches represent one *bit*—the smallest piece of information with which the Mac can work. Like a light switch, a bit can have one of two settings: 1 ("on") or 0 ("off"). The term *bit* is derived from the phrase *binary digit.*

In the Mac world, this on/off concept surfaces frequently. On a black-and-white Mac monitor, such as a Classic or Classic II, each dot on the screen corresponds to a bit. If the bit is a 1, that dot is turned on (black). If the bit is 0, the dot is turned off (white). So under the hood, the Mac's terrific graphics are nothing but a group of bits—some on, some off (see figure 1.1).

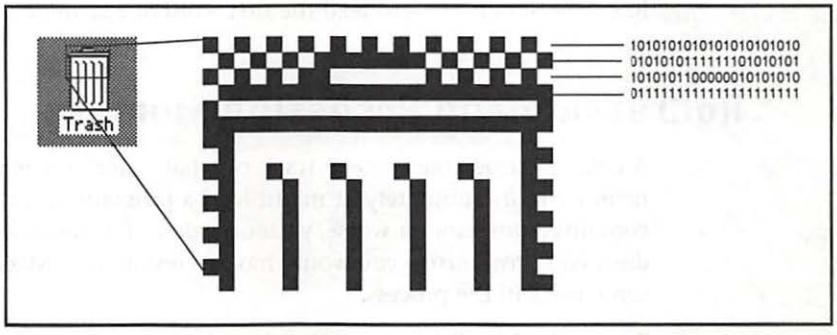


Figure 1.1: The Mac's screen display corresponds to a collection of bits.

Just as writers combine letters into words, computers combine bits into larger, more useful units called *bytes*. A byte is a group of eight bits. A single byte can represent a number or a letter of the alphabet. You often will hear the terms *byte* and *character* used interchangeably, as in "this cable can transfer 15,000 characters per second." (If you want to learn more about bits and bytes and how computers work with numbers, see Appendix B.)

As you peruse computer magazines or brochures, often you will see a computer described as being a *16-bit* or *32-bit* computer. These phrases refer to how many bits of data the computer can process at a time. Generally, the capability to process more bits simultaneously makes the computer faster—just as a bus can move more people in a single trip than can a car.

Most Macs are 32-bit computers: they can work with information in 32-bit chunks. (By comparison, early personal computers, such as the Apple II, were 8-bit computers.) Macs that use the 68000 processor—the Classic, PowerBook 100, and the now-discontinued Plus and SE—are hybrids of 16- and 32-bit computers. Some portions of the 68000 microprocessor can work with only 16 bits of data at once, while others can work with 32. This is one reason why these machines aren't as fast as their true 32-bit cousins.



Memory: The Mac's Storage Space

A microscopic switching station isn't worth much if it isn't connected to something. The Mac's CPU is connected to many components, but one of the most important is *memory;* the Mac's short-term storage area. The Mac's memory contains software instructions as well as *data*—the information you're creating and storing, whether it be a letter, a name-and-address list, or a picture.

The Mac's memory consists of a set of chips, each containing thousands of electronic switches, each of which represents one bit. The CPU reads and changes the settings of these switches as it stores the bits that comprise the programs you use and the information you create. And all of this happens in less time than it takes to read the first word of a sentence.

Addressing and Accessing Memory

A CPU must be able to keep track of what's stored where. If it were to use memory indiscriminately, it might load a program into an area that already contains a program, or worse, your own data. The result would probably be a dreaded *system crash*—you would have to restart your Mac, and probably lose some work in the process.

To enable the CPU to keep track of memory, each memory location—each group of eight switches—has its own *address,* the computer-memory equivalent

of post office box numbers. By keeping track of memory addresses, the CPU is able to determine where things are, and equally important, how much unused memory, or *free memory*, is available for new data or more programs.

RAM: Short-Term Memory

In the early days of computers, CPUs had to access memory sequentially, one byte after another. To keep our post office box analogy alive, it was as if, in order to retrieve your mail, you had to go through all the boxes with lower numbers first. Needless to say, a sequential approach to accessing memory wasted the CPU's time and slowed the computer's performance. These problems were solved with the development of *random-access memory*, or *RAM*—memory whose addresses the CPU could access in any order. With RAM, the CPU can go directly to a given memory address—just as postal patrons go directly to their mailboxes.

Perhaps the most important point to remember about RAM is that it retains its contents only while the Mac is turned on. In technospeak, RAM is *volatile*. This is why programs provide Save commands—and why it's a good idea to use them often. Computers contain other kinds of memory that isn't volatile. This second category of memory (there are several) helps give the Mac its unique personality.

ROM: Memory that Doesn't Forget

The non-volatile memory we're referring to is called *read-only memory*, or *ROM*. The Mac's ROM chips store software that enables the Mac to operate—to check its hardware for problems when you first switch on the computer, for example.

In ROM chips, the electronic switches that represent ones and zeros are "glued" in place. The contents of a ROM chip are recorded permanently when the chip is manufactured, and cannot be erased or changed (except by lightening bolts and other electrical mishaps). Because ROM-based software is permanent and doesn't need to be restored each time the computer is turned on, ROM is an ideal place to store the fundamental software a computer needs to operate. (This rudimentary software is often called *low-level* software because it performs very basic tasks.) Software that's frozen into ROM form is sometimes called *firmware*.

Technically speaking, ROM is random-access memory, too. That is, the Mac doesn't need to access the fixed addresses in a ROM chip in sequential order. So, the term *random-access memory* and the acronym *RAM* are a bit outdated and misleading. Because of this, some people prefer to describe RAM as *read/write*

memory, a phrase that more accurately describes what it does. In this book, we use the term *memory* when it's obvious that we're talking about RAM; when there might be some confusion, we use *RAM* or *ROM*.

Kilobytes and Megabytes: Measuring RAM and ROM Capacity

The capacity of RAM or ROM chips—the amount of information they can hold—is determined by the number of electronic switches built into the chips. This capacity is measured in units of 1,024 bytes called *kilobytes*, usually abbreviated with the letter *K* or the letters *KB*. 1,024 kilobytes equal a *megabyte* (*M* or *MB*), or roughly one million bytes.

You might wonder why kilobytes are formed by 1,024 bytes rather than a nice, round number such as 1,000. The answer is simple—if you think in binary terms. 1,024 equals 2 raised to the tenth power. So, in binary, 1,024 *is* a round number—just as, in the decimal numbering system with which we're used to working, 10 to the third power (1,000), is a round number.

Most Mac models come with 2 or 4 megabytes of RAM. You can add additional memory to improve the Mac's performance and increase the number of programs you can run simultaneously. We will have much more to say about memory expansion in later chapters.

Disks: Long-Term Storage

Because RAM loses its contents when the power goes, computers need a way to store the information we create. The answer: *mass-storage devices*, such as floppy disk drives or their more copious cousins, *hard disks*. Floppy and hard disks translate the ones and zeros that make up software or data into magnetic patterns on a circular spinning disk. When you save your work, the Mac copies data from RAM to the disk, as shown in figure 1.2. When the Mac needs to read the stored information, the drive's magnetic recording head interprets the magnetic patterns and translates them back into ones and zeros, which the CPU stores in memory.

When you save your work, the information is recorded on disk in a *file*. A file is a named collection of data stored on disk. Files can be documents, such as memos, pictures, or publications; or they can store software. Anything that resides on disk is stored in a file.

Because floppy and hard disks contain mechanical parts, they're much slower than all-electronic RAM or ROM chips. Still, disk drives are quite a bit faster

than the mass-storage devices computers used to have. Early personal computers, for example, used cassette tapes to store programs and data. Just starting the computer up could take several minutes—and several tries.

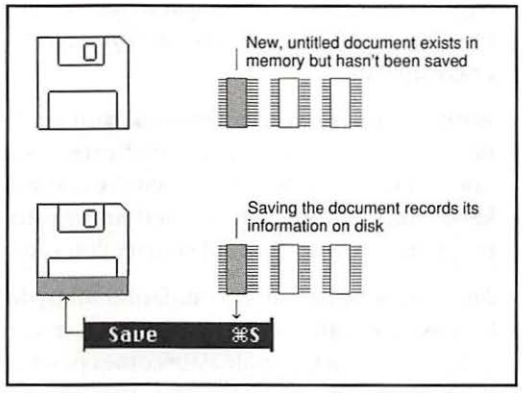


Figure 1.2: How RAM and a disk work together.

Because disks really are just another kind of memory, their capacities are described using the same units of measurement used for RAM and ROM—kilobytes and, more frequently, megabytes. Most Macs, for example, include a hard disk that stores at least 40MB.

Some Mac newcomers confuse RAM and hard drive capacity; we often have heard people say things like, "I have 40MB of memory in my Mac" when they're actually describing the capacity of their hard drive. Remember: RAM and disk storage are two different things.

Virtual Memory—When a Disk Acts Like RAM

In addition to being a safe haven for programs and data, a hard disk can act as an extension of the Mac's RAM. Using a technique called *virtual memory,* the Mac can treat part of a disk as if it were RAM (and just when we told you disks and RAM were two different things!). Most word processing programs use this technique to enable you to create documents larger than would otherwise fit into memory. The word processing program keeps only the portion of the document with which you're working at the moment in memory, and "swaps" the rest of the document to and from the disk.

We look at additional applications of virtual memory in later chapters. Until then, keep in mind that a mechanical disk is slower than an electronic RAM chip, so virtual memory will always be slower than the equivalent amount of real RAM.

Input and Output

A computer must be able to get information and instructions from you to show you the fruits of its labor. The circuitry and devices responsible for interacting with you form the Mac's *input/output*, or *I/O*, section. A Mac's *input devices* are the keyboard and the mouse, and you can use both to either issue instructions or create data.

With the mouse, you can choose commands and click on options. These tasks fall into the "issuing instructions" category. But you also can use the mouse to draw an image, in which case you're using the mouse to create data. With the keyboard, you can issue instructions by using the *keyboard shortcuts* that many programs provide. And, of course, you can create data by typing text.

The microphone that accompanies many Mac models also is an input device because you can use it to create data—recorded sound. In the near future, as *voice recognition* technology becomes practical, you also may be able to use the microphone to control the Mac, issuing spoken commands rather than typing or using the mouse.

The Mac's primary *output device* is its video screen, but the speaker also qualifies. It enables the Mac to inform you of a problem aurally or to get your attention before performing an operation that would result in data loss, such as quitting a program without saving your work. Other output devices are printers, such as Apple's ImageWriter, StyleWriter, and LaserWriters, all of which enable you to commit your work to paper.

A disk drive is also an input/output device, although you don't use it to choose commands or view responses. A disk drive is an I/O device for the Mac itself; it enables the Mac to read (input) information into its memory, and write (output) information from memory to disk.

Connecting to the Outside World

Most input/output devices attach to the Macintosh by means of sockets called *ports*. The word *port* may sound like jargon at first, but when you think of a shipping port—a point where ships can "connect" with a city to discharge and take on cargo—you can see how the term applies to input/output devices. Ports sometimes are called *connectors* because that is what you see on the outside of the machine.

Serial and Parallel: Two Ways to Transfer Information

We explore the Mac's "ports-of-call" in later chapters. For now, let's look at the underlying concepts of how Macs transport data. The ways in which a computer moves bits from place to place are straightforward and they lend themselves nicely to real-world comparisons. Understanding them will help you understand why some ports can move data faster than others.

There are two basic ways to move data from one place to another: *parallel* and *serial*. With parallel transmission, the eight bits that form each byte move alongside each other, each in its own wire. With serial transmission, each bit in a byte travels in single file, one behind the other. Now imagine the wires on which bits travel as lanes on a roadway. With parallel transmission, you have eight lanes; with serial, you have just one (see figure 1.3). You don't have to be a computer scientist to figure out which method can move data faster.

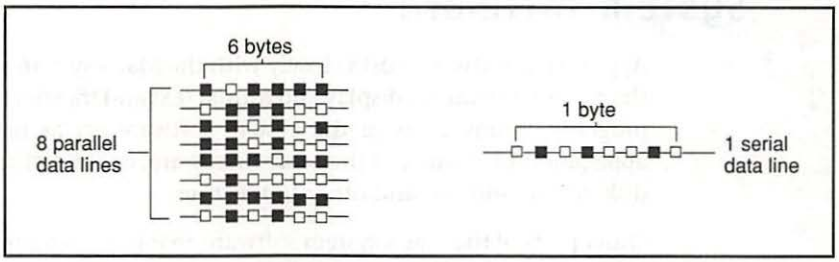


Figure 1.3: Serial versus parallel data transmission.

Anyone who has driven in rush hour traffic has experienced the frustration of whizzing along an eight-lane freeway, but slowing to a crawl on a one-lane exit ramp. Data can fall victim to the same bottleneck. The circuits that carry bits within the CPU and between the CPU and memory are parallel ones, but if the final destination of the data is a serial device, transmission speed decreases when the data begins moving serially.

Types of Software

The final stop on our tour of computer fundamentals is a look at the two basic types of software a computer needs. We briefly defined both types, and if you have used a Mac, you have encountered them yourself already. The first type is *system software,* also called *operating system software.* System software transforms a box of parts into a working computer.

The second type is *application software*, such as word processing programs or drawing programs. Application software—usually called *applications* or, more simply, *programs*—is the software we encounter more directly because it's what enables the Mac to perform specific computing tasks.

One way to understand the difference between system and application software is to think of system software as the Mac's basic education and application software as its college education. When the Mac loads its system software at start-up time, it learns the basics. When you run an application program, its instructions give the Mac a specialized education that enables it to manipulate text, calculate numbers, organize names and addresses, and so on. A word processing software, such as Microsoft Word, instructs the Mac how to manipulate and store large passages of text. A graphics program, such as MacDraw, instructs the Mac how to translate mouse movements into an on-screen image.

System Software

Application software works closely with the Mac's system software, relying on the system software to display and format text and transfer information among programs. Many parts of the system software act as liaisons between the application program and the Mac's hardware, enabling the program to access disk drives, printers, and other I/O devices.

Other parts of the Mac's system software enable a program to acquire memory in which to run. When you start a program, it requests a chunk of free memory from the operating system. Because a Mac is capable of storing more than one program in memory at a time, the system software must rule with an iron fist, doling out memory as needed and making sure that one program doesn't clobber another.

As we have said previously, some system software is stored in the Mac's ROM. Because the contents of a ROM chip are permanent, Apple stores in ROM those elements of the Mac's system software that are the least likely to change. Most of the Mac's system software is stored on disk and loaded into memory at start-up time; this approach enables Apple to add features or fix problems by supplying new system software rather than requiring you to buy new ROM chips.

Utility Software

A cousin to application software is *utility* software. Utilities are programs that enhance the Mac's operation or enable you to perform troubleshooting tasks, such as repairing a damaged disk. As you will see in later chapters, you can use

utilities to customize keyboard shortcuts, back up the contents of a hard disk, play silly sounds when you start up your Mac, and much more.

Bugs—When Programs Go Wrong

In the 1940s, Grace Hopper, a pioneering computer scientist in the United States Navy, was troubleshooting a problem with a dinosaur of a computer. Peering into the bowels of the beast, she saw that a moth had wedged itself between the contacts of a mechanical switch. As the legend goes, she yanked the intruder, pasted it into her notebook, and next to it wrote, "Found bug in computer today."

The term stuck. Today, *bug* is used to describe an error in a program, an error that can take several forms. A bug might perform a calculation inaccurately—nasty business for an accounting program. A bug might access the Mac's hardware components in a way that causes a system error. Or it might cause one program to fail when you run another program. In any case, when a software developer finds a major bug in a program, the developer fixes it and makes updates available to the customers.

But what about ROM chips, whose software is permanently frozen? If a bug is found in a ROM chip, do you need to buy new ROMs? Fortunately, no. The Mac's ROMs are designed so that their software can be bypassed and replaced with corrected or improved software that's loaded into RAM at startup. This process, called *patching*, involves loading the replacement software into RAM and erecting a detour sign at a key memory address. When the CPU reaches that address, it dutifully executes the patch rather than the original software.

If you belong to a user's group or read Macintosh magazines, you may occasionally hear an application program described as "ill behaved" or as "violating Apple's guidelines." This usually means that the program's developer may have bypassed certain parts of the Mac's system software in the interest of faster performance. It's a fairly common practice, but can sometimes cause a program to not run properly when Apple revises its system software or releases a new Macintosh model.

A more serious violation is when a program doesn't use the Mac's pull-down menus, dialog boxes, and other personality traits in the way that Apple prescribes. A program that strays from Apple's *user-interface guidelines*—its rules for how Mac programs should look and work—is likely to be more difficult to learn because you will not be able to apply to it your knowledge of existing Mac programs. Programs like these are rare; Apple strongly promotes its interface guidelines, and programs that stray from them are usually harshly criticized by reviewers.

CHAPTER

2

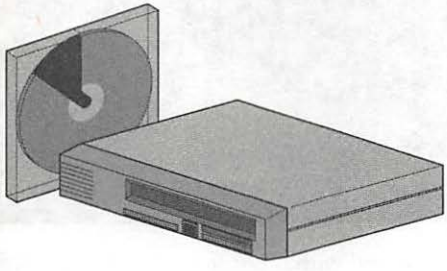
A STANDARD IS BORN

WHAT'S INSIDE

- User interfaces: the way in which people interact with computers
- The Mac's forerunners
- The breakthroughs in interface design that made the Mac possible

All computers have the basic components covered in the previous chapter: RAM, ROM, disk drives, input/output devices, and system software. But the way in which you use and interact with these components can differ dramatically from one brand of computer to the next. Like cars, all computers work in the same basic way—but some models are easier and more fun to drive than others.

In this chapter, we look at the advantages of the Mac's way of operating and at the events that led to the development of the Macintosh. We also will look at the events that led to the development of the Macintosh. This historical background isn't essential to using or understanding the Mac, but if you're a Mac enthusiast, we think you will like the historical anecdotes and the glimpses of the people and places behind the Macintosh.



Interacting with Computers

Next to the phrase "available soon," the word "revolutionary" is the most abused set of letters in the computer industry. But the word does apply to the Macintosh. The Mac represents a revolution in *user interface* design—the way in which a computer accepts commands and interacts with you. The Macintosh was the first affordable computer built around a mouse-based *graphical* user interface, which uses sharp graphics, pictures, and a consistent design that combine to make the computer easier to learn and use.

Types of User Interfaces

To appreciate the advantages of the Mac's operating style, let's step back and look at the methods in which people can interact with computers.

The most spartan user interface (and the kind still used on many IBM PC-type computers) is the *command-line* interface. With a command-line interface, you type commands in response to a *prompt*—a character, such as a question mark or ">" symbol that the computer's system software uses to say, *I'm ready for a command.* To view a list of the files on a disk, for example, an IBM PC user types *"dir"* (short for *directory)* and presses the Enter key (see figure 2.1). Unless you ask for help, the PC's system software, MS-DOS, doesn't provide any hints as to what command you must type to view a file listing. It's up to you to remember the computer's commands and their correct spelling. (IBM's new operating system, *OS/2 2.0*, provides a friendlier interface, but still offers a command-line option.)

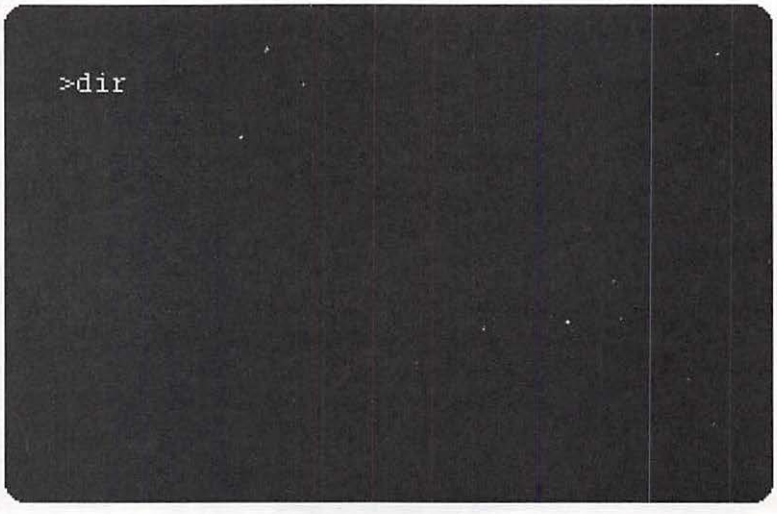


Figure 2.1: Issuing a command with a command-line user interface.

Command-line interfaces place a mammoth obstacle on the path toward proficiency. It's hard enough for a beginner to come to terms with a computer; needing to memorize and type cryptic commands makes it harder still. Command-line interfaces are throwbacks to an era when a computer's primary output device was a typewriter-like *terminal* that clattered the computer's responses onto a sheet of paper.

As video screens replaced typewriter-like terminals, user interfaces improved. Being able to quickly display a full screen of information enabled a computer to display *menus*—lists of available commands, each with a corresponding letter or number (see figure 2.2). With a *menu-driven* user interface, choosing a "directory" command might involve pressing the D key. By listing available options, menus take the mystery out of issuing commands, and they eliminate error messages caused by clumsy typing or misspelling.

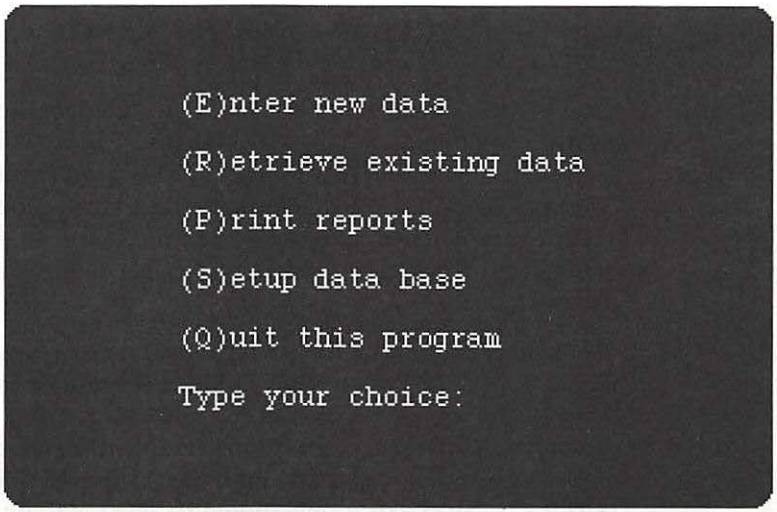


Figure 2.2: A typical menu-driven user interface.

Menus are a big improvement over command-line interfaces, but sometimes it seems like a software firm has its own ideas of how menus should be set up. One company might think it's best to assign each command a number for you to type. Another might want you to type the letter corresponding to the first character in a command. Still another thinks you should use the keyboard's arrow keys to point to the command you want. Each time you buy a new program, you must learn a new method of interacting with the computer. That's hardly efficient—imagine if you had to learn to drive each time you got a new car.

The Macintosh changed all that by being the first personal computer in its price range to provide a consistent user interface—one that doesn't vary from program to program. The Mac's ROM chips contain small software routines that programmers tap into to create the user interface elements you see in Macintosh programs. As mentioned in Chapter 1, Apple provides interface-design guidelines to programmers writing Mac software. By following these guidelines, software developers can create programs that look and work like other Macintosh programs. The advantage: once you learn one program, you have a head start in learning others.

Consistency, however, is only one of the Mac's strengths. The others are the pervasive use of graphics and the mouse. Those concepts trace their beginnings to a time long before Apple's founders, Steve Jobs and Steve Wozniak, formed the company in a garage in Cupertino, California.

The Mac's Forerunners

Many of the concepts behind the Mac's user interface were conceived at several research institutions: ARPA, MIT, SRI, and PARC. (You might say the Mac evolved in a pool of alphabet soup.) ARPA is short for the Advanced Research Projects Agency, a government-funded research hotbed formed in the late 1950s. It was the dawn of the space race, a time when Americans were enamored of all things scientific and modern, and it led to some significant breakthroughs (besides tailfins).

The first person to head ARPA's Information Processing Techniques division was a J. C. R. Licklider. In 1960, Licklider wrote a paper called *Man-Computer Symbiosis,* in which he proposed a new relationship between people and computers. Up to then, people supplied instructions to computers on punched cards, and waited hours or days until their cards were able to be processed. But Licklider believed that people should be able to "think in interaction with a computer." To make his vision possible, he and his successors pioneered the concepts behind *timesharing.* With timesharing, many people, each at his or her own typewriter terminal, could access a central computer, with the computer dividing its time between each person to give each the illusion that he or she alone was interacting with the machine.

In 1962, an ARPA scientist attached a video tube to a computer and programmed the world's first computer game: Spacewar, in which you blasted a moving blip with torpedoes. ARPA never officially acknowledged Spacewar, but everyone who played it could see that the key to interactive computing was a video screen.

Sketchpad and the Mouse

Meanwhile, at the Massachusetts Institute of Technology (MIT), a graduate student named Ivan Sutherland was working on a program called Sketchpad, which used a video screen and light pen to enable users to draw and alter geometric shapes (see figure 2.3). With Sketchpad, users could change the size of shapes, attach them to each other, move them on the screen, and store them in the computer's memory for later recall. Sketchpad was a primordial drawing program that foreshadowed a new era in which people would interact directly with computers. As for Ivan Sutherland, he would later succeed J. C. R. Licklider at ARPA.

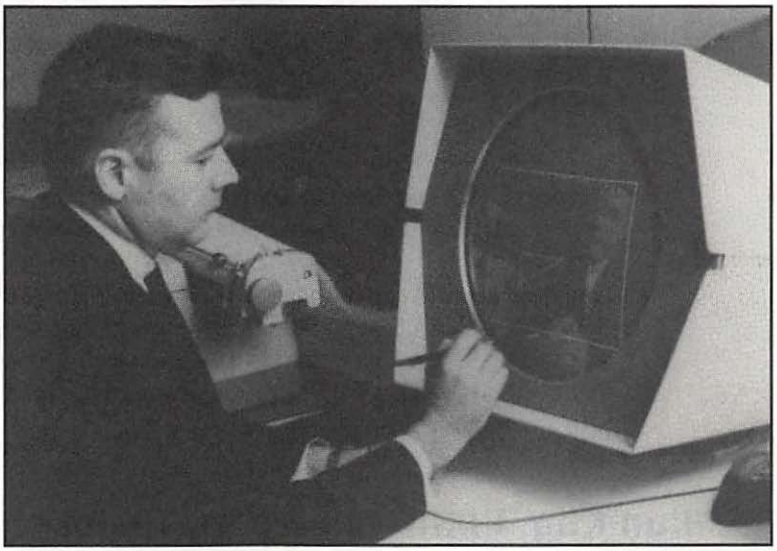


Figure 2.3: Ivan Sutherland operating Sketchpad, circa 1963.

In 1964 and across the continent at the Stanford Research Institute (SRI), a researcher named Douglas Englebart developed a device he called the "X-Y Position Indicator for a Display System." Shown in figure 2.4, U.S. Patent #3,541,541 is now called a mouse.

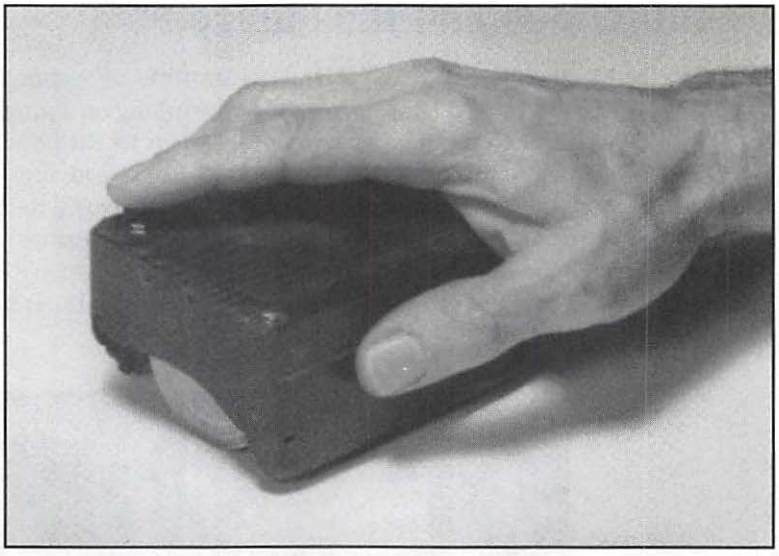


Figure 2.4: The first mouse: Douglas Englebart's "X-Y Position Indicator for a Display System" (photo courtesy of Douglas Englebart).

Englebart invented the mouse in the course of SRI's research into advanced computer systems that augmented the traditional keyboard with specialized input devices. The input devices Englebart's group created showed that the traditional typewriter keyboard was not necessarily the best way to interact with a computer.

Alan Kay, PARC, and Larry Tesler

This concept intrigued another visionary computer scientist, a University of Utah graduate student named Alan Kay, who also wanted to make computers more approachable. Kay's vision was of a $1000 computer small enough to fit in a bookbag, but with the power of a room-sized mainframe computer. He called this still-unrealized dream machine the Dynabook. In 1967, Kay and a hardware designer named Edward Cheadle began designing a computer that would provide sharp graphics and windowing features, and in 1969, they completed work on a computer they dubbed *FLEX*.

After building FLEX, Kay joined the research group where the previous years' advancements in interactive computing and keyboard augmentation were to gel: Xerox's Palo Alto Research Center, or PARC. Xerox formed PARC in 1970, giving it free reign to conduct research and development, with no obligation to produce commercial products. PARC combined an academic atmosphere with the deep pockets of a large corporation—a combination that attracted many of the best computer scientists of the day.

Xerox hired an ARPA administrator named Bob Taylor to head PARC's Computer Sciences Lab. Taylor's team included Alan Kay, Charles Simonyi (now a chief software engineer at Microsoft), Chuck Thacker (who helped develop Ethernet, a networking and communications technology that remains one of the industry's standards), Butler Lampson (a timesharing pioneer), and Larry Tesler (a software engineer).

In 1971, a dozen PARC researchers headed by Kay formed the *Learning Research Group*. One of their first projects was to create a programming language called *Smalltalk*, which was designed to be the centerpiece of an easy-to-use computer employing sharp graphics and a mouse or other pointing device.

Smalltalk made its way into a Xerox computer called Alto (see figure 2.5). Alto was to be PARC's version of the computer system Douglas Englebart helped create at SRI. It combined Smalltalk, sharp graphics, a mouse, and the Ethernet networking system, which enabled a group of interconnected Altos to communicate and share each other's resources.

What was especially noteworthy about the Alto was the way its software worked. After working with Douglas Englebart's system, Larry Tesler felt it was fast and responsive, but difficult to learn. The problem: the system required users to memorize a large number of abbreviated commands. To delete a word, for example, users had to type a command, point to the word with the mouse, and then press the mouse button to confirm the command. Tesler's solution was to reverse the procedure: users would first point to the information they wanted to change, and the software would respond with a list of commands.

This *select and then act* procedure forms the foundation of the Mac's operating style. To delete a word, for example, you select the word and press the Delete key. To quote from Apple's interface-design guidelines, "Selecting the object of an operation before identifying the operation is a fundamental characteristic of the Macintosh user interface, since it allows the application to avoid modes."

A *mode* is a state in which the range of tasks you can perform is restricted. An overly modal word processing program, for example, may require you to enter a text-entry mode to type new text, an editing mode to edit existing text, and a printing mode to print text. When you're typing new text in such a program, you cannot edit or print. This restrictive operating style is contrary to the way people work, and reinforces a computer's reputation as an intimidating machine. Avoiding modes was another key concept born at PARC.

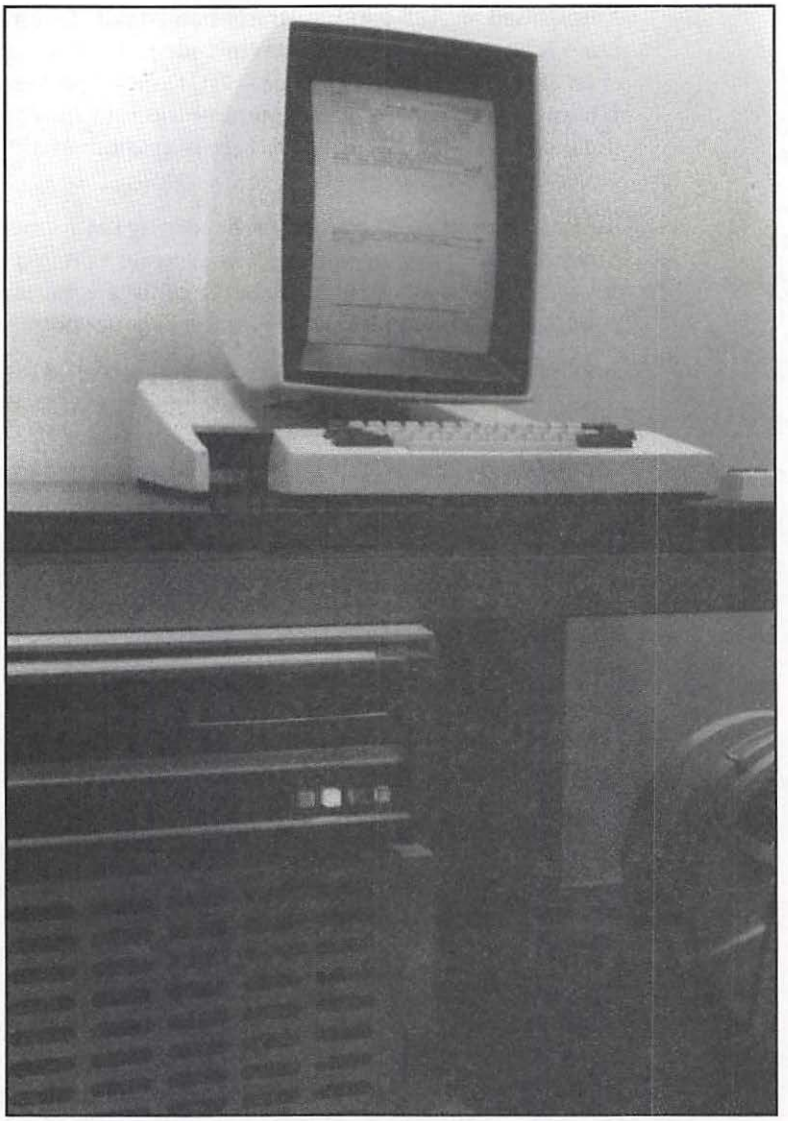


Figure 2.5: Xerox's Alto computer (photo courtesy Xerox Corporation).



The Graphics Connection

The Alto's developers believed that sharp graphics also helped make a computer easy to use. The Alto's graphics enabled the computer to accurately show on-screen how a document would appear when printed, taking the guesswork out of document formatting and eliminating trial-and-error print runs. This operating style has come to be called *what you see is what you get,* and abbreviated as *WYSIWYG* (pronounced *wissy-wig* or *wizzy-wig*).

Equally significant was the Alto's use of small, on-screen pictures, or *icons,* to represent real-world objects, such as file folders and sheets of paper. PARC researchers believed these metaphors for real-world objects made computers easier to use because they replaced unfamiliar concepts (such as transmitting work to another computer) with familiar concepts (such as putting a piece of paper in an out basket).

If all these software innovations took place in the 1970s, why didn't they show up on Desktops until the early 80s? Several reasons. PARC researchers, from their vantage point in the ivory tower of R&D, failed to realize that people were anxious for any kind of personal computer, even if it didn't embody every PARC breakthrough. (Alan Kay would later admit, "What I completely misunderstood about the microcomputer industry was the hunger people had for any kind of computer.") Xerox was hesitant to enter the microcomputer field, and when it did in 1981, its offering—the 820—used outdated system software, called CP/M, and an aging, 8-bit microprocessor chip, the Z80. The 820 was a flop, and when IBM announced its much more powerful PC later that year, the 820 died a quick and quiet death. These events failed to convince Xerox that personal computers were a great new frontier for profits.

Another reason was the high cost of the memory and circuitry required to build a graphics-oriented computer. Xerox supplied several government agencies with Altos, but the computer was never a commercially marketed product—only 2,000 were built. In 1981, Xerox announced the *Star,* an office system that used the Alto's breakthrough technology (see figure 2.6). With a price of $16,595, however, the Star wasn't a personal computer, either. Nor did Xerox try to sell it as one; the Star was marketed through Xerox's national sales force, not computer stores.

In the end, it wasn't Xerox that would bring PARC concepts to the masses. It was Apple.

Trend: Toward Graphical Computing—and Beyond

When the Mac appeared in 1984, the IBM PC was a red-hot star around which revolved a solar system of software developers and hardware manufacturers. Today, the Mac is at the center of its own solar system—and it has exerted a strong pull on IBM's. In the years since the Mac appeared, the PC world has gravitated toward graphical user interfaces. PCs that run the MS-DOS operating system can run Microsoft Windows, software that looks so much like the Mac that it was the subject of a lawsuit between Apple and Microsoft. PCs also can run an operating system called OS/2, developed by Microsoft and IBM, that also provides a graphical interface. And smaller personal computer manufacturers, such as Atari and Commodore also have introduced computers that use graphical user interfaces.

Is the graphical user interface the last word in human-computer interaction? Probably not. Improvements in voice recognition technology have been dramatic; today, you can bark commands at your Mac using Articulate Software's Voice Navigator. (Don't laugh—many artists and designers find it a fast, efficient way to switch between the various drawing tools a program provides.) Some form of voice recognition is likely to be built into the Mac soon, although it may be some time before a Mac can take dictation—deciphering words based on their context is no simple job.

Another user-interface technology is *pen-based* computing, where a computer recognizes hand-printed and simple graphics. Apple's Newton line of personal digital assistants relies on this technique.

Then there's virtual reality. Perhaps someday you will don a pair of goggles and throw words around like building blocks, yank menus down like window shades, and peer into an electronic trash can. It sounds slick, but wouldn't an office full of workers look silly?

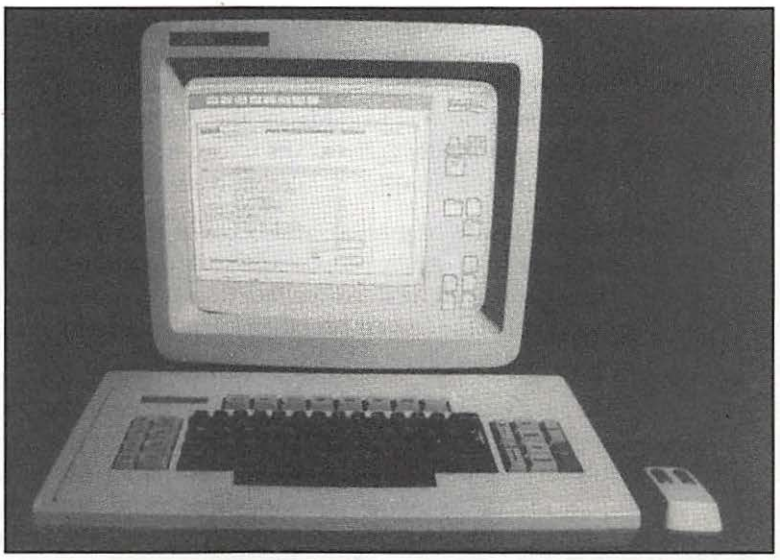


Figure 2.6: The Xerox Star (photo courtesy Xerox Corporation).

Steve Jobs' Field Trip

In 1979, Apple began work on a computer whose destination was vaguely described as "the office market." The machine was code-named *Lisa*. The Lisa was to use Motorola's then-brand-new 68000 microprocessor—arguably the most powerful microprocessor available at the time.

As it worked on the Lisa project, Apple began looking for additional financial backing (its first public stock offering was a year away), preferably from a corporation with a presence in the office market. Apple cofounder Steve Jobs approached Xerox and offered a deal to its investment arm, the Xerox Development Corporation: Apple would sell Xerox a million dollars worth of stock if Xerox would part the curtain and show Apple what was going on at PARC. The trade press had reported that big things were happening there, and Jobs wanted a closer look. Xerox agreed, and later that year, Steve Jobs, Bill Atkinson (an Apple graphics programmer), and several other members of the Lisa team went to PARC.

By then, Larry Tesler had become PARC's personal computer expert and proponent. A few years earlier, a neighbor of Tesler's had dragged him to some meetings of the Homebrew Computer Club, a band of build-it-yourself computer hobbyists. Initially skeptical, Tesler soon saw the potential and increasing momentum of personal computers. Because he was one of the few PARC researchers who felt that way, he was assigned to show Jobs and his entourage the Alto.

The Apple contingent was impressed. They liked the way the Alto's sharp graphics enabled it to mimic a desktop and the documents on it. They liked how the mouse and icons supplanted the keyboard for issuing commands. Bill Atkinson, who was working on the graphics software that drove the Lisa's display, reportedly gazed at the screen from a distance of a few inches. Steve Jobs decided that Apple would build an Alto for the masses.

Tesler was also impressed, and believed that Apple could do it. He liked the enthusiasm the Apple people expressed toward the Alto. He liked the questions they asked. And he liked the fact that they wanted to take PARC's advancements out of the labs and put them on people's desks. A few months later, Larry Tesler was working for Apple.

The Lisa was to be Apple's Alto, but a variety of reasons—including Apple's desire to weigh it down with features and to write a complete set of application software for it—detoured it from its destination of "the masses." The Lisa grew from a $2,000 computer to a $10,000 one when it was finally released in 1983. Critics were wowed, but accountants winced. The Lisa never sold well and it attracted only a few software developers.

The Lisa for the Rest of Us

Meanwhile, another new computer was taking shape within Apple: the *Macintosh*. Jeff Raskin, who came to Apple in 1977 to head the company's documentation group, was in charge of producing an "appliance" computer—a sealed box you could turn on and use without fussing with cables, circuit boards, or operating system commands. He led a small group that was working on the machine, which he code-named Macintosh—an imperfect speller's tribute to the apple.

The Macintosh project was a small, obscure effort in a company whose primary focus had become the Lisa. The project came close to being canceled on several occasions. All that changed in the beginning of 1981 when Steve Jobs made the Macintosh his project.

Jobs liked the notion of an appliance computer. Under his influence, the Macintosh's software direction changed. The machine was to be a "little Lisa." Programmer Bud Tribble was put in charge of the Macintosh software, and began lobbying for the use of a Motorola 68000 in the Mac. Basing the Mac on a 68000, he said, would enable it to use the graphics system software that Bill Atkinson developed for the Lisa. Burrell Smith, the Macintosh team hardware designer, reworked his prototype to use the 68000. By the end of 1980, Smith, a self-taught hardware specialist who started at Apple as a service technician, had designed a compact circuit that ran twice as fast as the Lisa and used fewer parts.

The goal was for the Macintosh and the Lisa to ship at the same time. But the Macintosh project was two years behind the Lisa. Jobs drafted Andy Hertzfeld, then a programmer in the Apple II group, to convert Bill Atkinson's graphics routines to run on the Mac. It was decided that the machine must have a detachable keyboard and take up no more desk space than a telephone book. That meant giving the Mac an unheard-of vertical orientation. Burrell Smith refined the Mac's hardware accordingly. The ROM software that would form the basis of the Mac's personality slowly came together.

The Macintosh that was taking shape bore little resemblance to the machine Jeff Raskin envisioned, except for its "sealed box" design. Jobs was against giving the Macintosh internal expansion slots, which can accept add-on circuit boards and which helped make the Apple II and IBM PC such versatile and successful machines. One of his arguments was that the variety of boards available for Apple IIs and IBM PCs made it difficult to write software that would run on every possible machine configuration. By casting the Mac's hardware traits in stone, software developers could be assured that their wares would run on every machine. This argument had some merit, but in the end, the sealed-box design almost killed the Mac in its early days.

In 1981, Jobs met with Bill Gates, chairman of Microsoft Corporation, one of the largest microcomputer software firms—and the company that supplies the IBM PC world with its system software as well as many important application programs. Jobs wanted Microsoft to commit to writing software for the Macintosh, and to have several packages ready for the machine's 1984 release. At a demonstration at Apple's Cupertino offices, Burrell Smith explained the hardware and Andy Hertzfeld detailed the software.

Gates saw the Mac's potential, and agreed to become involved. Microsoft completed two products—its Multiplan electronic spreadsheet and BASIC programming language—in time for the 1984 release. Numerous other products followed, and Microsoft quickly became a leading Macintosh software developer.

The Macintosh Unveiled

The next few years were tumultuous. The Mac's introduction was postponed regularly, as deadlines fell to the daunting technical tasks involved in creating the Mac's system software. The growing Mac team slaved on the fledging machine days, nights, weekends, and holidays. They saw themselves as pirates who would steal the market from IBM and change the world. A pirate's flag was hoisted over the Macintosh headquarters. Specifications—even such basic ones as the size of the screen—were changed in mid-stream. Programmers sweated to complete MacWrite and MacPaint, the word processing program and painting program that would be included with the machine.

Finally, toward the end of 1983, the first Macs were shown to journalists in a series of "sneaks." Everyone in attendance was required to sign forms prohibiting news about the Mac from appearing until after January 24, 1984—the date when the Mac would be unveiled at Apple's annual shareholder meeting in San Francisco. But word leaked out, and Apple's own pre-introduction television commercials fueled the public's curiosity. In the most famous of these, a woman hurls a sledge hammer through a huge video screen on which drones Big Brother—intended to represent IBM. The 1984 commercial aired just once—during the half-time break on Superbowl Sunday of 1984. All these carefully orchestrated public relations created a sense of anticipation so strong that when the Macintosh was announced, the ABC, CBS, and NBC television networks carried the story on their evening news programs.

In the survival-of-the-fittest world of computing, establishing a standard isn't easy. A computer has to prove itself by surviving a financially risky Catch-22: people won't buy it unless a selection of hardware and software is available, but hardware and software developers won't make products for a computer until it's popular enough to make their efforts pay off. A computer isn't considered a standard until it attains that combination of popularity and *third-party support*—the availability of products from independent manufacturers.

And yet thousands of people bought Macs in the first months after the machine's release, even though at the time, you could have counted the number of Macintosh products on two hands. What's more, the original Mac was woefully underpowered, a Porsche body with a team of chipmunks under the hood.

How did the Mac succeed despite these handicaps? Some might say good marketing—Apple's pioneering "the Mac will save the world from IBM" commercials were controversial and award winning. But more likely, what sold the Mac in 1984 was the promise held in its unique and appealing operating style. Many people could sense there was something groundbreaking about the Mac, and they were willing to blaze the pioneer's trail and endure slow performance, a limited selection of products, and occasional teasing from friends who used PCs.

The Mac stumbled for a while, with too little memory and too few programs and hardware add-ons to choose from. But subsequent Mac models shed the sealed box design, contained more memory, and ran faster. In 1990, Apple embarked on a new low-cost strategy designed to increase its share of the personal computing pie and help fight the growing popularity of Microsoft Windows, a program that gives IBM PCs and their clones many of the Mac's personality traits. In 1991, the PowerBook line was launched, and 300,000 of them were sold in less than a year. In 1992, the PowerBook line expanded to include the Duo system.

The result? The Mac has attained that combination of popularity and product availability that makes a computer a standard.

CHAPTER

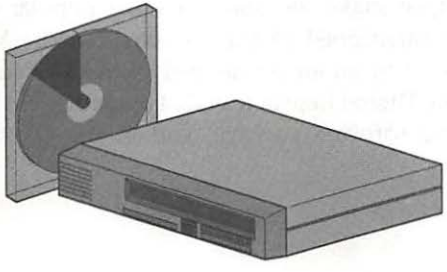
3

THE MACINTOSH INTERFACE

WHAT'S INSIDE

- A closer look at the Mac's personality
- The Finder, which you use to start programs and manage the contents of your disks
- The basic concepts behind startup disks
- The Clipboard, which enables you to move information among documents and programs
- The software Apple included with the Mac
- The roles of color, sound, and animation in the Mac interface

We covered the basics of how computers operate, and you have seen how advances in user interface design have made them easier to use. Now it's time to meet the Mac face-to-interface. In this chapter, we set the stage for our journey inside Mac. If you're just starting out with a Mac, this chapter teaches you basic Macintosh terminology we use throughout the rest of our trek. If



you're sitting alongside your Mac, you may want to try some of the operating techniques we describe. If you're a veteran Mac user, you probably know many of the terms and concepts discussed here, but you may still want to skim this chapter.

The information in this chapter pertains to System 7 and later versions. See Appendix A for details on the differences between System 7 and earlier versions. (If you're not sure what we mean when we say *System 7*, read the section "A Word About System Versions" in the Introduction.)



The Screen and the Mouse

Before Apple's Lisa, personal computers generally used one of two techniques to create screen displays. In *text mode*, the computer displayed text by retrieving the appearance of each character from a *character-generator chip*. In *graphics mode*, the computer displayed graphics by selectively turning on or off the dots on-screen—the *picture elements*, or *pixels*. These different display modes made it difficult for programmers to create programs that combined text and graphics, and limited the variety of type styles the computer could display on its screen.

The Mac, like the Lisa and Xerox's Star, always operates in graphics mode. The Mac creates text in the same way it creates circles or lines—by drawing it on-screen. The Mac has a *bitmapped display:* each screen pixel corresponds to (is *mapped* to) a bit in the Mac's memory. As you may recall from Chapter 1, a bit with a value of 1 creates a black dot; a bit with a value of 0 creates a white dot.

Everything that appears on the Mac's screen is created by a portion of the Mac's system software called *QuickDraw*. Technically, QuickDraw is a library of small software routines for drawing shapes, patterns, and text. QuickDraw is practically what enables the Mac to mix text and graphics easily on the same screen. And it's what enables the Mac to display a variety of type styles, or *fonts*. Rather than gazing at a boring, computer-like font, you can choose from thousands of attractive fonts—the same ones used in books and magazines. Its bitmapped display, driven by QuickDraw, is what makes the Mac's WYSIWYG operating style possible.

The Mac's bitmapped display and its capability to combine typographic fonts with graphics have helped make the Mac the most popular computer for desktop publishing. As mentioned in the last chapter, the Mac has even influenced the IBM world to adopt bitmapped displays—you see them in Microsoft's Windows and Digital Research's GEM operating environments, in the GeoWorks Ensemble software package, and in the OS/2 Presentation Manager.

Mouse Basics

The other essential part of the Mac's personality is the mouse (the X-Y Position Indicator for a Display System, for you nostalgia buffs). As you move the mouse on your desk, an on-screen *pointer* moves accordingly. The Mac's pointer is usually shaped like an arrow, but it can assume other shapes, depending on the program you're using and on what the Mac is doing. When the Mac is performing a time-consuming operation, such as saving a file, the pointer looks like a wristwatch. When you're drawing a shape in a program, such as MacDraw II, the pointer looks like a crosshair (+).

If you have a Macintosh PowerBook portable computer (or the discontinued Macintosh Portable), you move the pointer using a *trackball* rather than a mouse. As you see in Chapter 16, a trackball works much like a mouse, but remains stationary rather than wandering around your desk. A trackball's stationary lifestyle makes it a better pointing device for a portable computer, which is often used where there isn't room for a mouse. (Unless otherwise noted, all references to the Mac's mouse in this book also apply to trackballs.)

Moving the mouse around simply moves the pointer. The action begins when you press the mouse *button*. You can perform three basic mouse-button maneuvers:

Clicking. The most common maneuver, clicking involves simply pressing the mouse button and then releasing it.

Double-clicking. The double-click—two clicks in rapid succession—is usually a shortcut that enables you to perform a two-step job in just one step.

Dragging. Dragging involves holding down the mouse button while moving the mouse. One use of the dragging technique is to move things around on-screen.



The Machine of Metaphors

The real secret to the Mac's easy operating style isn't the bitmapped display or even the mouse. It's the metaphor. The Mac's designers created on-screen versions of things people use every day: desktops, push buttons, volume controls—and trash cans.

The Desktop, Icons, and Windows

The Mac's *Desktop* is the screen background on which rest icons for disks and the Trash (see figure 3.1). You may remember from the previous chapter that

icons are small pictures that represent objects (such as disks) or functions (such as the Trash).

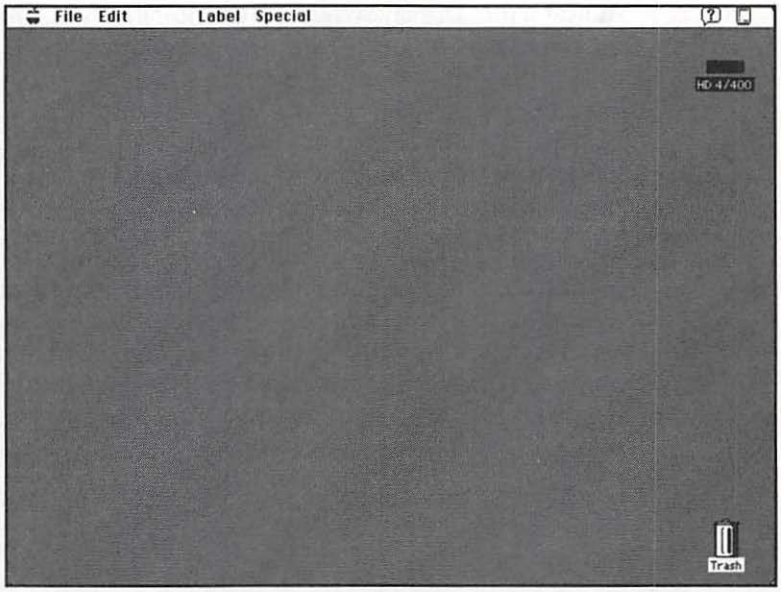


Figure 3.1: The Macintosh Desktop.

The Finder uses icons to represent disks, applications, documents, the Trash, and disk *folders* (which can hold programs and documents). *Application icons* usually have a diamond shape (Apple recommends that developers use the basic diamond shape, but it's up to the developer to design the icon). *Document icons* represent the information you create and save with applications. They usually look like a piece of paper with its upper-right corner folded over. Most document icons also have additional graphic flourishes that visually tie them to their corresponding applications' icons (see figure 3.2).

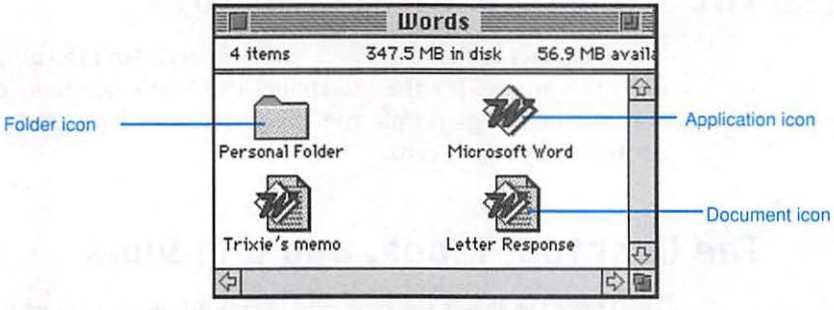


Figure 3.2: A typical directory window.

To start a program, access a document, or view the contents of a disk or folder, you *open* its icon. When you open a disk or folder icon, a *directory window* appears and displays the contents of that disk or folder. (By the way, if you're using a black-and-white Mac or a color Mac set to black-and-white mode, your windows and icons will not have the three-dimensional appearance of those in this book. Other than appearance, they work identically.)

Window Controls

Directory windows have standard *controls* that enable you to move them on-screen, change their size, close them, and *scroll* through them to see portions of the directory that don't fit within the window's boundaries. The *document windows* that applications create to display your work have these same controls (see figure 3.3).

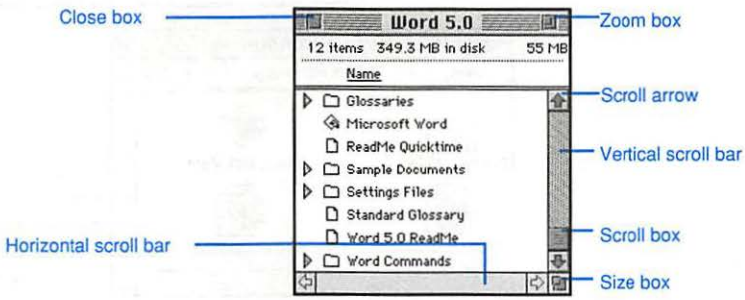


Figure 3.3: Standard window controls.

You can *close* a window—make it disappear—by clicking within the *close box*. The *size box* enables you to *resize* a window to make it larger or smaller. The *zoom box* enables you to quickly resize a window to fill the screen.

A scroll bar has several components, each of which scrolls the window in a different way.

- Clicking the up or down scroll arrow causes the window to scroll a small amount. A word processing program, for example, usually scrolls one line at a time when you click on a scroll arrow. Pointing to a scroll arrow and holding down the mouse button causes the window to scroll continuously.
- Clicking the shaded area above or below the *scroll box*—the box within the scroll bar's shaded area—causes the window to scroll by the windowful. Holding the mouse button down while pointing to the shaded area causes the window to scroll continuously until the scroll box reaches the spot where you're pointing.

- Dragging the scroll box up or down (or left or right) causes the window to scroll quickly in that direction. You can move to the top or bottom of a window by dragging the scroll box to the top or bottom of the scroll bar. (Incidentally, you also may hear the scroll box called the *thumb* or the *elevator.)*

The Active Window

The Mac can display many open windows simultaneously, but only one window is *active* at a time. The active window is the frontmost window—the window you're currently working with. As figure 3.4 shows, an active window has horizontal stripes running across its title bar; an inactive window doesn't.

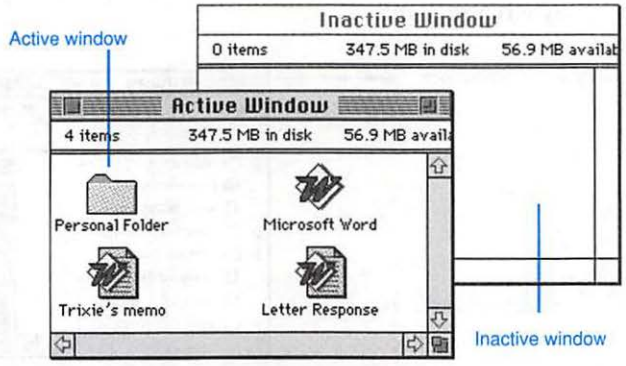


Figure 3.4: Active and inactive windows.

You activate a window by clicking it once. You activate the window named Inactive Window by clicking any part of it, for example.



Interacting with the Mac

You control the Mac by using the mouse or keyboard to choose *commands,* and by selecting options and supplying information in special windows called *dialog boxes.*

Menus and Commands

The main tool for controlling the Finder and the applications you use is the *menu bar,* which spans the top of the screen (see figure 3.5). The leftmost menu is the *Apple menu,* represented by an apple icon. The Apple menu is generally always available no matter what program you're running. (Some small

applications that perform simple tasks may not have a menu bar, and thus, lack Apple menus.)

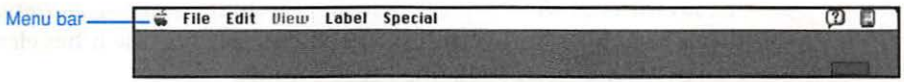


Figure 3.5: The menu bar.

The first command in the Apple menu is the *About command.* When you choose it, a message appears describing the application you're currently using. Some applications use the About command as the gateway to their on-screen help systems. If you choose the About command when using the Finder, a window appears showing how your Mac's RAM is being used by the programs you're currently running.

Below the About command appears a list of *Desk Accessories,* small programs you can access at any time. We look at Desk Accessories again shortly.

You can customize your Apple menu to include the names of programs and documents you use frequently. You then can open a program or document by choosing its name from the Apple menu. Chapter 9 contains tips for customizing your Apple menu.

At the right end of the menu bar are two more menus: the *Help* menu and the *Application menu.* We discuss the Application menu shortly; for now, let's look at the Help menu. You can use it to activate the Mac's *balloon help* feature, which displays small, cartoon-like text balloons when you point to objects and commands (see figure 3.6.) (Note that not all application programs provide help balloons.)

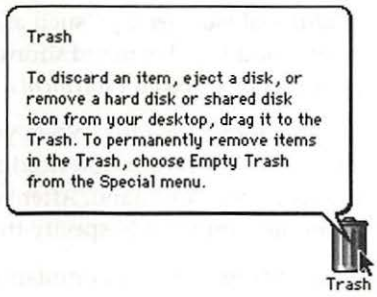


Figure 3.6: Balloon help in action.

As the preceding figure shows, balloon help describes what an icon or menu command is or does. Balloons generally don't tell you how to accomplish a task.

A Closer Look at Menus

When you start a program, it takes over the menu bar, replacing the Finder's menus with its own. A typical menu appears in figure 3.7. This menu—the File menu from Microsoft Word—is a good example because it has elements you find in most menus, including the following:

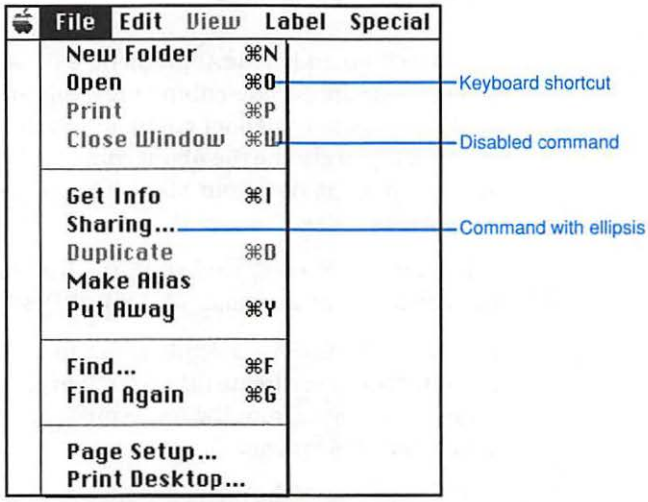


Figure 3.7: A typical menu.

Keyboard shortcuts. When a command has a keyboard shortcut, you can use the keyboard to choose the command by holding down the Command key and then pressing the letter that appears next to the Command symbol. Some keyboard shortcuts require you to press additional *modifier keys,* such as Option or Shift, along with the Command key. Keyboard shortcuts are often called *Command-key shortcuts* or *keyboard equivalents.*

Commands with ellipsis. When you see a command that ends with ellipses (...), it means you need to supply additional information after choosing the command. After you choose the Print command, for example, you need to specify the number of copies you want to print.

Disabled commands. A command is *disabled* when it does not make sense for you to choose it or when you reach a limitation of the program. If a program can open only one document at a time, for example, its Open command is disabled when a document is already open. When a command is disabled, it appears gray. You can move the mouse pointer over a disabled command, but the command will not be highlighted.

It's also possible for an entire menu to be disabled. In a drawing program, for example, the Font menu may be disabled unless you're currently typing or editing text. You can pull down a disabled menu to view its commands, but all of them appear gray. (If you activated balloon help, you often will get a description of *why* the command is disabled. If you point to the Finder's Open command when it's disabled, for example, the balloon says `Not available because nothing is selected.`)

Hierarchical Menus

A *hierarchical menu* is a menu within a menu. When you select a hierarchical menu title and pause briefly, an additional menu called a *submenu* appears. A hierarchical menu is indicated by a right-pointing triangle adjacent to the menu item (see figure 3.8). You don't need to point to this triangle to open a submenu; the submenu opens automatically after a very brief delay.

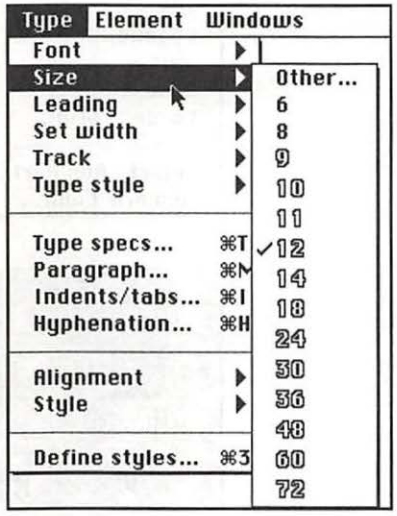


Figure 3.8: A typical hierarchical menu.

As figure 3.8 shows, a submenu can have its own keyboard shortcuts, and can even have submenus of its own. Hierarchical menus enable programmers to cram more commands into menus, but they can be awkward to use, especially if a submenu contains submenus of its own. If you see a program that uses hierarchical menus with reckless abandon, evaluate it carefully before buying; awkward design may crop up in other areas of the program, too.

Tear-Off Menus and Floating Palettes

Some programs provide *tear-off* menus that you can remove from the menu bar and leave open on-screen for convenient access. Figure 3.9 shows a tear-off menu from the Lotus 1-2-3 spreadsheet program. To tear off a menu, simply drag away from the menu bar after opening the menu. A dotted border follows the mouse pointer as you drag; when you release the mouse button, the menu appears. Tear-off menus often contain tool icons rather than text commands.



Figure 3.9: Tearing off a menu in Lotus 1-2-3.

A menu that you remove from the menu bar becomes a *floating palette.* It "floats" above other windows on-screen so that its icons or commands are always available.

Dialog Boxes

Programs need information frequently. What document do you want to open? How many copies do you want to print? What text do you want to search for? With the Macintosh, you supply such information using *dialog boxes*. A dialog box is a special kind of window that appears when a program needs more information—often after you choose a menu command. Dialog boxes contain controls that enable you to supply information with a minimum of typing (see figure 3.10).

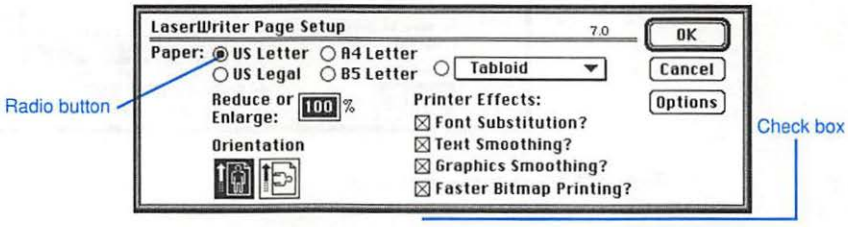


Figure 3.10: The Page Setup dialog box

The Page Setup dialog box contains almost all the controls that appear in a dialog box, including the following:

Checkboxes. Enable you to select or deselect a specific option.

Radio buttons. Enable you to select only one option out of a list of options. Radio buttons are so named because they work like the station-changing buttons on a car radio.

Text boxes. Enable you to supply typed values.

Buttons. Enable you to confirm your choices by clicking a button labeled OK, or cancel them by clicking a button labeled Cancel. Some buttons, such as the Help and Options buttons in the Page Setup dialog box, can lead you to additional dialog boxes.

Notice the difference between check boxes and radio buttons. With check boxes, you can select any or all options in a group of options. But with radio buttons, only one option within the group can be selected. If you click a different option within that group, the previously selected option is deselected.

Dialog boxes are almost always *modal*. When a modal dialog box is open, you cannot perform any other tasks until you either confirm or cancel the dialog box. If you try to click outside of the dialog box, you hear an error beep. (Many programs enable you to access the help menu when a modal dialog box is open, however. This enables you to activate balloon help to learn about a particular option without having to close and then reopen the dialog box.)

Pop-Up Menus

Dialog boxes can contain menus of their own called *pop-up menus*. A pop-up menu normally displays the currently selected option. When you point to the option and click, the menu "pops up," revealing additional options (see figure 3.11). When you choose a different option and release the mouse button, the pop-up menu closes and the new option becomes the visible one.

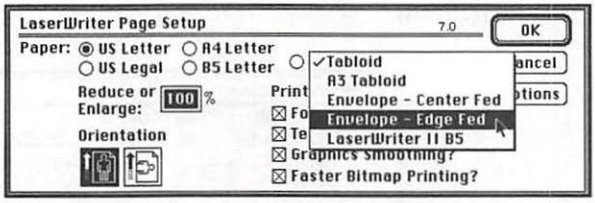
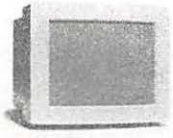


Figure 3.11: A pop-up menu.

Typing in Text Boxes

The text box is the only place in a dialog box where you need to type. You use text boxes to enter a name for a new document, to specify search-and-replace text in a word processing program, and to specify the number of copies you want to print.



TIP: In a dialog box containing more than one text box, you can move from one text box to the next by pressing the Tab key.

The Insertion Point and the I-Beam Pointer

While we're talking text entry, let's cover two terms you encounter throughout this book and in most Mac programs. When you're typing text, it appears at the *insertion point,* which is represented by a blinking vertical bar. (In the IBM PC world, the blinking underline that appears at the point where you're typing is called the *cursor.*)

To control the location of the insertion point, you can use the *I-beam pointer.* The arrow-shaped mouse pointer assumes an I-beam shape when you move the pointer to an area where text can appear. In a word processing program, the I-beam pointer appears when you're pointing at the page area. You also see the I-beam when you're working in a dialog box and you move the pointer to a text box. Figure 3.12 compares the I-beam pointer and the insertion point.

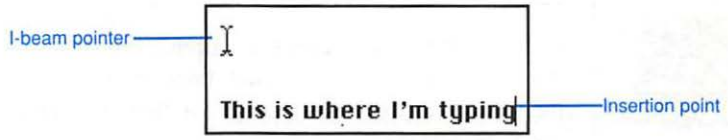


Figure 3.12: The I-beam pointer and insertion point.

Most programs (including the Finder) also enable you to move the insertion point by pressing the arrow keys on the keyboard. This is handy when you need to move the insertion point a short distance and don't want to grope for the mouse.

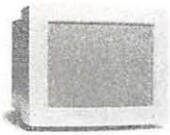
Selecting Text

Before you can delete, copy, or format text, you need to select it. The Mac provides standard text-selecting features that work in all programs as well as in the text boxes that appear in dialog boxes. (Many programs also provide additional text-selection shortcuts; we spotlight some of these shortcuts in Chapter 9.)

Dragging. The most common technique for selecting text, dragging, involves moving the mouse pointer to the location that marks the beginning of the passage you want to select, and then dragging until you've reached the last character you want to select. As you drag, the Mac highlights the text you've selected.

Double-clicking. When you're working with text, double-clicking selects words. If you double-click and then drag, the Mac continues to select text in one-word increments.

Shift-clicking. Shift-clicking involves pressing the Shift key while clicking the mouse pointer elsewhere in the document. (This technique is sometimes called *extending a selection.)* Shift-clicking is especially useful for selecting a large portion of text. Simply move the insertion point to the start (or end) of the text you want to select. Next, use the mouse and the window's scroll bar to locate the point that marks the end (or start) of the passage you want to select. Finally, press and hold down the Shift key while clicking at that point. It's much faster than dragging—and yawning—while the document window scrolls.



TIP: When you select text as a prelude to replacing it with new text, don't bother pressing the Backspace or Delete key before typing the new text. Simply begin typing; the first character you type will clear the selected text.



Font Basics

Thanks to the Mac's bitmapped display, fonts are an important part of the Mac world. Most Mac programs enable you to take advantage of the Mac's typographic features by allowing you to alter the appearance of the text in your documents.

We explore the Mac's font features in detail in later chapters. For now, keep in mind the following points.

- The Mac comes with an assortment of fonts, each of which has a name, such as Chicago, New York, Helvetica, and Times. You can add additional fonts or remove unused fonts easily.
- Using mathematical formulas, the Mac can simulate bold, italic, outlined, underlined, and shadowed type styles (see figure 3.13). When you specify italic, for example, the Mac can slant the upright, or *plain* (Roman), version of the font to simulate italics.

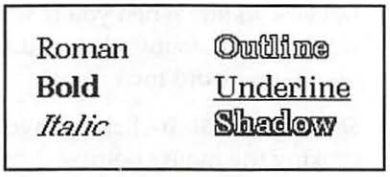


Figure 3.13: Type styles the Mac creates by altering the plain version of a font.

- The Mac uses the font named Chicago in its menus and in many other user interface elements. The disk, folder, file, and application names that appear in the Finder's directory windows are in the Geneva font.
- Most fonts include a variety of *point sizes*. A *point* is a printer's unit of measurement; there are 72 points in an inch. Several different point sizes of the Times font appear in figure 3.14.
- You can tell which point sizes are available in a given font by examining Font or Size menus of the application in which you are working. When a specific point size exists, that size appears in outlined type. If

you choose a size that doesn't appear in outlined type, the Mac must simulate that size by *scaling* an existing size. This process causes characters to appear distorted on-screen (see figure 3.15). Whether the final printed results appear distorted, however, depends on your printer. (For more information on printing, see Chapter 8.)

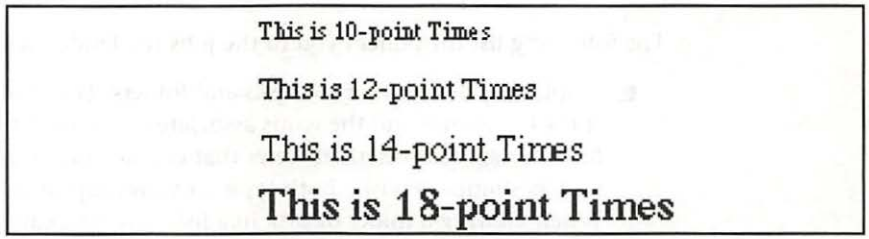


Figure 3.14: Several point sizes of Times.



Figure 3.15: Distorted text (bottom) results when the Mac scales an existing font size (top).

- The fonts included with System 7 are *TrueType* fonts that the Mac can scale to virtually any size. When you choose a TrueType font and examine a Font or Size menu, notice that all sizes appear in outlined type. TrueType fonts aren't prone to the on-screen distortion we just described.



The Finder

The first place you encounter the user interface elements we have just described is the *Finder*, the Mac's file- and disk-management software. Some people erroneously describe the Finder as "the Mac's operating system." The Finder is actually a program—like Microsoft Word or MacDraw. Unlike these programs, however, the Finder runs immediately after you start your Mac. And rather than enabling you to process words or draw pictures, the Finder helps you manage disks, applications, and documents.

If you have used the IBM PC, you may think of the Finder as a very sophisticated version of MS-DOS' COMMAND.COM command processor, which displays the DOS prompt and interprets your typed commands. If you have used the

Microsoft Windows operating environment under MS-DOS, there is a closer parallel: the Finder performs for the Mac many of the same jobs performed by Windows' File Manager and Program Manager.

What the Finder Does

The following list introduces you to the jobs the Finder performs.

- Displaying the contents of disks and folders. The Finder's *icon views* show the names and the icons associated with each file. The Finder's *list views* are text-oriented views that enable you to see more files and folders simultaneously. Both types of views appear in figure 3.16. When viewing a folder or disk in a list view, you can click the small triangle that appears next to a folder to view the folder's contents in outline form. You can switch views using the View menu. You can mix and match views as desired; you may prefer an icon view for some windows and a list view for others.

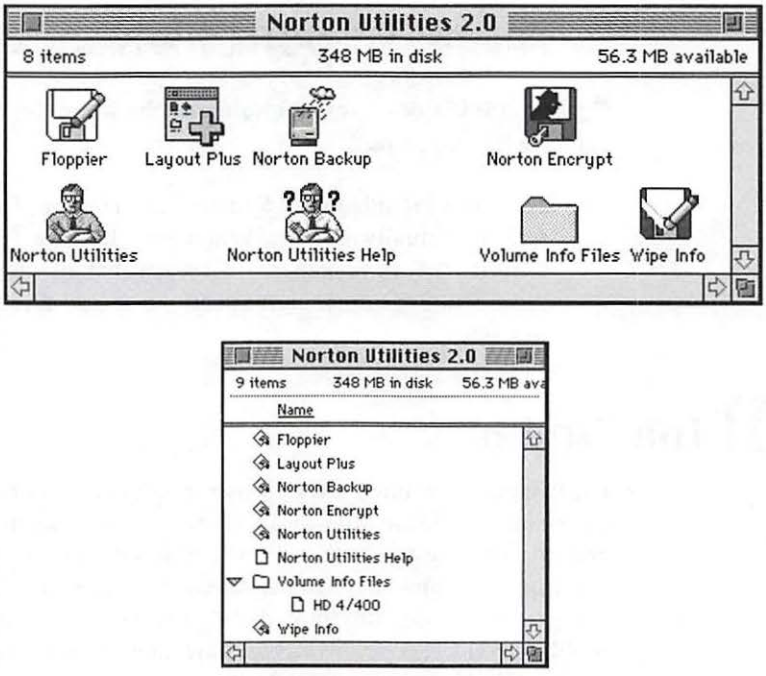


Figure 3.16: Comparing icon and list views.

- Opening programs and documents. When you double click a program's icon, the Finder starts that program. When you double-click a document, the Finder determines which application created it, and

it starts that application, which then opens the document. (The term *launch* is often used to describe the process of starting a program, as in, "I launched Microsoft Word.")

- Organizing documents and applications in folders and on the Desktop. The Finder works with the Mac's system software to enable you to create a filing system for your documents and programs. You also can move document and program icons on the Desktop and in disk and folder windows to create a personalized workspace where everything is where you want it.
- Managing program and document files. The Finder helps you manage the contents of disks. With it, you can perform the following tasks:

  Copy a file to a different disk by dragging its icon to that disk's icon or window.

  Duplicate a disk by dragging its icon to a different disk's icon.

  Delete a file by dragging it to the Trash.

  Copy a file by selecting it and choosing Duplicate from the File menu.

  Use the Get Info command to find out information about files, attach brief descriptive comments to them, and alter the memory requirements of application programs (we look at the latter option in detail in Chapter 9).

  Change a file's name by selecting it and then typing a new name.

  Use the Label menu to give files descriptive text labels, such as *Personal* or *Urgent*. Labels also can have colors associated with them—your urgent icons can appear in red, for example.

  Print a document by selecting it and choosing Print. Doing so causes the Finder to start the document's application program, tells it to print the document, and then returns you to the Desktop.

  Create an *alias* to a file. An alias is a small file that acts like a remote control for another file. When you open an alias, the Mac opens the file that the alias points to. As you see in Chapter 9, aliases have many uses, but the most common is to give you convenient access to a file you buried within folders.

Locating files

It isn't named the Finder for nothing! The System 7 File menu's Find command enables you to locate files according to a variety of criteria—their names, creation dates, size, and more.

If your Mac is connected to other Macs on a network, you can use the File menu's Sharing command to make a folder or an entire disk available to the other Macs on your network. We examine the Mac's file-sharing features in Chapter 13.

You can supplement the Finder with other file- and disk-management utilities, most of which operate as Desk Accessories. We look at some of these utilities in Chapter 11.

Selecting Multiple Icons Simultaneously

You can perform many of the previous disk-management tasks on more than one icon at a time by first selecting all the icons you want to work with. You can open two or more documents in one step by selecting their icons and then choosing Open, for example. (If the documents were created by different programs, your Mac must have enough memory to open all the programs for this to work.) You can select multiple icons using either of the following two methods:

- By drawing a selection marquee around the icons (see figure 3.17).

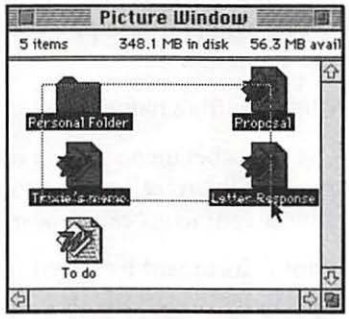


Figure 3.17: Selecting multiple icons using the selection marquee.

- By Shift-clicking. Select the first icon, and then hold down the Shift key while clicking on each subsequent icon (see figure 3.18).

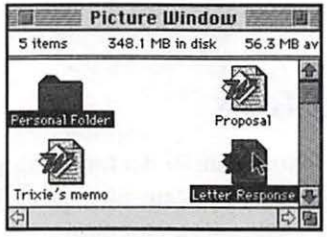


Figure 3.18: Selecting multiple files by Shift-clicking.

It's also possible to combine both techniques. You can, for example, use the selection marquee to select files located next to each other, and then scroll to a different part of the window and Shift-click on additional files.



The Mac's Filing System

Floppy disks can hold hundreds of files; hard disks can hold thousands of files. The Mac provides a way to efficiently organize the contents of your disks: folders.

With the Mac, organizing your disk files is much like organizing paperwork on your desk. The Desktop is the outermost level of your filing system where you can keep the files and folders you use most often. Below the Desktop are disks. Think of them as file drawers. Within the file drawers are folders.

And just as you can place paper folders within other paper folders, you can place disk folders within other disk folders. A folder can hold application programs, documents, or both. Although some programs require that certain files be located in certain folders, as a general rule, how you use folders is entirely up to you. (For more information about filing strategies, see Chapter 9.)

The folder icons that appear in disk directory windows are another example of how the Mac uses metaphors for objects people encounter every day. While you're working with disk folders, the Mac is working with a *directory*—a special area of the disk that acts as a table of contents for the disk. As you see in Chapter 17, the directory enables the Mac to keep track of where files are located on the disk, and of how much free space is available for new files.

Directory Dialog Boxes

When you're working in a program and need to save or retrieve a document, you use a *directory dialog box*. The Mac provides standard directory dialog boxes for the Open and Save commands. These dialog boxes offer buttons for switching between disks, ejecting disks, and canceling the Open or Save command (see figure 3.19). Both list the documents on a given disk or in a given folder.

The Desktop button in the Save dialog box enables you to save a document on the Mac's Desktop. Although it's best to store documents in folders to keep your Desktop uncluttered and your hard disk organized, the Desktop can be a convenient place to store documents or programs you use frequently. (This is also where aliases can be a big help. You can create an alias for a document or program stored in a folder, and then move the alias to the Desktop. You can then open the document or program by double-clicking its alias on the Desktop.)

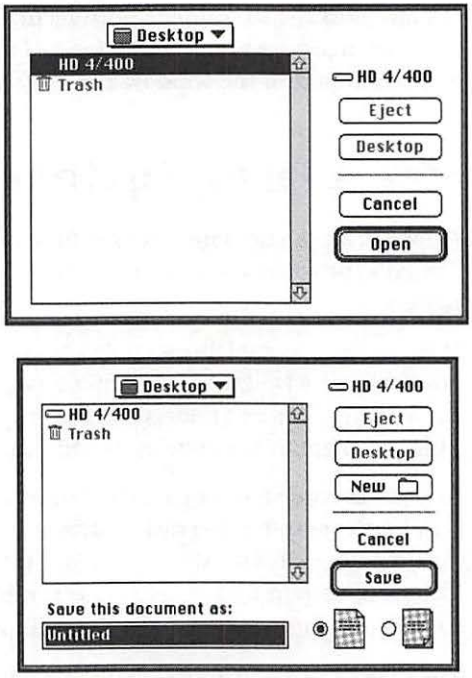


Figure 3.19: The Open dialog box and the Save dialog box.

When you choose a program's Open command, the program's directory dialog box lists only those files that the program knows how to open. If you choose Microsoft Word's Open command, for example, the Open dialog box will not list any Aldus PageMaker publications or Microsoft Excel spreadsheets.

Working with Folders

Whether you're opening or saving documents, you often need to maneuver within the Mac's storage hierarchy to access a specific folder. Knowing how to navigate efficiently can help you make the most out of the Mac's file system.

Suppose that you're writing a letter using your word processing program, and you decide to save it in the Letters folder. Saving your letter can be a three-step process:

1. Open the Documents folder by double-clicking it (or by selecting it and clicking Save, or by selecting it and pressing Return). Notice that the pop-up menu above the list box changes to reflect the currently open folder.

2. Open the Letters folder. Again, the pop-up menu above the list box changes to show that the Letters folder is open.

3. Type a name for the document and click the Save button or press Return.

Now, you have finished your letter and have started working on that overdue proposal that you want to save in the Documents folder. When you choose the Save command, however, the pop-up menu at the top of the Save dialog box indicates that the Letters folder is the current folder. To save the proposal in the Documents folder, you must move up one level in the hierarchy by using the pop-up menu to select the Documents folder.

These same techniques also apply to the Open dialog box. Following is a summary:

- The Desktop is always the outermost level of the storage hierarchy, followed by disks, followed by folders.
- To move deeper into your storage hierarchy, double-click the folder you want to open. (You also can select the folder and click the Open button, or you can select the folder and press the Return key.)
- To move out toward the Desktop, use the pop-up menu above the list box to select the desired folder name (or select the disk name to move to the outermost level). Alternatively, you can move one folder at a time by clicking the disk name that appears above the Open (or Save) and Eject buttons.
- To move to the Desktop quickly, click the Desktop button.



Startup Disk Basics

As you may recall from Chapter 1, some of the Mac's system software is stored in ROM, and the rest is stored on disk and loaded into memory during startup or as you use your Mac. This disk-based system software is stored in a variety of files located in a folder named System Folder, which has a small Macintosh icon on it. A disk that contains a System Folder is called a *startup disk*.

The Finder always positions the startup disk's icon in the upper right corner of the Desktop. You can drag the icon elsewhere on the Desktop, but it will return to its original location the next time you start your Mac. (For more information about the System Folder, see Chapter 4.)

Erasing the Startup Disk

You cannot erase the startup disk; that would be like trying to remove a car's tires while it's moving. If you try to erase the startup disk, an error message appears (see figure 3.20).

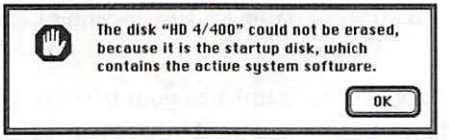


Figure 3.20: You cannot erase the current startup disk.

If you need to erase your Mac's hard disk (perhaps a major-league system crash damaged its contents), use the HD SC Setup utility that came with your Mac. It's located on the floppy disk named Disk Tools. Start your computer using the Disk Tools disk, and then run the HD SC Setup program and click its Initialize button (erasing a disk is also called *initializing).*

Initializing a hard disk is a drastic measure. Depending on what went wrong, you may be able to repair the damage rather than starting from scratch. (For more information on troubleshooting, see Chapter 11.)

Extensions: Customizing the Mac During Startup

Extensions are a special type of software that loads into the Mac's memory during startup and enhances or customizes some aspect of the Mac's operation. Shortly after displaying the `Welcome to Macintosh` message, the Mac looks in a variety of places within the System Folder for extensions. When the Mac finds an extension, it loads its software, and adjusts some key values in memory to ensure that the extension's turf isn't invaded by other programs or extensions.

The workings of extensions generally span programs; that is, rather than being "use and quit when you're finished" programs, extensions perform tasks you can use in any program. Just a few of the tasks an extension can perform include the following:

- Controlling a hardware add-on.
- Creating your own keyboard shortcuts.
- Customizing your Mac by displaying the current time in the Mac's menu bar or by playing silly sounds when you insert a floppy disk or shut down.

Most extensions display their icons at the bottom of the Mac's screen as they load into memory during startup.

Extensions are a wonderful way to enhance and customize your Mac, and they're becoming more and more popular. Unfortunately, you have two prices to pay for their flexibility.

- Each extension you use reduces the amount of free memory available to other programs or extensions. If you load up your Mac with dozens of extensions, you may not have enough memory left over to run any programs.
- Extensions can sometimes conflict with each other, causing your Mac to crash during startup or when you try to use a particular extension.

In later chapters, we take a detailed look at both drawbacks and provide some tips for dealing with them.



The Clipboard

The Mac's *Clipboard* enables you to move data created in one document into another document—even if the documents are from different application programs. Using the Clipboard, you can illustrate a report with graphs or drawings, move text from one document to another, or include financial data retrieved over the phone from your company's central computer in a spreadsheet document.

The gateway to the Clipboard is the Edit menu and its Cut, Copy, and Paste commands.

- The Cut command removes what is selected from the document and places it on the Clipboard, replacing the Clipboard's previous contents.
- The Copy command places the selection on the Clipboard, replacing the Clipboard's previous contents, but doesn't remove the selection from the original document.
- The Paste command adds the contents of the Clipboard to the active document. That document can be the same document you cut or copied the data from, or it can be a different document created by the same program, or it can be a document created by a different program. In any case, the data remains on the Clipboard so that you can paste the same information over and over again by repeatedly choosing Paste.

Many programs include a Show Clipboard command that displays the contents of the Clipboard. The Show Clipboard command is usually in the Edit menu, but also may appear in a Window menu. (In most Microsoft programs, Show Clipboard is in the Window menu.)

(Moving information among programs is usually a straightforward process, but there are some subtle points you may want to be aware of. For more information, see Chapter 12.)

Publishing and Subscribing

The Clipboard is a straightforward way to move information from one document or program to another, but it has a drawback. If the original information changes, you have to repeat the copy-and-paste routine in order to update the documents containing that information. Suppose that you copy a bar graph from a spreadsheet document and then paste that graph into a report you're producing using a word processing program. If the graph's underlying data changes, you need to copy the new graph, switch to your word processing program, delete the outdated graph, and then paste the new one. If you work with information that changes regularly, that routine can get old quickly.

System 7's *publish and subscribe* features can streamline scenarios like this one by helping to automate the process of updating information exchanged between documents. After selecting the information you want to include in another document, you use the Edit menu's Create Publisher command to create an *edition file* that's available to any other program that supports publish and subscribe. You can then use the Subscribe To command to include that edition in a different document.

This is where things get interesting. Using the Subscriber to: or Publisher Options commands, you can specify that the information be updated whenever the original data changes (see figure 3.21).

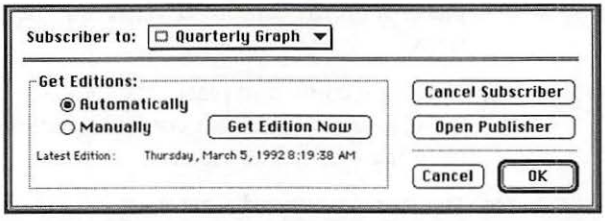


Figure 3.21: Using the Subscriber to: dialog box.

As this example shows, the primary difference between the Clipboard and the publish-and-subscribe mechanism is that the latter enables you to create a link between the original information and other documents. The Clipboard is a *static* data-exchange mechanism, while publish and subscribe is *dynamic*.

In Chapter 12, we take a close look at publish and subscribe and show some ways you may apply it using today's most popular programs.

Multitasking

When you're working at your desk, chances are you switch between different tasks frequently—talking on the phone, writing a memo, reading a trade

magazine. Sometimes you do two (or more) things simultaneously, such as dialing a phone number and then reading a memo until someone answers. You're *multitasking.*

The Mac enables you to apply this working style to your electronic Desktop, too. You can run as many programs as will fit in memory, and switch between them with a mouse click. You can start a time-consuming task, such as printing a document, and then continue working while the Mac completes the task *in the background.*

The Mac's multitasking features make it easier to exchange information between programs and to use the Finder's disk- and file-management features. In the Mac's early days, you had to quit a program to return to the Finder's Desktop; with multitasking, a single mouse click takes you back to the Finder.

When you switch from one program to another, the menu bar changes to reflect the menus available in the second program, and the second program's windows become active. Although you can run numerous programs simultaneously, only one program at a time can be the *active program.*

Switching Between Programs

You can switch between programs in the following several ways:

Using the Application menu. The Application menu at the right end of the menu bar enables you to switch between programs and hide the windows of programs you aren't using. (Hiding a program's windows doesn't quit the program or close any documents, nor does it save any memory; hiding a program simply removes the windows from the screen to reduce clutter.) The Application menu always displays the icon of the active program in the menu bar. If the Finder is active, for example, the Application menu's icon is a small Macintosh. If Microsoft Word is active, however, the Application menu's icon is the same as Word's icon. When you pull down the Application menu, a check mark appears next to the active program's name (see figure 3.22).

Clicking "behind" the active program. The Mac runs each program—including the Finder—in its own *layer.* Unless the active program's window completely fills the screen, you usually can see the windows of inactive programs beneath it. Beneath your Microsoft Word document, for example, you may be able to see part of the Finder's Trash icon, or part of a picture you're drawing with MacDraw.

You can switch to the Finder or a different program by clicking within that visible portion (see figure 3.23). If the active program's window

fills the screen, you can close the window, drag it to the side, or resize it in order to see programs beneath it.



Figure 3.22: The Application menu.



Figure 3.23: You can activate a different program by clicking one of its components.

Double-clicking dimmed program or document icons. The Finder dims (turns gray) the icons of open programs and documents. You can return to a given program by double-clicking its dimmed icon, or by double-clicking the dimmed icon of an open document. You also can return to a given program by double-clicking a document that you haven't opened; this causes the Mac to activate the program, which then opens the document.

Multitasking and Memory

Exactly how many programs can you open simultaneously? That depends on the following three primary factors:

- The size of the programs you run. Some programs have a bigger appetite for memory than others; generally, the more fancy features a program has, the more memory it requires. Programs that work with color graphics often require lots of memory, too; Adobe Photoshop is a good example. The larger the programs you run, the fewer you can fit into your Mac's memory simultaneously. This is where the Finder can help: by using the Get Info window to carefully fine-tune the

amount of memory you give to programs, you increase your chances of being able to run more of them simultaneously.

- The amount of RAM contained in your Mac. A Mac with only 2MB of RAM usually has room for one "full-featured" program, such as Microsoft Excel or Word, and also may have enough free RAM left over for a smaller program. Even so, 4MB is a much more realistic minimum memory configuration for getting the most out of the Mac's multitasking features.
- The number and size of the system extensions you're using. As mentioned earlier, the more extensions you use, the less free memory is available for application programs.

In the end, using the Mac's memory efficiently is like packing for a trip. Your suitcase has a finite amount of space, and only by choosing and arranging your clothes and toiletries carefully can you squeeze everything you need into that space. We have been speaking in general terms here because many variables influence how many programs you can pack into memory. In Chapter 9, we look at more of these variables and present some tips for packing the most into your machine's memory.

The Mac's system software provides a *virtual memory* feature that enables certain Macintosh models to treat a hard disk as an extension of memory, thus dramatically increasing the number of programs you can run simultaneously. We examine the advantages and disadvantages of virtual memory in later chapters.

If you're curious about how the Mac is capable of running multiple programs simultaneously, read the following sidebar.

Backgrounder: How Multitasking Works

Multitasking is an illusion. Although it seems as if the Mac is capable of running several programs simultaneously, in reality, the Mac is doing only one thing at a time—even when you're printing a document in the background. The Mac simply switches between each task so quickly that it *appears* to be doing several things simultaneously.

You may encounter a few multitasking-related terms as you work with the Mac, and each deals with how a computer provides the illusion of running several programs simultaneously. One is *context-switching*. Context-switching is the simplest kind of multitasking. It involves simply putting Program A on hold while activating Program B. When

continues

continued

you use the Application menu to switch from Microsoft Word to Aldus PageMaker, for example, you're using the Mac's context-switching features.

Another term you may hear is *cooperative multitasking*. This is the type of multitasking the Mac uses to perform background tasks. With this scheme, the system software gives each program a chance to run, and each program turns control of the machine over to the next, in round-robin fashion. With cooperative multitasking, it's up to each program to not monopolize the computer to the point where other programs don't get a chance to run. Each program is like a guest at a banquet: the tray of food gets passed from one guest to the next, and it's up to each guest to take only as much as he or she needs before passing the tray along to the next guest. If one guest takes too much, the others don't get a chance to eat. Worse, if one guest passes out at his chair (some banquet!), the tray stops moving entirely. Cooperative multitasking is sometimes called *non-preemptive* multitasking because the computer's operating system never interrupts, or preempts, a program. Microsoft Windows, a Mac-like operating environment for MS-DOS computers, also uses this multitasking technique.

The third type of multitasking has been used by big computers for some time, but is just making its way to the Desktop. Called *preemptive* multitasking, it's found in IBM's OS/2 operating system as well as in *AU/X*, Apple's version of Unix, an operating system popular in the scientific and academic worlds. With preemptive multitasking, a system software component called a *task manager* doles out chunks of time to each program, and exercises strict control over how much time each program gets. It's as if a strict waiter has arrived at the banquet and dishes out each serving himself rather than letting the guests help themselves.

Operating systems that provide preemptive multitasking usually also provide *memory protection* features that prevent one crashed program from bringing down all the other programs that may be running. To return to the banquet table, if one guest passes out, the waiter takes over to ensure that the tray keeps moving.

Multitasking gurus often deride non-preemptive operating systems, such as the Mac's, claiming they don't provide "true" multitasking. The fact is, however, that the Mac's non-preemptive approach works well, provided that programs are written to behave within its round-robin operating style. The Macintosh operating system may not yet

offer the "true" multitasking that OS/2 and AU/X provide, but it does enable programs to print, transfer files, and perform other time-consuming tasks in the background, and it enables users to switch between programs quickly and conveniently.



Desk Accessories

Desk Accessories (DAs) are small programs whose names often appear in the Apple menu. (In system versions prior to 7.0, Desk Accessories *always* appear in the Apple menu.) You can open a Desk Accessory whenever the Apple menu is available, provided that no modal dialog box (the kind you cannot click outside of) is open and that enough memory remains free to open the Desk Accessory.

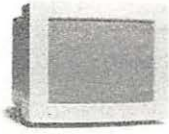
The Desk Accessories that accompany the Mac include the following:

Alarm Clock. This Desk Accessory displays the current time and date as stored by the Mac's built-in, battery-powered clock and calendar (see figure 3.24). True to its name, Alarm Clock also provides an alarm feature. At the time you set, the Mac beeps once and the Apple menu flashes until you reset the alarm.

Calculator. This Desk Accessory mimics a simple four-function calculator—the kind that costs almost as much as a Mac when they first came out (see figure 3.25). You can click the on-screen buttons or "press" them using the keyboard's number keys or the numeric keypad.



Figure 3.24: The Alarm Clock Desk Accessory.



TIP: To include the results of a calculation in a document, choose Copy when the Calculator is active, and then activate the document and choose Paste. You also can paste the contents of the Clipboard into the Calculator, but if the Clipboard contains any characters the Calculator doesn't recognize, you will hear a lot of error beeps.



Figure 3.25: The Calculator Desk Accessory.

Chooser. The Chooser enables you to select and switch between devices, such as printers (see figure 3.26). If you have just one Mac and one printer, you may never have to use the Chooser at all; on the other hand, if your office has many Macs and laser printers interconnected on a network, you may use the Chooser many times a day for the following tasks:

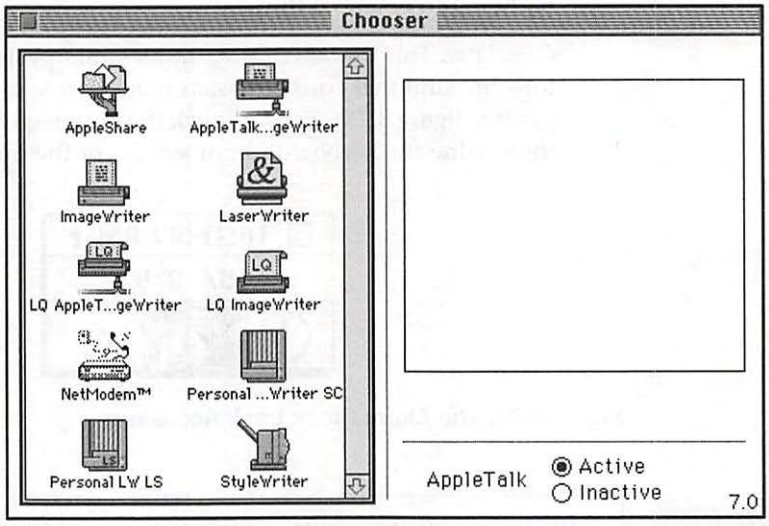


Figure 3.26: The Chooser Desk Accessory.

- Switching from one laser printer to another
- Activating or deactivating the Mac's background printing option
- Connecting to a central network storage disk, called a *file server*

- Connecting to hard disks that other users have made available using the Finder's file-sharing features
- Connecting to a network electronic mail system for communicating with other members of your network

When you open the Chooser, it examines the contents of your System Folder for files designed to control printers and access network devices. (As you see in Chapter 5, these files are called *Chooser extensions.)* The icon for each Chooser extension appears on the left side of the Chooser's window.

To select a given device, click its icon. The Chooser modifies the right side of its window to display any options appropriate to the device you choose (see figure 3.27).

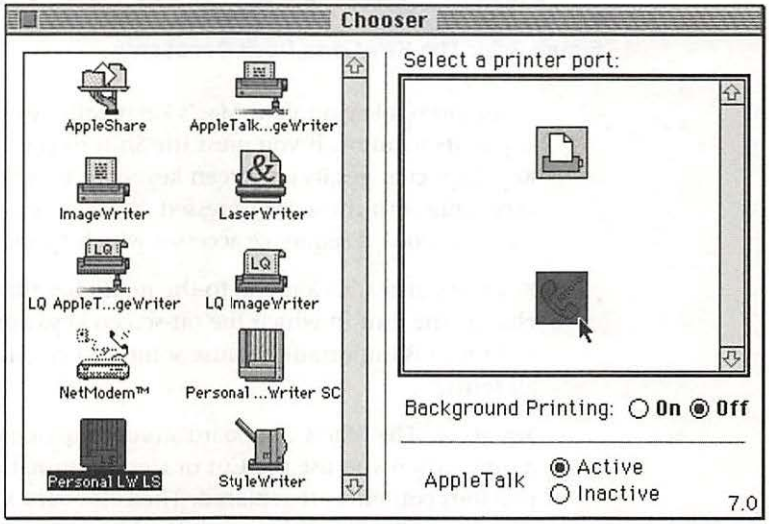


Figure 3.27: Selecting a device with the Chooser.

Key Caps. The Mac's fonts include a wider range of characters than those of most computers. In addition to the standard alphabet, numerals, and math symbols all computer fonts provide, the Mac's *character set* includes special characters, such as accents, typographic opening and closing quotes, math symbols, copyright and trademark symbols, and more. You summon these special characters by holding down the Option key (and, sometimes, the Shift key) and then pressing another key. This other key is often related to the character you want; for example, pressing Option+N and then typing *n* gives you an *n* with a tilde over it: *ñ.*

Remembering every possible Option-key sequence is next to impossible, and that's where Key Caps can help. Key Caps' window is an on-screen keyboard (see figure 3.28).

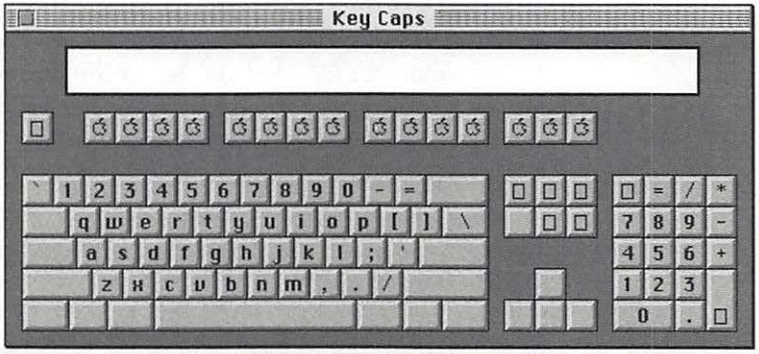


Figure 3.28: The Key Caps Desk Accessory.

If you press a key on your Mac's keyboard, Key Caps highlights that key in its window. If you press the Shift or the Option key (or both), Key Caps changes its on-screen keyboard to reflect the characters accessible with those keys pressed. You can use Key Caps to find out which keyboard sequence accesses which special characters.

Key Caps also adds a menu to the menu bar that enables you to change the font in which the on-screen keys appear. Choosing the right font is important because some special characters don't appear in all fonts.

Scrapbook. The Mac's Clipboard stores only one piece of information at a time; when you use the Cut or Copy command, the Clipboard's previous contents are replaced. The Clipboard also loses its contents when you shut down or restart the Mac. The Scrapbook Desk Accessory works along with the Clipboard to enable you to save cut or copied data for future use. When you open the Scrapbook and choose Paste from the Edit menu, the Mac pastes the contents of the Clipboard into a new Scrapbook page (see figure 3.29).

You can flip through the Scrapbook by using the horizontal scroll bar at the bottom of the Scrapbook window. The Scrapbook can hold as many pages as disk space allows. (For more information about the Scrapbook, see Chapter 12.)

Note Pad. The Note Pad Desk Accessory enables you to type and store up to eight "pages" of notes. Each page holds 256 characters. To move to the next or previous page, click the dog-eared corner of the current page (see figure 3.30).

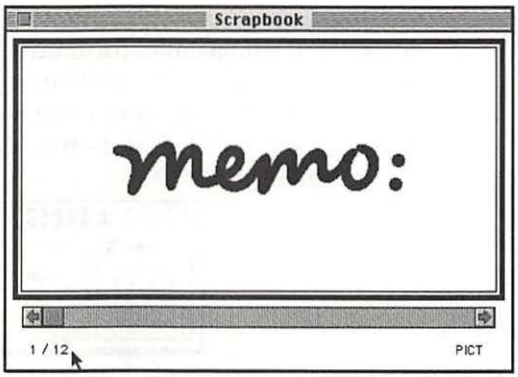


Figure 3.29: Choosing Paste adds a page to the Scrapbook.



Figure 3.30: The Note Pad Desk Accessory.

Battery. The Battery Desk Accessory displays a gauge showing how much juice you have left in the rechargeable battery used by the PowerBooks as well as the original Macintosh Portable (see figure 3.31). If you have a PowerBook 170 running System 7, you can use the Power Saver option to save power by slowing down the computer's processor from 25MHz to 16MHz. (The Battery Desk Accessory that accompanies System 7.1 lacks this option; to control processor speed, use the PowerBook Control Panel.) (For more information about tips on using the Battery Desk Accessory and saving battery power, see Chapter 8).

Puzzle. The Puzzle Desk Accessory creates an on-screen version of the classic kid's puzzle in which you try to arrange the tiles in the correct order (see figure 3.32). The Puzzle Desk Accessory works just like the

real thing, except that you cannot rip the tiles out of the Desk Accessory in a moment of frustrated rage. (Actually, there are other differences: You can paste a different picture into the Puzzle, and best of all, you can cheat: Choose Copy when the Puzzle is active, and then choose Show Clipboard—the assembled picture appears.)

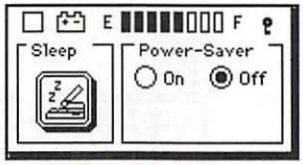


Figure 3.31: The Battery Desk Accessory on a PowerBook 170.

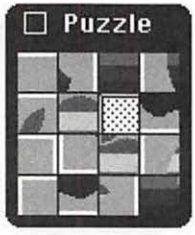


Figure 3.32: The Puzzle Desk Accessory (unsolved).

Control Panels

You can customize and adjust many aspects of the Mac's operation, from the date and time settings of its built-in clock to the speed of the mouse pointer. You make these adjustments using small programs called *Control Panels*, such as the General Controls Panel (see figure 3.33).

You access the Mac's Control Panels by choosing Control Panels from the Apple menu. The Control Panels themselves are stored in the Control Panels folder, located within the System Folder.

Many Control Panel settings are stored in a special area of memory called the *parameter RAM*. The parameter RAM is powered by the Mac's battery so that its settings are retained even when the Mac's power is off.

For more information about Control Panels, see Chapters 5 and 8.

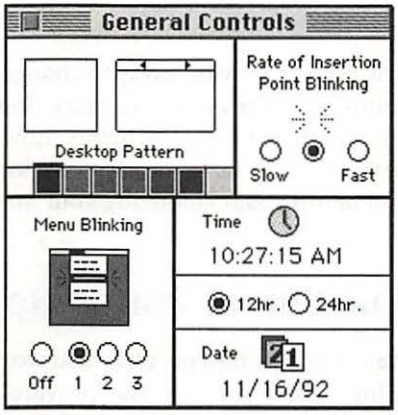


Figure 3.33: The General Controls Panel.



Color in the Mac Interface

As you see in the next chapter, many Macs provide color display capabilities. A color Mac can display startlingly detailed photographic images, as well as color graphs, charts, text, and more. Equipped with Apple's QuickTime system extension, a color Mac can even display animations and digitized video clips.

Color also plays a role in the Macintosh's interface elements—windows, icons, and so on—but on the whole, Apple takes a conservative approach to color. One obvious reason is that thousands of Macs lack color capabilities. A subtler reason is because color is a powerful communications medium, and Apple's user interface designers feel strongly about not overwhelming users with a rainbow of colors in scroll bars, menus, and other interface elements.

For these reasons, the screen of a color Mac looks very similar to that of a monochrome one. Still, there are a few differences. Color Macs offer the following characteristics:

- The Apple menu appears in color.
- Certain window components (including the title bar, scroll arrows, and scroll box) appear in color, with a three-dimensional look.
- The Finder's Label menu enables you to associate a color with each text label. As mentioned earlier, you may associate the color red with a label named Urgent.
- You can use a Control Panel called Colors to change the color in which selected (highlighted) text appears and to change the color the Mac uses for windows.

Colorizing Your Mac

Apple doesn't provide a way to change the color of menus, menu commands, buttons, and many other interface elements. The ROM chips of color Macs do support color interface elements, however. Several utilities are available that enable you to colorize nearly every aspect of your Mac's interface. (For more information about colorizing your Mac, see Chapter 9.)

The Color Wheel Dialog Box

When you're using a program that works with color, you often need to specify the hues you want. The Mac provides a standard dialog box, the *color wheel* dialog box, that enables you to do just that. Just as the Open and Save dialog boxes provide a standardized way to open and save files, the color wheel dialog box gives you a standardized way to specify colors. (For more information about the color wheel dialog box, see Chapter 14.)



Sound in the Mac Interface

Historically, sound has played a minor role in the computer world. Most games produce grating squawks and tinny musical effects and some programs beep at you if something goes wrong. Beyond that, computers haven't taken advantage of the power of sound.

That's changing, thanks largely to the Mac. In addition to producing the same tinny music and error beeps as other computers, the Mac can play back digitally recorded sounds. You can choose from a number of error beep sounds, from a water droplet to a duck's quack. Most Macs also include a microphone that enables you to record your own error beeps.

The value of the Mac's digital sound features go way beyond funny error beeps. Digital sound can add another perspective to computing and create entirely new ways to use the Mac. In The Voyager Company's *Baseball's Greatest Hits* HyperCard stack, you can hear the voices of many baseball Hall of Famers and you can listen to the play-by-plays of some of baseball's greatest moments.

The sounds in *Baseball's Greatest Hits* are stored on a *CD-ROM,* a cousin to a compact disc. As you see in the next chapter, CD-ROMs can hold hundreds of megabytes of data as well as digital audio. With digital sound, animation, and full-motion video becoming more and more popular in the Mac world, the CD-ROM drive is close to becoming a mainstream add-on, as important as a printer or hard drive.

Some business programs also provide *voice annotation* features that enable you to attach recorded comments to documents ("Wendy, check out these sales

figures right away"). There's no doubting the value of sound for education and entertainment applications, but we're not sold on the value of voice annotation—not only do many people feel self-conscious about recording their voices, but recorded comments use far more memory and disk space than typed ones, and their extra size can bog down office networks.

In Chapter 10, we also show how you can record your own sounds and add sound-recording hardware to older Macs. In Chapter 14, we explain how Macs record and play back digital sound, and we look at the differences in the sound capabilities of each Mac model.



Motion in the Mac Interface

Color and digital sound come together when you use software that supports Apple's QuickTime system extension (described in Chapter 5). QuickTime enables programs to work with *dynamic data*—video clips, sound recordings, animation sequences. You can create QuickTime video clips using a video camera and video-digitizer hardware, such as SuperMac's VideoSpigot. You can create QuickTime animations using animation software, such as MacroMedia's Director as well as three-dimensional graphics packages from firms, such as Strata and Pixar. You can edit, combine, and enhance clips using editing software, such as Adobe Premiere and DiVA Corporation's VideoShop. (Note that you need many megabytes of hard disk space.) Many CD-ROM based entertainment and education packages rely on QuickTime for sound and/or video playback.

A QuickTime clip is called a *movie*. You can include movies in a growing number of application programs, including word processing programs, such as WordPerfect and Microsoft Word; spreadsheet programs, such as Microsoft Excel; and presentation programs, such as Aldus Persuasion.

When you paste a QuickTime movie into a program, one *frame* of it appears, with a small movie icon in the lower-left corner. The small icon is called a *badge*, and distinguishes the movie from a still graphic (see figure 3.34).

The badge disappears when a movie is playing, and several controls appear at the bottom of the movie enabling you to pause, adjust sound volume, and step forward or back in the movie (see figure 3.35). These standard controls are part of the Mac's user interface, so they work the same way in all QuickTime-supporting programs.

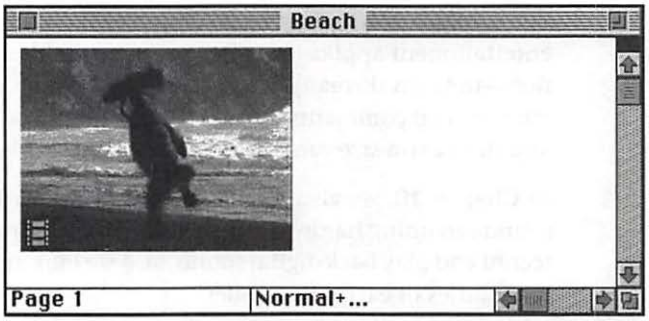


Figure 3.34: A QuickTime movie pasted into a Microsoft Word document.

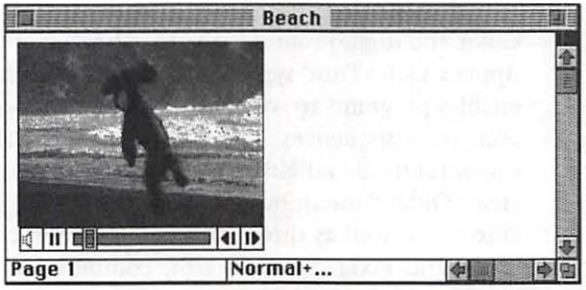


Figure 3.35: QuickTime movie controls.

CHAPTER

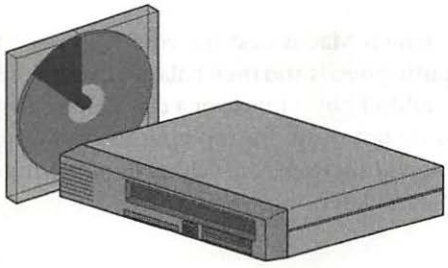
4

THE MACINTOSH FAMILY

WHAT'S INSIDE

- Factors to consider when shopping for a Mac—speed, expandability, video features, size, and more
- The members of the Mac family and the differences among them
- Used or discontinued Macs—should you buy one?
- The upgrade options Apple offers that enable you to keep pace with the evolving Mac family

All Macs have the same basic "personality" described in the previous chapter, but each model has significant differences. If you're in the market for a new Mac, knowing these differences can help you select the Mac that is best for you. In this chapter, we climb the Mac's family tree and spotlight the differences between each member.





Mac Categories and Capabilities

The Macintosh line breaks down into the following three general categories:

- The classic Macs are those with compact, vertically oriented cases and built-in, black-and-white screens, such as the Classic and Classic II, as well as the now-discontinued SE, SE/30, and Mac Plus.
- The modular Macs are those models that lack built-in screens, such as the LC II, IIsi, and Quadra series.
- The Macintosh PowerBooks are phone book-sized, battery-powered Macs.

Size and portability are two obvious areas where the members of the Mac family differ, but following are more important differences:

Speed. Some Macs are faster than others and are better equipped to handle jobs that require extensive calculations. With personal computers, speed is determined in part by the type of microprocessor used and the speed at which it runs, called the *clock rate.* Clock rates are measured in millions of cycles per second, or *megahertz (MHz).*

Expandability. Some Macs can accept a wider range of hardware add-ons than others.

Video features. The classic Macs display only black and white pixels—these Macs have *monochrome* displays. Other Macs can accommodate color displays and *gray-scale* displays that show true shades of gray rather than simulated gray shades. The Mac Quadra family contains *true color,* also called *24-bit,* video circuitry that can display photo-realistic color images.

System 7 support. Any Mac with 2MB or more of RAM can run System 7, but some Macs are better equipped than others to take full advantage of System 7's features.



Assessing Your Needs

How do you determine which Mac is best for you? You need to assess your present and future computing needs and then balance those needs against your budget. You probably wouldn't buy a house or a car without first determining the features you do and do not need. By applying the same strategy to your computer purchases, you will increase your chances of buying the hardware that will serve you now—and later.

Who Needs Speed?

In one sense, everyone needs speed. No matter how you use or plan to use a Mac, chances are that you would prefer hardware that responds to your commands instantly rather than leaving you twiddling your thumbs. After all, no one likes to wait.

But speed costs money. While you may *want* the speed of the fastest Macs—the IIci, IIvx, and the Quadra family—you may not be able to justify the higher price. Some tasks do demand the fastest Macs, but most are well within the capabilities of the Classic II or LC II. Rather than breaking the bank to buy a Quadra, it may be better to buy a slower Mac and pocket your savings or spend it on software or hardware add-ons.

To help you decide how much speed you need, Table 4.1 lists some typical applications and divides them into the following three categories:

Speed is essential. These applications all but require the fastest Macs. You may be able to perform some of these jobs on slower Macs, but you're likely to spend a lot of time looking at the wristwatch pointer.

Speed is beneficial. These applications don't require the fastest Macs; if your budget is tight, you can use a Classic II or LC II without worrying about cobwebs forming between you and the screen. But a fast Mac's extra speed will not be wasted on these jobs; if your budget permits, consider springing for the extra horsepower.

Speed is not critical. With the applications in this category, the Mac's speed isn't a large variable; a slower Mac, such as a Classic or PowerBook 100, can handle the task almost as well (if not just as well) as a faster one.

These categories aren't carved in stone. Use them as starting points in deciding how much speed you need. (If you aren't familiar with the applications listed below, you can find some brief definitions in Appendix B.)

Table 4.1: Speed considerations of common applications.

Speed is Essential	Speed is Beneficial	Speed is Not Critical
Computer-aided design and drafting (CAD)	Desktop publishing	Telecommunications
Advanced word processing (large processing documents with automatic indexing)	Simple word processing	

continues

Table 4.1: Continued

Speed is Essential	Speed is Beneficial	Speed is Not Critical
Complex spreadsheet and statistical analysis	Monochrome drawing	MIDI sequencing and patch editing
Color illustration and image processing	Presentation graphics	General-purpose spreadsheet analysis
Data base management	Simple filing	
Creating and using professional digital audio recording	HyperCard stacks	File serving to small a network
Advanced database management (multi-user, large databases)	Gray-scale image processing	
File serving to large network	Amateur animation and video	
Professional animation and video		

Trend: More of Everything in Smaller Packages

What are the trends in Mac hardware? There are several, and they parallel the trends you will find throughout the personal computer industry—faster processors, more memory, higher-capacity and faster hard disks, and increasingly vivid video. Macs have been heading in these directions since the Mac II was introduced, and the journey isn't likely to stop any time soon.

All of these trends complement the main trend in software: bigger, more complex programs that work not only with text and still pictures, but also with animation, sound, and digital video.

Macs also are becoming smaller. Popular desktop machines, such as the LC series and the IIsi, take up little desk space, and PowerBooks—especially the Duo models—make only a small bulge in a briefcase.

Room to Grow

The best way to anticipate your future requirements is to buy a Mac that offers *expansion slots*—internal connectors that accept plug-in expansion *cards*, also called *boards*, that contain additional hardware.

Expansion slots enable Apple and other manufacturers to create specialized hardware that enables you to tailor the Mac to your needs. Like a camera that accepts different lenses, a computer that accepts expansion boards is more versatile and less prone to obsolescence.

The most popular types of expansion cards include:

Accelerator boards, which boost the Mac's performance by replacing the Mac's original microprocessor with a faster one. Accelerator boards are available that make a Mac LC faster than a Mac IIsi, and that make most Mac IIs faster than a Quadra. A new machine sometimes makes more sense; however, an accelerator board can be an economical way to add new spunk to a old Mac. (Examples include Radius' Rocket and DayStar Digital's PowerCache series.)

Video boards control *large-screen monitors* that show one or two full pages at once; color monitors display images with photographic realism; and gray-scale monitors display true shades of gray. (Examples include Apple's Macintosh Display Card 8•24 and SuperMac's Spectrum/24.)

Video-capture boards work with Apple's QuickTime software to enable you to record video from a videocassette recorder or camera. (Examples include SuperMac's Video Spigot and Video Spigot Pro.)

Communications and networking boards provide the Mac with high-speed (often EtherNet) network ports for communicating with other computers and peripherals. (Examples include Asanté's FriendlyNet and Apple's EtherNet NB Card.)

Coprocessor boards contain specialized microprocessors that work together with the Mac's CPU to improve performance with specific tasks, such as recording and playing back sound. (Examples include Digidesign's Audiomedia and Sound Accelerator.)

The Classic and Classic II and the PowerBooks lack expansion slots. Still, some hardware firms have developed ways to shoehorn additional hardware into these machines. The LC II and IIsi (and the discontinued Mac SE and SE/30) each contain one slot. The other members of the Mac II family contain between three and seven slots, the IIvx, IIvi, and Performa 600 models contain three, and the Quadras contain between three and six. As you will see, the slots in the Mac II, Performa 600, and Quadra families are more sophisticated than those of the LC II, Performa 400, and the SE and SE/30.

Video Features

Do you need a color or gray-scale display, or will a monochrome display suffice? How large of a screen do you need? The answers to these questions depend on how you plan to use your Mac. Table 4.2 lists some common applications and the video hardware that are best for them.

Table 4.2: Matching video hardware to the application.

Color/Gray-scale	Monochrome	Large Screen
Image processing /scanning	Word processing	Word processing
Desktop publishing	Database management	Desktop publishing
Presentation graphics	Monochrome drawing	Advanced drawing and drafting (CAD, 3D illustration)
Animation	Music	Advanced image processing
Color drawing	Telecommunications	
Desktop video/ QuickTime	Spreadsheet and statistical analysis	
	Programming	
	HyperCard work	

There are other factors you may want to consider. Monochrome displays tend to be sharper than color displays, and they cost less, for example. Also (for technical reasons, we examine this in later chapters) monochrome displays are generally faster than color or gray-scale displays. Many applications for which a color or gray-scale display is preferable are still possible on a monochrome display. You can use a monochrome monitor for simple color desktop publishing (such as assigning spot color to headlines or boxes) or gray-scale image processing; you just don't see colors or accurate shades of gray.

The classic Macs are monochrome Macs; however, when equipped with appropriate video hardware, classic Macs, such as the SE/30, can attach to an external color monitor, and their ROM chips contain the *Color QuickDraw* software needed to create color screen displays. The LC, Quadra, Performa 400 and 600, and Mac II families lack built-in displays and connect to an external display that you buy separately. Finally, although all PowerBooks have built-in displays, most PowerBook models also can connect to an external display.

How Much Memory?

Most Macs include 2MB or 4MB of RAM. In theory, a 2MB Mac can run System 7, but as mentioned in the last chapter, 4MB is more realistic. As you use your Mac more and more and add to your software library, you probably will become addicted to multitasking and you will want to switch between the programs instantly that you use most. When that day comes, you will want to upgrade to 5MB, 8MB, or more. If you plan to work with color image processing programs, such as Adobe Photoshop, or with QuickTime products, such as Adobe Premiere or SuperMac's Video Spigot, consider upgrading to 5MB or 8MB right off the bat.

You can expand the RAM in any Desktop Mac using small, plug-in boards called *SIMMs,* short for *single in-line memory modules.* (The PowerBook portable Macs use a different kind of memory board.) As we describe each Mac model, we list the maximum amount of RAM it can accommodate if you install 4MB SIMMs. Some Mac models can accommodate even more RAM if you use 16MB SIMMs, but these high-capacity SIMMs are costly and, at this writing at least, not as popular as 4MB SIMMs. For details on adding memory to specific Mac models, see Chapter 15.

What Size Hard Drive?

Most Macs include a 40MB or 80MB hard disk; some high-end models include a 120MB, 160MB, or 400MB hard disk. A 40MB hard drive was a vast expanse at one time. Today, it's barely adequate. Application programs are getting larger and more complex, and more and more users are working with space-devouring data, such as color images, digital sound, and QuickTime movies. (A 30-second QuickTime movie, for example, can gobble up 4MB of disk space.)

Our advice is to buy the largest-capacity hard drive you can afford. Besides providing plenty of space (although you probably will be surprised at how quickly you fill it), a drive that stores 100MB or more is usually faster than one that holds 40MB or 80MB.

If you have a Mac that doesn't have a hard drive—or if you have outgrown your Mac's existing drive—you can buy a separate hard drive from a large selection of manufacturers. Consider an *external* hard drive—one that sits outside of the Mac's case. An external hard drive is easy to move from one Mac to another and if it breaks, you don't need to do without your Mac while it's in the shop.

Chapter 17 describes some factors to consider when shopping for a hard drive. It also examines an alternative to hard drives and `disk full` messages: *removable-media* drives that combine the high capacity of a hard drive with the eject-and-insert convenience of floppy disks.

Trend: CD-ROM Drives: Coming On Strong

In the last chapter we mentioned that CD-ROM drives are close to becoming mainstream add-ons. What's making them so popular? Besides being able to hold CD-quality sound, CD-ROM discs also can hold vast amounts of data, such as an entire set of encyclopedias, a year's worth of stock exchange figures, or a library of high-quality stock photographs and animations you can use in desktop publications or presentations.

Many font vendors sell CD-ROMs containing vast type libraries in encoded form; to access a given font, you dial a toll-free number and supply credit card information, and you're given an access code that enables you to use the font.

CD-ROMs also are playing a larger role in the up-and-coming field of electronic photography. With Kodak's Photo CD system, you can have photographs transferred to a CD-ROM at the same time that you have them processed. You can view the photos on the Mac and include them in documents.

Then there's the entertainment angle. Firms, such as The Voyager Company, Warner New Media, and Icom Simulations, are pioneering new entertainment forms that take advantage of a CD-ROM's vast capacity and capability to play stereo sound and digitized QuickTime video clips. You can even use a CD-ROM drive to play audio compact discs.

One traditional problem with CD-ROM drives is that their relatively slow data-transfer speeds have resulted in frustrating performance. This is changing. Apple's AppleCD 300 is particularly swift, thanks to the fact that it doubles the rotation speed of the CD. The AppleCD 300 still isn't as speedy as most hard drives, but it's considerably faster than most older CD-ROMs.

High-quality images, digital video, and sound are becoming key aspects of Macintosh computing. CD-ROMs can deliver—and store—all three.

CD-ROM Drives

The Macintosh IIvx and Performa 600 are available with a built-in CD-ROM drive. Both models also include a selection of CD-ROM sampler discs, as well as software that streamlines the process of viewing Kodak Photo CD images (see Chapter 17).

You don't need to buy one of these Macs, however, to join the CD-ROM revolution. A large selection of external CD-ROM drives is available, and some sell for below $500; internal models are available for Macintosh Quadra 900 and 950. In Chapter 17, we list some points to consider when shopping for one, and we take a closer look at the CD support software Apple provides with its drives.

Taking Full Advantage of System 7

System 7's virtual memory feature enables the Mac to treat a hard disk as an extension of RAM, enabling you to run programs that otherwise wouldn't fit into RAM—or to run more programs at the same time. System 7's virtual memory feature works only on Macs containing a piece of hardware called a *paged memory management unit* (PMMU). The 68030 or 68040 processors used in all current Macs except the Classic and PowerBook 100 contains PMMU circuitry. The SE/30, IIx, and IIcx also use the 68030, and thus also support virtual memory; with the addition of a single chip, so does the original Mac II. The stock Plus, PowerBook 100, and SE do not support virtual memory, although they can still run System 7 and take advantage of its other enhancements.

Virtual memory is useful, but it isn't a substitute for real RAM. The best way to take full advantage of System 7's multitasking features—and of today's complex, memory-hungry programs—is to add RAM to your Mac.



The Mac Family

In this section, we look at each member of the Mac family. First, let's cover the common ground—the basic features found in all currently manufactured Macs—then we look at what makes each machine unique.

The Common Ground

All Macs provide the following common features:

- A minimum of two megabytes of RAM. Most Macs are available in more powerful and more expensive configurations that include more RAM.

- Built-in networking capabilities. You can attach two or more Macs together to share information as well as expensive add-ons, such as printers, CD-ROM drives, and hard disks. The Mac's built-in network connector goes by the name *LocalTalk*.
- Two serial ports (the printer port and the modem port). You can attach many types of serial add-ons to these ports, but generally, you use the printer port to attach the Mac to a LocalTalk network or to an Apple ImageWriter, StyleWriter, or Personal LaserWriter LS printer; and you use the modem port to attach an external *telephone modem* that enables the Mac to communicate with other computers over the phone lines.
- An expansion connector for attaching external hard disks, scanners, and other add-ons. This port is based on an expansion standard called the *Small Computer System Interface,* or *SCSI* (commonly pronounced *scuzzy).*
- At least one *Apple Desktop Bus,* or *ADB,* port for the keyboard, mouse, and other input devices.
- One internal *SuperDrive* floppy disk drive capable of storing 1.4MB on a disk. Some Macs can accommodate two floppy drives, with the second drive residing inside the case or connecting via an external floppy port. (Some PowerBook models lack a built-in floppy disk drive, but can connect to an external drive. Also, Macs manufactured before August 1989 have a lower-capacity floppy drive that stores 800K. The first, pre-Plus Macs stored only 400K.) When used with the Apple File Exchange program (included with the Mac) or with Apple's Macintosh PC Exchange extension (sold separately), a SuperDrive also can access disks created by MS-DOS. See Chapter 14 for more information on reading and writing IBM PC floppies.

Backgrounder: Introducing SCSI and ADB

The Mac's SCSI and ADB ports give all Macs a degree of hardware expandability. The SCSI port is the faster of the two, intended for hard drives, scanners, and other add-ons that need to exchange large amounts of data with the Mac. A SCSI port attains its superior performance by transferring data in parallel, 8 bits at a time. The Mac's serial modem and printer ports are limited to a maximum speed of roughly 29,000 bytes per second; the SCSI port can transfer between 600,000 and 4 million bytes per second (depending on the Mac model). Which port would you rather attach a hard disk to?

Another of SCSI's benefits is that it enables you to connect several add-ons to one port using a wiring technique called *daisy-chaining*. Every SCSI device contains two connectors. You can attach two SCSI devices to the Mac by plugging the first device into the Mac's SCSI port, and then attaching the second device to the first. To add a third, you plug it into the second. You can continue daisy-chaining devices in this way until the total length of all the SCSI cables reaches 15 to 20 feet. (SCSI interfaces cannot reliably transmit data over cable distances longer than that.)

As for the Apple Desktop Bus, it's a relatively low-speed bus designed primarily for input devices like the keyboard and mouse (although Global Village Communications sells several appealing telephone modems that connect via the ADB port). Such devices don't require blazing transmission speeds because even their slow speeds can keep up with typing and mouse movements. But like SCSI, the ADB enables you to daisy-chain hardware add-ons, plugging one into the next, and the first into the Mac itself.

Some Macs contain two ADB ports; others contain just one. On Macs with two ADB ports, you can plug the mouse into one and the keyboard into the other, or you can plug the keyboard into one and the mouse into the keyboard's second ADB connector. You can attach up to three devices to one ADB port, so chances that are the single ADB port most Macs provide will be sufficient. If you anticipate attaching a variety of alternative input devices to your Mac, such as graphics tablets, trackballs, and so on, however, you may find a single ADB port limiting. (For more information about ßSCSI connections, see Chapter 16.)



The Classic Macs

Now that we covered the common ground, let's look at what makes each Mac unique, starting with the compact Macs—the Classic and Classic II.

The Macintosh Classic

The Classic isn't much to write home about (see figure 4.1). It contains a 68000 processor running at 8MHz. That's 1984 technology—the Mac Plus and the SE that replaced it used the same processor and clock speed. The Classic performs adequately when running basic word processing and integrated software, but more sophisticated applications tax it.

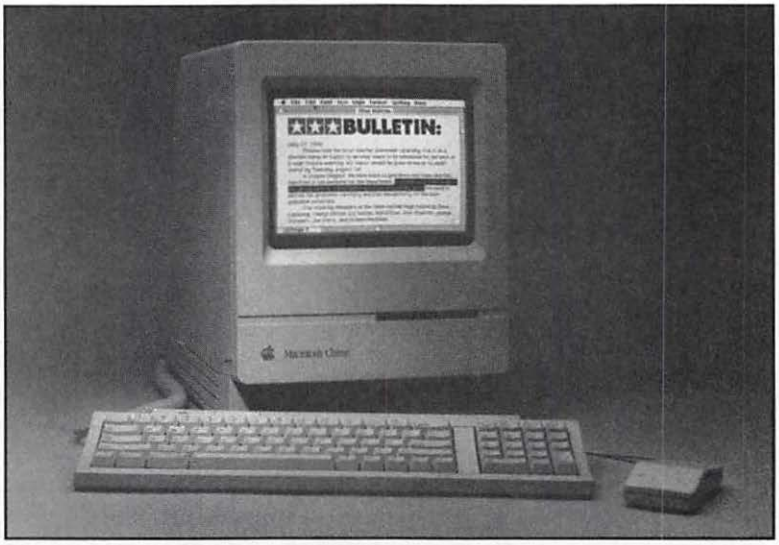


Figure 4.1: The Macintosh Classic (photo courtesy Apple Computer, Inc.).

Perhaps the Classic's biggest limitation is that it lacks a general-purpose expansion slot, eliminating many categories of expansion. Some accelerator boards are available for the Classic, but they attach directly to the 68000 using a special clip or they install in the machine's memory-expansion slot. These back-door expansion techniques can be unreliable. And because the Classic wasn't designed to accommodate internal add-ons, its power supply may be stressed and overheated. The Classic isn't the machine to buy if hardware flexibility is important.

But it's hard to argue with the Classic's low price. A Classic without a hard drive sells for well under $1,000—a bargain unheard of in the Mac world a few years ago. A Classic with a hard disk is a much more capable machine, and is well worth the extra few hundred dollars.

The Classic has 1MB of RAM attached to its main circuit board. (A Mac's main circuit board is also often called its *logic* board.) By adding SIMMs to a small memory expansion board, you can upgrade to 4MB of RAM.

If you do outgrow a Classic, you can upgrade it to a faster, more capable machine: the Classic II.

The Macintosh Classic II (and Performa 200)

The Classic II is the most powerful Classic Mac, sporting a 68030 processor that runs at 16MHz. The Classic II is available in 2MB and 4MB configurations, both

of which include an internal hard disk. The Classic II has 2MB of RAM built into its main circuit board; by adding SIMMs to a special memory expansion board, you can upgrade to 10MB of RAM (the Performa 200 includes 4MB of RAM).

The Classic II replaced the Mac SE/30 in October 1991. The Classic II is less expensive than the SE/30 was, but it's slower and less capable, too. The Classic II is about 25 percent slower than the SE/30 and lacks a general-purpose expansion slot. The Classic II's ROM chips do support color and gray-scale displays, but you need to resort to some back-door expansion methods to attach the computer to an external monitor. (We look at such options in Chapter 14.)

Although the Classic II lacks a general-purpose expansion slot, it does provide a specialized slot into which you can plug a *68882 math coprocessor,* a microprocessor fine-tuned to perform math calculations. Generally, only number-crunching programs, such as spreadsheets and 3D graphics programs, can take advantage of a math coprocessor.

Why is the Classic II slower than the SE/30, especially since both use 16MHz 68030 processors? The answer is that the Classic II uses 16-bit data paths between the processor and memory, while the SE/30 used 32-bit data paths. As you may remember from Chapter 1, more data paths mean the processor is able to move more data in a given amount of time. Using 16-bit data paths in the Classic II enabled Apple to keep the machine's cost down. It's an example of how, in the world of low-cost, high-volume computing in which Apple now competes, technical innovation must sometimes take a back seat to economics. We see more examples of this unfortunate reality as we continue our tour of the Mac family.

The Modular Macs

If your work requires color and expandability, consider a modular Mac—the LC II, Performa 400 or 600, or a member of the Mac II or Quadra families. If you need portability and expansion, there's the unique PowerBook Duo line.

The Common Ground

Like all classic Macs, all modular Macs have two serial ports, one rear-panel SCSI port, and at least one ADB port. But the modular Macs part company with their classic cousins in the following several areas:

- They're more expandable. The Performa 600 and the members of the Quadra and Mac II families contain between three and seven expansion slots, depending on the model. The PowerBook Duo Dock docking station contains two NuBus slots.

- They lack built-in video screens. A modular Mac has the circuitry required to drive a video monitor, but lacks the monitor itself; you need to buy a display from Apple or another manufacturer. If you have specialized video needs or require faster performance than the built-in video circuitry provides, you also can buy a video card. You can expand your electronic desktop to suit your needs and work habits. (The discontinued Mac IIfx also lacks video circuitry; you must buy a video card as well as a monitor.)

  Being able to choose your own display system by adding a video board and monitor is nothing new; owners of Apple II and MS-DOS computers have been doing it for years. What *is* new is the way a Mac can control several screens *simultaneously,* even ones of different sizes and color capabilities. You can drag a window from one screen to another, or even position it to span several screens (see figure 4.2).

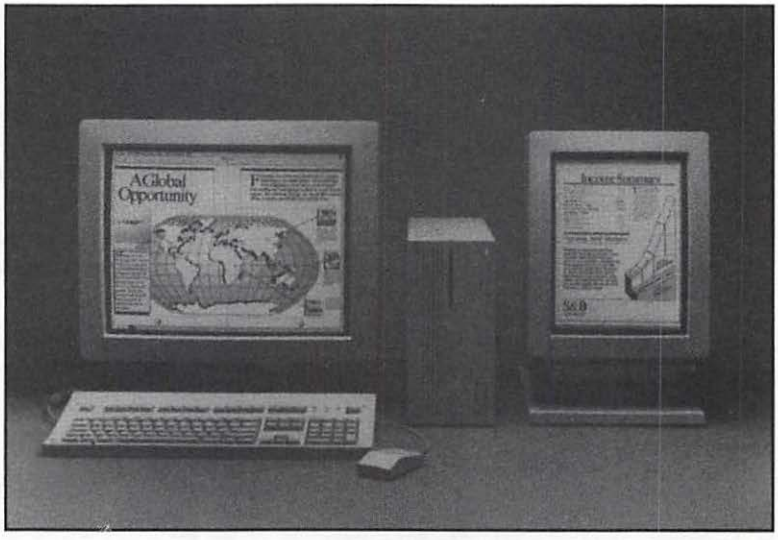


Figure 4.2: A Mac controlling multiple displays (photo courtesy of Apple Computer, Inc.).

  Although all current modular Macs, the actual number of colors they can display depends on the Macintosh model, on how much *video memory* it contains, and on the monitor to which it is attached. Chapter 14 explores this point and details the color capabilities of each Mac model and video display combination.

- Most support soft power. All modular Macs except the LC II support a feature called *soft power,* which enables the computer to be turned on or off by software control as well as a physical on/off switch. You

switch on a modular Mac by pressing its keyboard's *power-on* key that has a large left-pointing triangle on it. To turn off the computer, choose Shut Down from the Finder's Special menu—no need to grope behind the machine in search of the power switch. When you choose Shut Down on a Mac that doesn't support soft power, a dialog box appears saying it's safe to switch off your computer. But you need to flick the switch.

- Most provide stereo sound output. All modular Macs except the LC II have stereo sound-output jacks. In Chapter 8, you learn how to connect a stereo Mac to an amplifier.

Differences Between Slots

The LC II, Performa 400 and 600, Quadras, and Mac II lines use a variety of expansion slot designs. We take a technical look at the ins and outs of each design in Chapter 15; for now, here's a brief overview.

NuBus. The most sophisticated of the three, NuBus slots are the most common in the modular Mac world. Every modular Mac, except the LC II, has at least one NuBus slot, and one—the Quadra 950—has five. The NuBus slots in the Quadra family are faster than the NuBus slots in the Performa 600 and Mac II family.

030 Direct Slot. The 030 Direct Slot provides access to all of the 68030 processor's signal and data lines. Although some aspects of the 030 Direct Slot make it less sophisticated than a NuBus slot, an 030 Direct Slot can actually provide faster performance.

LC Slot. The LC Slot is a 16-bit version of the 030 Direct Slot. It's similar to the 030 Direct Slot in that it provides access to the 68030's signal lines, but the LC Slot uses 16-bit data paths rather than 32-bit paths. The LC Slot currently is used in the Macintosh LC II and Performa 400 only. Its predecessor was the 020 Direct Slot that was used in the original LC.

Accelerator Slot. This specialized slot is used in the Performa 600 and Mac IIvx and IIvi models and is designed to accept performance-boosting accelerator cards.

The Macintosh LC II

Introduced in March 1992, the LC II is Apple's least expensive color Macintosh. Its 68030 processor runs at 16MHz, but internally, the computer uses 16-bit

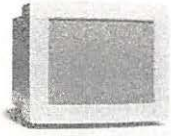
data paths that limit its performance. As the result, the LC II is no faster than the LC, which it replaced. This is another example of the economy winning over innovation; Apple could have given the LC II 32-bit data paths, but this would have required a costly redesign of several components.

The LC II and the LC have become very popular in schools, where they're replacing the aging Apple IIs that were the mainstays of educational computing for so long. One secret to the LC series' success in schools has been Apple's Apple IIe Card that enables the LC II and LC to run Apple II software.

The LC II contains one expansion slot—the *LC Slot*. This slot is compatible with most cards that were developed for the original LC's 020 Direct Slot, although some cards may require new ROM chips or updated driver software. The LC II includes 4MB of memory, expandable to 10MB.

The LC II includes 256K of separate video memory that enables the computer to display 256 colors. You can upgrade the LC II's video memory to 512K that allows for the display of up to 32,000 colors or 256 grays on appropriate displays. Some LC II configurations include the extra video memory.

An LC II is a good choice if you need a color Mac but your budget rules out the faster, more-sophisticated Mac IIsi. The LC II may be on the sluggish side for advanced color applications, such as creating and playing back QuickTime movies or working with Adobe Photoshop or 3D graphics programs, but it's more than adequate for other color tasks. And its small size makes it the most portable modular Mac.



NOTE: An LC II upgrade is available for original LCs.

The Macintosh IIsi

The Mac IIsi is also a single-slot Mac, but it's an all-around better computer than the LC II (see figure 4.3). The IIsi is a true 32-bit computer, and its 68030 runs at 20MHz versus the LC II's 16MHz. Unlike the LC II, the IIsi supports soft power and provides stereo sound output.

The IIsi's single slot is also superior to the LC II's. It's an 030 Direct Slot, but by buying one of two inexpensive adapter cards, you can install a NuBus card or an 030 Direct Slot card designed for the Macintosh SE/30. (Although the IIsi's slot is similar electrically to the SE/30's, a card designed for the SE/30 is too tall to fit in the IIsi's case.)

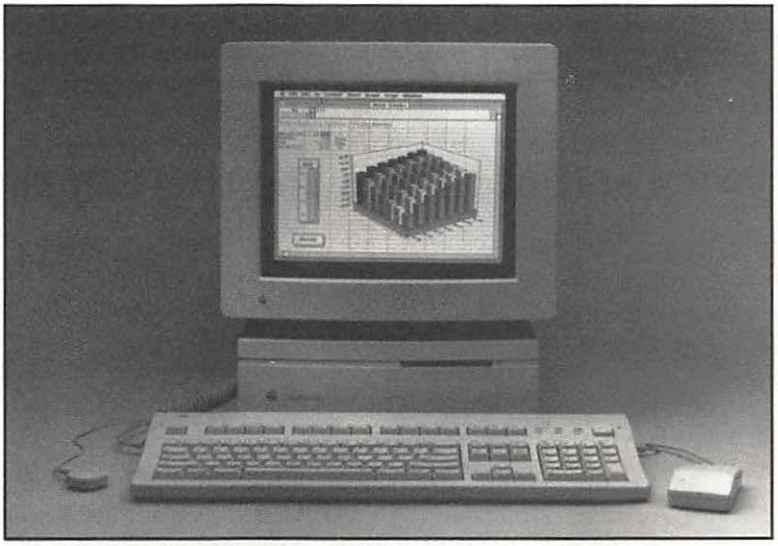


Figure 4.3: The Macintosh IIsi (photo courtesy of Apple Computer, Inc.).

The NuBus adapter card is called the Macintosh IIsi NuBus Adapter Card; the direct slot adapter is called the Macintosh IIsi 030 Direct Slot Adapter Card. Each adapter card also contains a 68882 math coprocessor that the stock IIsi lacks. Its support of both 030 Direct Slot and NuBus cards makes the IIsi's expansion slot very versatile. The IIsi's logic board contains 1MB of RAM, expandable to 17MB.

The Macintosh IIci

Introduced in 1989, the Mac IIci was the first modular Mac to include built-in video circuitry; prior to the IIci, you not only had to buy a monitor, you also had to buy a video card to drive it.

The IIci's processor is a 68030 running at a fairly fast 25MHz; a 68882 math coprocessor is built in and runs at the same speed. The machine contains three NuBus slots as well as one specialized slot that accommodates a *cache memory* card. The cache card boosts the IIci's performance by providing a small amount of very fast memory that holds recently used instructions and data. The IIci's CPU can access this cache memory more quickly than it can access main memory. In early IIci models, the cache card was an extra-cost option. Later models include Apple's cache card. Several manufacturers sell IIci cache cards that provide more cache memory (and therefore, a bigger performance improvement) than Apple's.

All critical ventilation slots on the IIci's case are located on the front and back of the machine, enabling you to position the computer on its side so that it takes up less desk space. The IIci can accommodate up to 32MB of RAM.

The Macintosh IIvi and IIvx Family

The Macintosh IIvi and IIvx share much in common with the rest of the Mac II line, including NuBus slots, soft power support, and stereo sound output. One difference is that all members of the IIvi and IIvx line have room in their cases for a high-capacity, removable-media storage device, such as a CD-ROM drive or SyQuest removable hard drive. Prior to the introduction of the IIvi and IIvx, only the Quadra family could accommodate an internal removable-media device.

Another difference is that all the IIvx and IIvi models contain a slot for an accelerator board. The 68030-based IIvx and IIvi models also accept an Apple 68040 logic board upgrade. At this writing, however, the IIvx and IIvi have just been introduced and the 68040 upgrade is not available.

Macintosh IIvi

In terms of performance, the IIvi fits between the Mac IIsi and the Mac IIci—it's faster than the former and slower than the latter. The IIvi contains a 16MHz 68030; a 68882 math coprocessor is optional. Unlike the Mac LC II, though, the IIvi uses 32-bit internal data pathways, which allow for much better performance.

The IIvi includes 5MB of RAM—4MB installed on the logic board, and 1MB installed in its four SIMM slots. The IIvi is expandable to 20MB, and its on-board video circuitry is capable of displaying up to 32,000 colors.

Like its faster counterpart, the IIvi includes three NuBus expansion slots and one accelerator slot. An internal CD-ROM player (the AppleCD 300i) is optional. The CD-ROM player is connected directly to the logic board, enabling you to record sound from CDs as well as play CD sound through the computer's speaker. (The Mac IIvi is not sold in the United States.)

Macintosh IIvx (and Performa 600)

The Mac IIvx is the fastest 68030-based modular Mac. Its 68030 runs at 32MHz, as does the included 68882 math coprocessor chip. Another factor that contributes to the IIvx's swiftness is its built-in 32K cache.

The Mac IIvx has 4MB of RAM attached to the motherboard, and can be upgraded using SIMMs to hold up to 20MB. The computer's built-in video circuitry can display 256 colors on 12- and 13-inch monitors, and can be

upgraded to display up to 32,000 colors. Like the IIvi, the IIvx contains three NuBus slots.

The IIvx is available with or without a built-in AppleCD 300i CD-ROM drive. Models equipped with the CD-ROM drive include 5MB of RAM and the video memory upgrade. The CD-ROM player is connected directly to the computer's logic board, enabling you to record sound from CDs as well as play CD sound through the computer's speaker. Included software enables you to view Kodak Photo CD images in a variety of ways; see the section "Working with CD-ROMs" in Chapter 17 for more details.

The Macintosh Quadra Family

The Macintosh Quadra models represent Apple's top-of-the-line desktop computers. As the family name implies, all Quadras contain the 68040 processor. Besides being faster and more sophisticated than the 68030, the 68040 contains a built-in math coprocessor.

The Quadras have other features in common, too:

Superior built-in video. As mentioned earlier, the Quadras provide built-in support for 24-bit color. (Other color Macs are limited to a maximum of 256 colors unless you buy a separate video card.) As you see in Chapter 14, 24-bit color is preferable for color image processing, animation, and 3D graphics work.

EtherNet ports. EtherNet is a networking scheme that transfers data many times faster than LocalTalk, the built-in network cabling scheme that every Mac supports. You can add EtherNet ports to other Macs using expansion cards, but a Quadra provides a built-in EtherNet port. As Chapter 13 shows, EtherNet is preferable for network applications that require the transfer of large amounts of data, such as color and gray-scale images.

Faster NuBus slots. As mentioned earlier, a Quadra's NuBus slots can transfer data more quickly than the NuBus slots in Mac II family models.

A superior direct slot. Each Quadra provides an *040 Direct Slot.* Like the 030 Direct Slots in 68030-based Macs, the 040 Direct Slot provides direct access to the CPU's signal lines and allows for faster data transfer than a NuBus slot.

Faster SCSI circuitry. A Quadra's SCSI port can transfer roughly 4MB per second—about twice that of the Mac IIfx and several times faster than a Classic. The Quadras' faster SCSI port pairs up well with today's high-end hard drives.

Superior sound. A Quadra has superior sound circuitry and a larger built-in speaker than other Macs, enabling it to provide higher-fidelity sound.

The Macintosh Quadra 700

The smallest member of the Quadra family, the Quadra 700 has the same basic case size as the Mac IIci. (You can indeed upgrade a IIci to a Quadra 700.) Like the IIci, the Quadra 700 can be positioned vertically as well as horizontally. The Quadra 700's 68040 runs at 25MHz.

The Quadra 700 contains two NuBus slots and one 040 Direct Slot. Because of the way the slots are arranged on the computer's circuit board, however, adding an 040 Direct Slot card eliminates using one of the NuBus slots. The Quadra 700 can accommodate one internal floppy disk drive and one internal hard drive.

There are 4MB of RAM attached to the 700's circuit board. The 700 also contains four SIMM slots, so you can expand total RAM to 20MB using 4MB SIMMs.

The Macintosh Quadra 950

Introduced in May 1992, the Quadra 950 is an improved version of the Quadra 900. For starters, the Quadra 950 is faster. Its CPU runs at 33MHz rather than 25MHz; other aspects of its internal architecture are also faster. Also, the Quadra 950's improved video circuitry enables it to display more colors (up to 32,767) on 16- and 21-inch monitors.

Another difference between the 700 and the 950 is expandability. The Quadra 950 has five NuBus slots and has room inside its case for up to four storage devices, two of which can be removable-media devices, such as CD-ROM drives (unless you remove the floppy drive, there's really only room for one new removable-media device).

The Quadra 950's sound features are also superior to the 700's. If your Quadra 950 contains a CD-ROM drive, you can connect the audio-output jacks directly to the Quadra 950's circuit board. This enables you to play CD-ROM audio through the computer's speaker, to record audio from a CD or CD-ROM, and to mix Mac-generated sounds with CD-ROM audio.

To accommodate all these cards and storage devices, the Quadra 950 requires a large case. It's designed to stand vertically on the floor, as shown in figure 4.4.

The Quadra 950's front panel has a lock mechanism that enables you to lock the machine so that it cannot be turned on. A second position, called *lock,* enables you to turn the machine on but disable its ADB ports (preventing

mouse and keyboard use) as well as the floppy drive. The Quadra 950 has a whopping 16 SIMM slots. Equip them all with 4MB SIMMs, and you will have 64MB of RAM.

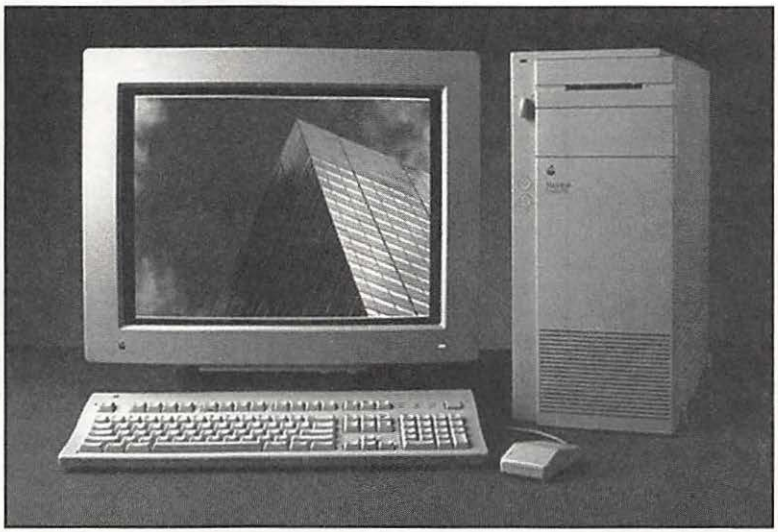


Figure 4.4: The Macintosh Quadra 950 (John Greenleigh photo courtesy Apple Computer, Inc.).

The Macintosh PowerBook Family

Apple's first battery-powered Mac, the Macintosh Portable, was underpowered and overweight—its 16MHz 68000 provided lackluster performance and at 16 pounds, the computer was more luggable than portable. The Portable failed to grab much of the fast-growing portable computer market—a market that quickly became dominated by MS-DOS manufacturers, such as Toshiba, NEC, Dell Computer Corporation, and Compaq.

But the PowerBooks, introduced in October 1991, can hold their own against most any notebook computer on the market. They're great looking, elegantly engineered, and competitively priced. And more important, they're truly portable—the heaviest models weigh 6.8 pounds, and the lightest (the PowerBook Duo series) weighs just over 4 pounds.

Figure 4.5 shows the original three members of the growing PowerBook family: the 100, the 140, and the 170.

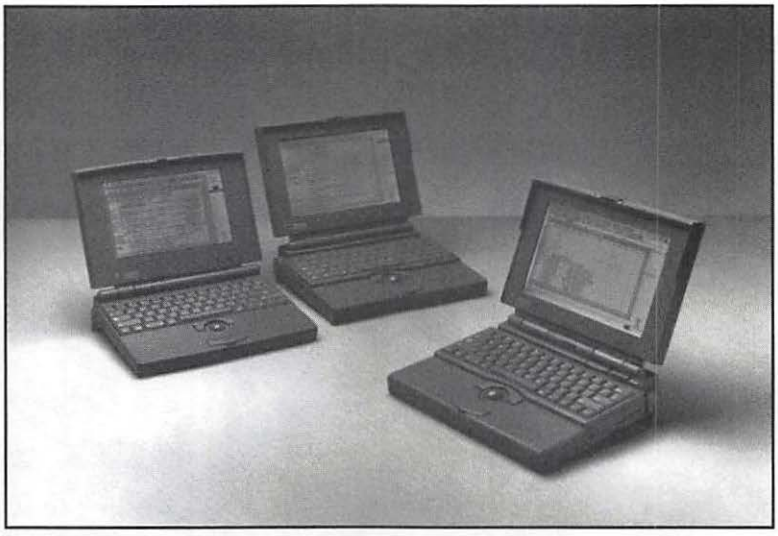


Figure 4.5: The original Macintosh PowerBook family; from left to right: PowerBook 100, PowerBook 140, PowerBook 170 (John Greenleigh photo courtesy of Apple Computer, Inc.).

The PowerBook family falls into two broad categories:

The all-in-one PowerBooks. All-in-one PowerBooks include the PowerBook 100, 145, 160, and 180, as well as the discontinued PowerBook 140 and 170. An all-in-one PowerBook contains almost everything a desktop Mac contains: a SCSI connector for attaching to external hard drives and other add-ons; an ADB port for a mouse or other input device; two serial ports; a SuperDrive floppy drive; and a video-output connector for attaching a display monitor. (The PowerBook 100, 140, and 170 models lack the video-out connector, and the 100 lacks a floppy drive.)

The PowerBook Duo series. Unveiled in October 1992, these ultralight PowerBooks lack the SCSI connector, video-out jack, ADB port, and floppy drive, and they provide just one serial port, not two. If you need these ports, simply attach a PowerBook Duo to one of several available *docking stations*. One station—the Duo Dock—even contains NuBus expansion slots. With a PowerBook Duo and a Duo Dock, you can come close to having the best of both worlds: the portability of a PowerBook with the expansion flexibility of a desktop Mac. A PowerBook Duo and Duo Dock station are shown in figure 4.6.

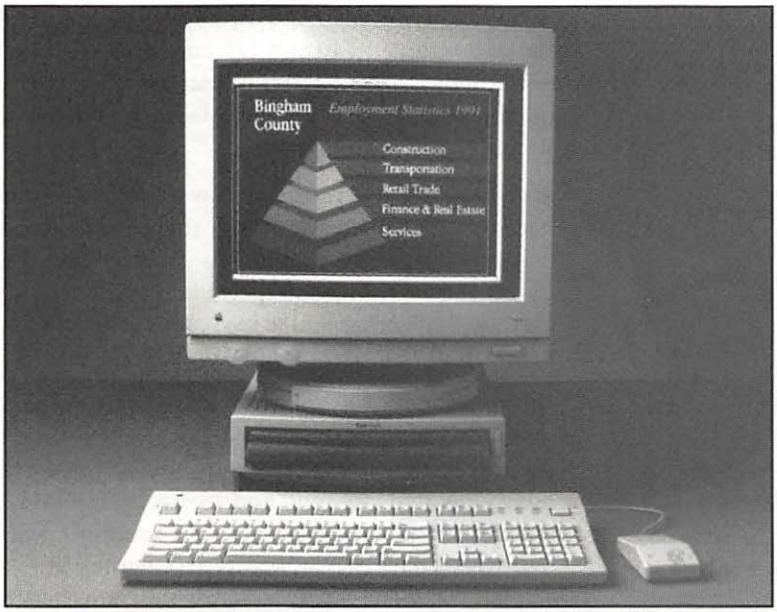


Figure 4.6: The PowerBook Duo inserted in the Duo Dock station.

Common Ground

All PowerBooks share the following numerous family traits:

A liquid-crystal display (LCD) screen. All PowerBooks have tack-sharp displays, although the displays themselves differ between models, becoming more legible as you climb the price ladder. The PowerBook 100, 140, 145, and 160 models use a backlit *supertwist* display; so do the PowerBook Duo 210 and 230. The PowerBook 170 and 180 use an *active-matrix* display that is considerably brighter and easier to read. The displays in the 160, 180, and Duo models can show up to 16 gray shades.

A built-in trackball. Because PowerBooks are likely to be used where there may not be roaming room for a mouse, they have a built-in trackball. Two crescent-shaped buttons surround the top and bottom of the trackball. A low-power ADB mouse designed for the PowerBooks is available as an option. (You can use Apple's standard ADB mouse, although it will quickly drain a PowerBook's battery.) To reduce the hand and arm fatigue that can occur after prolonged use (especially away from a desk), the PowerBooks provide a large, flat area where you can rest your wrists as you type or use the trackball.

A built-in microphone. All PowerBooks except the PowerBook 100 and the discontinued 140 and 170 contain a built-in microphone. The PowerBook 140 and 170 can attach to the same type of external microphone used by desktop Macs. The PowerBook 100 doesn't support a microphone.

A slightly smaller keyboard. A PowerBook's keyboard is about 2 percent narrower and 5 percent shorter than the standard Apple Keyboard II (which we examine later in this chapter). As a result, the keyboard may feel a bit cramped, especially if you have large hands or you're used to conventional Mac keyboards. The layout of the keyboard is identical to that of standard Apple Keyboard II.

Optional data/fax modems. Apple offers two modems for the PowerBook line. The 2400-bps PowerBook fax modem supports 2400-bps data transmission and also can send documents to a fax machine. A 9600-bps model that can send and receive faxes is also available; the 9600-bps modem supports the V.32 communications standard for high-speed data transmission (see Chapter 13). Both modems include Apple's AppleTalk Remote Access software that enables you to dial into a remote Macintosh to access files and even print documents. (We look at AppleTalk Remote Access and other remote-computing tools in Chapter 12.) A variety of third-party data/fax modems are also available from firms, such as Global Village Communications.

A smaller SCSI port. The PowerBooks' SCSI port is physically different from that of a desktop Mac. As a result, you may need adapter cables to connect certain SCSI peripherals (see Chapter 16). Also, the Duo models lack built-in SCSI ports; to use a SCSI device with a PowerBook Duo, you must connect the computer to a docking station.

Sophisticated power management. A PowerBook can run from a slide-in rechargeable battery or from an AC adapter, both of which are included with the machine. The battery is recharged when the computer is running from AC power. An external battery charger also is available that will charge up to two batteries simultaneously. Battery life is determined by many factors—including the screen's brightness setting and the amount of hard and floppy disk activity—but as a general rule, you can expect roughly two to four hours of operating time between charges. To extend the time between recharges, PowerBooks provide a variety of *power-management* features that reduce their thirst for juice. We look at some of these features in Chapter 8 and provide some tips for extending battery life.

The Macintosh PowerBook 100

The PowerBook 100 is the lightest and least expensive PowerBook—and the slowest. Like the original Macintosh Portable, it uses a 68000 processor running at 16MHz (actually, it uses a low-power version of the 68000 called the 68HC000). From the performance standpoint, the PowerBook 100 is much like the portly Mac Portable.

The PowerBook 100 contains a 20MB hard disk drive, but it's the only PowerBook that lacks an internal floppy disk drive. (An external SuperDrive is available as an option.) If you have a second Mac, you also can attach the 100 to its SCSI connector and work with the PowerBook's hard drive on the other Mac's desktop. This *SCSI disk mode,* as it's called, is the easiest way to move a flock of files between the 100 and another Mac.

The PowerBook 100 contains 2MB of RAM, expandable to 8MB. Like other PowerBooks, the 100 lacks a general-purpose expansion slot. (There is a 20-pin slot designed to accept an optional internal modem.) Unlike other PowerBooks, the 100 contains just one serial port. The 100 also lacks an audio-input jack and does not come with a microphone.

For power, the PowerBook 100 uses a rechargeable sealed lead-acid battery—a battery technology different from that of other PowerBook models. The battery slides into the front of the computer. The PowerBook 100 also uses three small lithium batteries that power the computer's internal clock and retain Control Panel settings while you're changing batteries.

The Macintosh PowerBook 145

The PowerBook 145 is the mainstream PowerBook, providing faster performance, a larger display, a built-in SuperDrive floppy disk drive, and a more durable case than the PowerBook 100. The PowerBook 145 uses a 68030 processor running at 25MHz to provide performance roughly equivalent to that of a Mac IIci. A math chip is not available.

The PowerBook 145's screen is about an inch wider than the 100's. That doesn't sound like much, but the extra inch does help make the 145's screen much more readable. Sliders located below the screen let you adjust brightness and contrast.

The 145 uses a nickel-cadmium (NiCad) rechargeable battery that's not too different from that used by today's portable video cameras. The 145 uses a lithium backup battery to retain Control Panel and clock settings, but unlike the PowerBook 100's backup batteries, it must be replaced by a technician. The PowerBook 145 includes 4MB of RAM, and can accommodate up to 8MB.

The Macintosh PowerBook 160

Like the PowerBook 145, the PowerBook 160 contains a 25MHz 68030, and no math coprocessor is available. The 160 is still slightly faster than the 145, however. To extend operating time between battery charges, the 160 provides a *power saver* operating mode that slows the computer's processor from 25MHz to 16MHz and reduces the maximum screen brightness. You activate the power saver mode using the PowerBook Control Panel that we look at in the next chapter.

Where the 160 really pulls ahead of the 145, however, is with its display and video features. The 160's built-in display can show up to 16 gray shades; the 145's display is strictly black and white. The 160 also provides a video-out connector that enables you to attach an external monochrome or color display; the 160 can display up to 256 colors on monitors as large as 16 inches.

Using the PowerBook Display Control Panel, you can configure the PowerBook to treat the external monitor as a second display or to *mirror* the contents of the PowerBook's screen. You may use the second-display option if you simply want to enlarge your electronic desktop when you're working in the office. By comparison, the video-mirroring option is handy if you're giving a presentation and you want the PowerBook's screen to display the same material as a large-screen monitor.

The PowerBook 160 is also more expandable than the 145, able to accommodate up to 16MB of RAM versus the 145's 8MB. The 160 is also available in a wider range of hard drive configurations, including 40MB, 80MB, and 120MB capacities.

The PowerBook 160 provides the same SCSI disk mode feature found in the PowerBook 100—attach a 160 to another Mac's SCSI port, and the 160's hard drive appears on the second Mac's desktop.

The Macintosh PowerBook 180

The fast PowerBook 180 uses a 68030 running at 33MHz to provide performance roughly 35 percent faster than a Mac IIci. Unlike the PowerBook 145 and 160 models, the 180 includes a 68882 math coprocessor (so did its predecessor, the PowerBook 170).

The PowerBook 180 is available in several RAM-and-hard-drive configurations. One includes 4MB of RAM and a 80MB hard drive; another includes 4MB of RAM and a 120MB hard drive. The 180's RAM is expandable to 16MB.

Speed aside, the 180's best attribute is its beautiful active-matrix display that can display up to 16 gray levels. Besides being brighter than the supertwist displays used in the 100, 145, and 160, the 180's display is also legible from a

wider range of viewing angles. (With supertwist displays, screen brightness drops dramatically when you aren't directly in front of the display. This can make it harder for a group of people to look at the screen.) The 180's display is also faster. The 100, 145, and 160 are more prone to a phenomenon called *ghosting,* in which objects moved rapidly across the screen leave a blurred trail in their wake.

The PowerBook 180 provides the same video-output features as the 160. You can connect an external display to its video-out connector and specify that the display be an extension of the 180's screen or a duplicate of it.

The PowerBook 180 also uses the same kind of rechargeable NiCad battery as the 145 and 160 models. And like the PowerBook 160, the 180 provides a power saver operating mode that slows the computer's processor—in this case, from 33MHz to 16MHz—and also reduces the maximum screen brightness.

The PowerBook 180 provides the same SCSI disk mode feature found in the PowerBook 100 and 160 models.

The PowerBook Duo Family

An all-in-one PowerBook is ideal if you spend most of your time on the road, but what if you divide your time between the office and other locations? Or between a dorm room and a computer lab? You probably will want a full-sized keyboard, a color monitor, expansion slots, and more storage capacity at your desktop. A second Mac is one alternative, but then you would be faced with the chore of transferring files between it and the PowerBook. Also, many budgets and corporate purchasing policies don't allow for more than one computer per person.

The answer may just be a PowerBook Duo system. The PowerBook half of a Duo system is a computer that's even smaller and lighter than an all-in-one PowerBook. The PowerBook Duo 210 and 230 models tip the scales at just over four pounds, and they're thinner—less than 1.5 inches thick when closed, versus the 2.25-inch thickness of an all-in-one PowerBook.

When you return to the office, you can dock your PowerBook Duo to the mothership—the Duo Dock docking station. After closing the PowerBook Duo's screen, slide the computer into the Duo Dock's front-panel slot and push it back. When the PowerBook is five millimeters away from its destination, a motorized mechanism within the Duo Dock takes over and finishes the job. Just like that, the 4-pound PowerBook has two serial ports, an ADB port, a SCSI port, a video-out port, a larger speaker—and two NuBus slots. The Duo Dock also has room for a second hard disk drive and an optional 68882 math coprocessor.

When it's time to hit the road again, push the Duo Dock's Eject button. If you have any unsaved documents open, you're asked if you want to save them. Then, the Duo Dock's motorized mechanism ejects and shuts down the PowerBook Duo, and you're on your way. Anyone who has used a videocassette or compact disc player has all the skills necessary to insert and eject a PowerBook Duo.

Some docking stations have been available in the IBM PC world, but they lack the polish of the Duo system. None provide a motorized insert-and-eject mechanism, for example, and instead make you push with some force to fully insert the computer in its docking station.

But the Duo Dock's motorized mechanism does more than eliminate having to push. Because it's tied to the PowerBook's system software, it can inform the PowerBook that you have pushed the Eject button, and the PowerBook can then ask if you want to save unsaved documents. Other notebook computers and docking stations lack these smarts. You can, for example, eject an MS-DOS portable even if unsaved documents are open. If you do, you lose work.

The underlying glue that ties together the Duo and the deskbound docking station is a collection of hardware and software Apple calls PowerLatch. In general, PowerLatch allows for easier transitions between portable and desktop computing. It's what keeps you from losing work when you press the Duo Dock's Eject button. If you're curious about the other benefits of PowerLatch, you will find some additional details in the backgrounder sidebar, "Inside PowerLatch."

Backgrounder: Inside PowerLatch

PowerLatch streamlines the process of switching between portable and desk-bound computing. Here are a few examples of what PowerLatch technology makes possible.

If your Duo Dock contains a high-speed EtherNet NuBus networking board, PowerLatch sees to it that the EtherNet port is activated when you insert the PowerBook Duo—even if the PowerBook was configured to use the built-in (but slower) LocalTalk port when you were on the road.

You can configure a PowerBook Duo to display 16 gray shades when it's on the road and 256 colors when it's docked. The PowerBook Duo senses whether it is docked, and configures itself accordingly.

If you attach a sleeping PowerBook Duo to a Duo MiniDock that's attached to a floppy drive and then wake the computer up, the

Powerbook Duo immediately acknowledges the presence of the floppy drive—no need to restart and waste precious battery power. If you have activated a PowerBook Duo's power saver feature (which saves battery life by slowing the processor to 16MHz) and you insert the PowerBook in the Duo Dock docking station, the power saver feature is turned off automatically because you're running from the Duo Dock's power supply. The battery is recharged automatically when the computer is installed in the Duo Dock. (And because the battery slides into the front of the PowerBook Duo, you can change batteries when the system is docked.) Also, if the Duo Dock contains the optional math coprocessor chip, the PowerBook Duo uses it automatically.

PowerLatch accomplishes this smooth integration through a combination of hardware and software. But its ultimate benefit is that it eliminates the need for you to make Control Panel or hardware adjustments every time you switch between portable and docked operation.

PowerBook Duo Common Ground

Here's a look at the features the PowerBook Duo computers have in common.

Compact, streamlined design. The PowerBook Duos are even smaller than the all-in-one PowerBooks; a standard PowerBook's screen is about 3/4-inch thick. Inside the PowerBook Duo, a subframe made of magnesium adds rigidity and plays an important role in establishing a firm connection between the computer and a docking station. A PowerBook Duo is shown in figure 4.7.

An even smaller keyboard. The keyboard in a PowerBook Duo is slightly smaller than a standard PowerBook keyboard (which, itself, is smaller than a standard desktop Mac's keyboard). If you have big hands, take a test drive before you buy.

A tiny trackball. The trackball in a PowerBook Duo is just 19mm in diameter—less than half the size of other PowerBook trackballs. Thanks to three ruby bearings, the tiny ball moves smoothly, but if you're not a trackball fan, try one for a while to be sure you can live with it.

Improved battery technology. The PowerBook Duo computers use nickel-metal hydride (NiHy) batteries that provide more power in a smaller package. NiHy batteries are also less toxic to the environment than NiCad batteries.

Minimal built-in ports. A PowerBook Duo contains just two rear-panel ports: a modem port and a printer port. If you need additional ports, you need to connect to a docking station. (Trackball haters take note: this also means you cannot attach a mouse without also attaching a docking station.)

A rear-panel expansion connector. On the back of a PowerBook Duo is a plastic door that, when opened, exposes a 152-pin expansion connector that forms the gateway between the PowerBook Duo and a docking station.

No internal floppy drive. To connect a PowerBook Duo to a floppy drive, you must attach a docking station. The Duo Dock station contains a built-in SuperDrive floppy drive; also available is an external drive that connects to one of two portable docking stations we describe later.

RAM expansion to 24MB. Thanks to an improved memory design, the PowerBook Duo models can accommodate up to 24MB of RAM.

Room for a modem. The PowerBook Duo models can accept an optional 9600-bps send/receive fax modem.

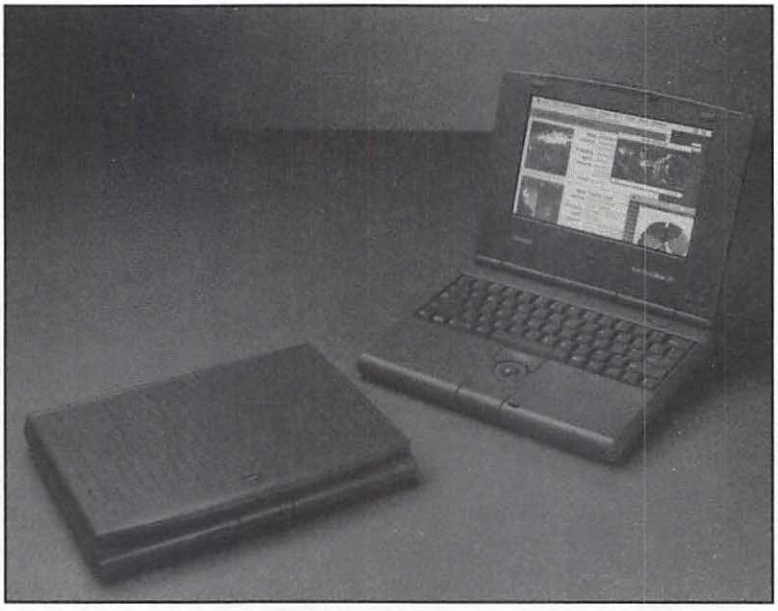


Figure 4.7: A PowerBook Duo.

The PowerBook Duo 210

The PowerBook Duo 210 uses a 25MHz 68030 processor and contains a supertwist LCD screen capable of displaying up to 16 gray shades. The Duo 210 includes 4MB of RAM and an 80MB hard drive.

The PowerBook Duo 230

The PowerBook Duo 230 is identical to the 210, except that its 68030 runs at a faster 33MHz to provide performance roughly equivalent to the Mac IIfx. The 230 is available with an 80MB or 120MB hard drive.

The Duo Dock

The Duo Dock is the key component in the Duo system's best-of-both-worlds design. As mentioned earlier, the Duo Dock adds ADB, SCSI, sound input and output, and video-output connectors as well as a SuperDrive floppy drive, two NuBus slots, and a larger speaker. The Duo Dock's logic board also has room for an optional 68882 math coprocessor, and there's room in the case for a hard drive. The Duo Dock is shown in figure 4.8.

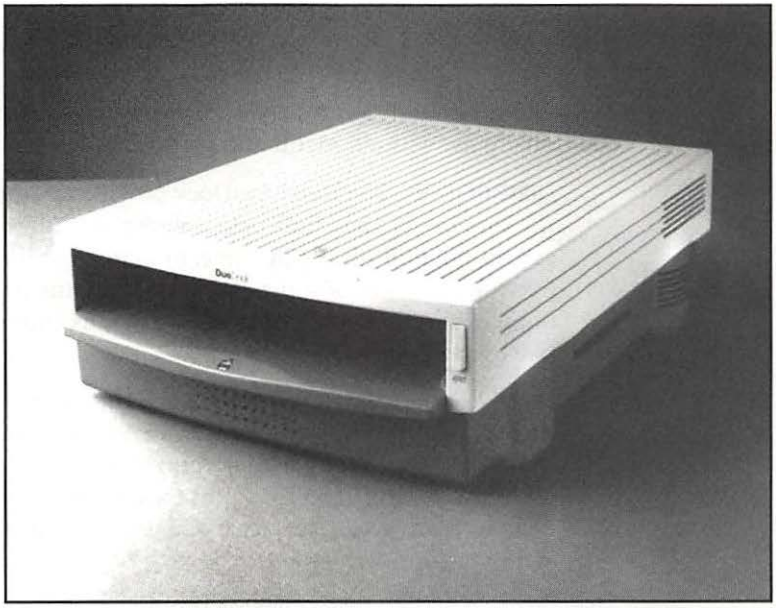


Figure 4.8: The Duo Dock.

The Duo Dock also contains a lock-and-key mechanism that you can use to lock your PowerBook Duo in place. You also can lock the dock when the PowerBook Duo has been removed, thereby preventing anyone else from using your docking station.

The Duo Dock's logic board contains a SIMM slot that accepts a video-memory expansion card. When the card is installed, the dock is able to display up to 256 colors on monitors as large as 16 inches. The top half of the Duo Dock's case contains two steel rails that enable the case to support up to 50 pounds. The Duo Dock includes an ADB mouse, but like most desktop Macs, does not include a keyboard. You will need to buy one of the ADB keyboards described later in this chapter.

From the expansion standpoint, the Duo Dock's best feature is its two NuBus slots. Unfortunately, accessing the slots isn't easy. You must remove the top half of the docking station's case, disconnect its power supply, remove two screws that attach the Duo Dock's innards to the bottom half of the case, and then turn the station upside-down. You also will probably want to disconnect your monitor, mouse, keyboard, and any other cables before inverting the docking station to avoid tangling the cables. Because of all the effort required to access the NuBus slots, the Duo Dock may not be suitable for people who need to swap expansion cards into and out of their machines frequently.

Other Docking Options

Apple offers two additional docking stations for the Duo system that provide additional ports without sacrificing portability.

Duo MiniDock. The Duo MiniDock provides all the same connectors as the Duo Dock. The MiniDock provides no NuBus slots, video RAM expansion, built-in floppy drive, or math chip option, but it does provide the ports most people need (including one for an external floppy), and in a small package that weighs about a pound and a half (see figure 4.9).

Duo Floppy Adapter. If you simply need an external floppy drive, there's the Duo Floppy Adapter, which is even smaller than the MiniDock. The Floppy Adapter provides a port for an external floppy drive and throws in an ADB port for good measure. The Floppy Adapter is an ideal accessory if you want an external floppy and the ability to connect a mouse.

Also, a variety of specialized docking stations that provide acceleration or fast network interfaces are or will be available from third-party manufacturers.

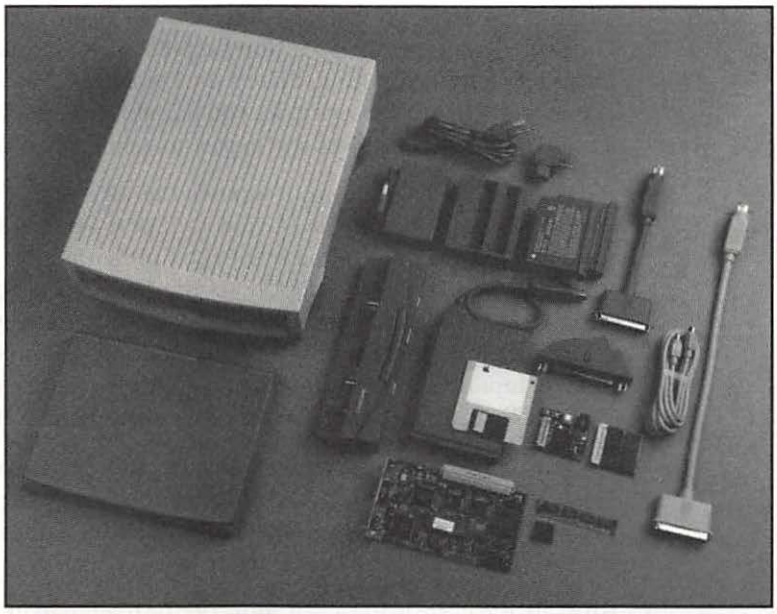


Figure 4.9: The Duo MiniDock and other docking accessories.

Can a PowerBook replace a desktop Mac?

When the first portable computers appeared, industry gurus began forecasting a day when they would replace bulky, power-hungry desktop machines. Do the PowerBooks bring us any closer to that day? Yes and no.

The PowerBook 100 is ideal for word processing and other basic tasks, and its SCSI disk mode makes it an ideal complement to a desktop Mac. But its relatively slow 68000, single serial port, and lack of an internal floppy disk drive make it a second-best choice as a sole computer.

On the other hand, the remaining all-in-one PowerBook models pack plenty of processing punch and their tack-sharp displays are actually larger than the built-in screen of a Mac Classic. The performance and active-matrix displays of the 170 and 180 machines are especially impressive.

Yet these PowerBooks still have limitations—small, nondetachable keyboards and no general-purpose expansion slots. For a better balance between portability and desktop computing, there's the *PowerBook Duo line.* A PowerBook Duo combined with a Duo Dock gives you portability when you're on the road and a full complement of ports and expansion slots when you're at your desk.

But even a Duo system cannot provide the very best of both worlds. Suppose that you need portability *and* a video-out port—perhaps you need to connect to an external monitor frequently to give presentations. In this case, you need to buy a MiniDock in addition to the Duo Dock you may have already purchased. If you do a lot of traveling, you will probably want to throw in an external floppy drive, too. When you're done, you may have spent a lot of money duplicating hardware that you already paid for when you bought the Duo Dock. And don't forget a carrying case to hold everything.

Of course, you don't need to buy a Duo Dock, but if you buy just the MiniDock, you forgo all the expansion opportunities the Duo Dock provides. And the Duo Dock itself has drawbacks. Although it provides NuBus slots, you practically have to disassemble the Duo Dock to access them.

All in all, if you are using a Mac more on the road than in an office, by all means consider a PowerBook as your sole computer. If you divide your time between locations, a PowerBook Duo system may make sense—but do evaluate the system and your requirements carefully to make sure you will not need to buy and lug around a briefcase full of add-ons. (And if you're a musician looking for the ideal bandstand computer, note that the entire PowerBook family has some potentially serious problems with the Musicial Instrument Digital Interface, or MIDI. See Chapter 8 for details.) In the end, if you're deskbound most of the time, a true desktop Mac will probably serve you best.



Mac Keyboards

The Mac's keyboards have evolved along with the Mac machines. The earliest Mac keyboards didn't even have arrow keys for moving the blinking insertion point. Legend has it that Steve Jobs believed the insertion point should be moved solely with the mouse. Today's Mac keyboards have arrow keys, of course, and embody a variety of other improvements.

The Classic, Classic II, and LC II include the standard Apple keyboard, called the Apple Keyboard II. With other Macs, however, the keyboard is sold separately. You can choose from the Apple Keyboard II or the larger Apple Extended Keyboard II. Both are shown in figure 4.10.



Figure 4.10: The ADB keyboards: the Apple Keyboard II (top) and the Apple Extended Keyboard II (bottom). (Photo courtesy of Apple Computer, Inc.)

The Apple Extended Keyboard II has 105 keys. This keyboard requires more desktop real estate, but it gives a lot in return, including the following:

- A row of 15 horizontally arranged *function keys*. Some programs use function keys as shortcut keys for menu commands or other functions that would normally require a trip to the mouse. You also can use keyboard-enhancement software (described in Chapter 9) to tailor the function keys to the tasks you perform most often.
- An arrow-key cluster that's arranged more logically than that of the standard Apple Keyboard II.
- Navigation keys labeled Page Up, Page Down, Home, and End. Most word processing programs enable you to use these keys to move the blinking insertion point quickly or scroll through documents without having to use the mouse.
- Two sets of Control, Option, and Command keys, one on either side of the space bar. The Control keys are most often used with telecommunications programs and keyboard-customizing utilities; we looked at the Option and Command keys in the preceding chapter.
- A layout identical to that of the IBM extended keyboard included with IBM's Personal System/2 series of computers. You will find this layout useful if you equip your Mac with a *PC emulator* software, such as Insignia Solutions' SoftPC or SoftAT that enable the Mac to run MS-DOS software.

Third-Party Keyboards

Apple's keyboards have a relatively short *travel*—the distance the key moves when you press it—that can lead to hand fatigue. (We speak from experience.) If it bothers you, you may consider a third-party keyboard, such as Prometheus Products' Mac-101E or Key Tronic's MacPro Plus.



The Discontinued Macs

Many Mac models are no longer manufactured, but they have been showing up in classified ads and college dorm bulletin boards for years. What are their limitations? Should you buy a used one? We will look at these issues in this section.

Discontinued Classic Macs

As a general rule, because classic Macs, such as the SE and Plus, are less expandable than modular models, such as the Mac II, they're more prone to obsolescence. But certain models have plenty of life in them, and in fact, are better computers than the Macs that replaced them.

The Macintosh Plus

The Mac Plus was an exciting machine when it debuted in April 1985, offering a SCSI port, RAM expandable to 4MB, and a keyboard that included arrow keys and a calculator-like numeric keypad.

The Plus has since been overshadowed by newer Macs, but it remains a workhorse, capable of running System 7 about as well as its successors, the SE and Classic. The Plus contains the same 68000 processor as these Macs, and it runs at the same clock rate of 8MHz. Because Apple made other improvements to the SE and Classic, however, the Plus is still somewhat slower than its successors.

A bigger problem with the Plus is that certain components on its power supply board tend to fail over time. As Chapter 10 shows, you can take preventative measures to reduce the chance of power supply burn-out, and you can have the power supply replaced with a durable one. After you have upgraded the power supply, however, you may be approaching the cost of a brand-new Classic.

A variety of accelerator boards are available for the Plus, but because the machine lacks an expansion slot, they must connect directly to the 68000

processor using a potentially unreliable clip. Given these drawbacks, you should think twice about paying any more than a few hundred dollars for a used Plus.

The Macintosh SE

An SE not only has plenty of life left in it, it actually has several advantages over a Mac Classic. It contains an expansion slot that can accommodate accelerator boards reliably, large-screen video adapters, and other upgrades; it can accommodate up to three floppy disk drives (two inside the case, one outside—the Classic can accommodate one internal and one external floppy drive); and it has two ADB ports versus the Classic's one.

An SE manufactured prior to August 1989 has 800K floppy drives; other SE models contain SuperDrive disk drives. If you buy an SE equipped with 800K drives, you can upgrade to a SuperDrive or buy a third-party high-density disk drive, such as Kennect Technology's Drive 2.4. Apple's SuperDrive upgrade requires new ROM chips; third-party high-density drives don't. Like the Plus and Classic, the SE can accommodate up to 4MB of RAM.

The Macintosh SE/30

The SE/30 has many of the same advantages over the Classic II that the SE has over the Classic: two ADB ports, room for more floppy drives, and an expansion slot (an 030 Direct Slot). With a 68030 running at 16MHz, there's nothing obsolete about an SE/30—if you find a used one in good condition, consider it over a Classic II. The SE/30 also has a 68882 math coprocessor.

The SE/30 does lack two features present in the Classic II: a microphone and sound-input jack. You can add both, and inexpensively—just buy a MacRecorder Sound System Pro from MacroMedia or a Voice Link from Articulate Systems.

When equipped with 4MB SIMMs, the SE/30 supports up to 16MB of RAM. To access more than 8MB, however, you must use the Mode32 system extension (see Chapter 15).

Discontinued Modular Macs

Thanks to expansion slots, there's no such thing as an obsolete modular Mac. With the right expansion boards, the oldest Mac II can become at least as fast as a Quadra 950. Whether you will have spent more than what a new Quadra 950 costs is another question.

The Macintosh II and IIx

The Mac II, also introduced in March 1987, was a Mac of many firsts: the first to use a microprocessor other than the 68000, to offer color capabilities, to work with a variety of monitors, and to offer a large number of internal expansion slots.

The Mac II was a revolutionary Mac when it was introduced, but today, it's showing its age. Its 68020 runs at 16MHz—fast then, middling now. Its 68881 math chip is also slower than the 68882 used in many of today's Macs. And the II lacks the PMMU hardware required to take advantage of System 7's virtual memory feature. (You can add the PMMU chip, a Motorola 68851, for less than $200.)

In its least-expensive configuration, the Mac II contains one megabyte of RAM. Its main system board has sockets that accept SIMMs similar (but not identical) to those of a Mac Plus or SE. When equipped with 1MB SIMMs, a Mac II can house up to 8MB.

The Mac II's hefty case can accommodate two internal 800K floppy disk drives and an internal hard disk. Many II and IIx models were sold equipped with one of Apple's 20MB, 40MB, or 80MB hard disks. Many hardware manufacturers still also offer internal hard disks for the II and IIx. You also can attach an external hard disk to the computer's SCSI port.

In September 1988, Apple introduced the Mac IIx. The IIx's 68030 helps make the computer roughly 15 percent faster than the II. More important, the 68030 contains built-in paged memory management hardware that supports System 7 virtual memory. The IIx also contains the newer and faster 68882 math coprocessor.

The IIx included 4MB of RAM as standard equipment. You can expand the IIx's memory to 8MB using 1MB SIMMs, to 32MB using 4MB SIMMs, and to far more than that using NuBus memory boards. Also like the II, the IIx contains 256K of ROM. The ROMs themselves are slightly different, however. Physically, they're mounted on SIMMs for easy replacement. Internally, the ROMs contain new software that supports the IIx's SuperDrive floppy disk drive.

If there's a drawback to the Mac II and IIx, it's that all their flexibility doesn't fit in a petite package. The II and IIx are big computers—if they had legs, they'd make fine end tables. And unlike the Quadra 900 and 950, the II and IIx were not designed to stand upright on the floor. The position of their ventilation slots prohibits floor-standing operation without a special stand, such as Kensington's Macintosh II Stand.

Perhaps the most exciting thing about a II and IIx is that you can upgrade it to a IIfx for a reasonable cost, or add a third-party accelerator board, such as a Radius Rocket. (Much of this second edition was written on a Rocket-equipped Mac II.) We list the upgrade options available for the II and IIfx shortly.

The Macintosh IIcx

Introduced in March 1989, the IIcx was the first Mac to straddle the fence between the large Mac IIs and the classic Macs, combining the expandability of the former with the small footprint of the latter.

The base IIcx included 1MB of RAM; a 4MB configuration was also available. The IIcx logic board contains 8 SIMM slots, and thus, can house up to 8MB of RAM using 1MB SIMMs. With 4MB SIMMs, the IIcx can accommodate 32MB of RAM. (The IIcx requires the Mode32 system extension to access more than 8MB of memory; see Chapter 15.)

The IIcx uses the same 256K ROM chips as the SE/30 and IIx, but the chips are soldered to the logic board, rather than mounted on SIMMs, as they are in the SE/30 and IIx. The IIcx has a separate set of SIMM slots to accommodate ROM upgrades, but Apple has never released any.

The IIcx provides three NuBus slots and contains one SuperDrive floppy drive. Unlike the II and IIx, the IIcx also has a floppy drive connector for attaching an external floppy drive.

The IIcx offers other features that the Mac II and IIx lack. Its power switch can be locked in the "on" position that causes the machine to restart itself automatically after a power failure—useful for a IIcx used as a network file server. Also, the IIcx's internal construction is more modular than that of its predecessors. Pop the lid, and you can disassemble the computer into its major components—logic board, disk drive, power supply, speaker, and so on—within minutes. This modular construction style contrasts sharply with the internal layout of the large Mac IIs that often require you to remove the hard disk or other internal components to perform simple jobs, such as installing a RAM upgrade.

The Macintosh IIfx

With a 40MHz 68030 CPU, the Mac IIfx was Apple's fastest Mac—for a while. The IIfx had other exotic features designed to boost performance, including 32K of fast cache memory and a variety of coprocessors that handle grunt work, such as moving data through the SCSI and serial ports. These coprocessors were never completely exploited by the Mac's system software, but they still did contribute to the IIfx's overall performance.

The IIfx contains six NuBus slots, but you need to sacrifice one of them to a video card right off the bat—like early members of the Mac II family, the IIfx contains no video circuitry. The IIfx also contains an 030 Direct Slot; a few companies have developed fast SCSI coprocessor boards that plug into this slot to provide maximum transfer rates to and from high-speed hard disks. We examine SCSI coprocessors in Chapter 16.

The IIfx can accommodate up to 32MB of RAM. Special SIMMs designed especially for the IIfx are required.

The Macintosh Quadra 900

Like the Quadra 700, the Quadra 900's 68040 runs at 25MHz. But thanks to having some of the same coprocessor chips found in the Mac IIfx, the Quadra 900 is slightly faster than the Quadra 700.

Most of the Quadra 900's other features are similar to those of its replacement, the Quadra 950.



Discontinued PowerBooks

In this section, we spotlight the PowerBook 140 and 170 models. Neither is obsolete by any means—both provide good performance and excellent displays. The 170's active-matrix display is especially good.

RAM expansion cards and modems aside, no official Apple upgrades are available for the PowerBook 140 and 170. You can, however, choose from a variety of third-party upgrades that provide 9600-bps modems and video connectors for external monitors.

The PowerBook 140

The PowerBook 140 contains a 68030 processor running at 16MHz, delivering speed roughly equivalent to that of a Classic II or LC II. The base model 140 included 2MB of RAM and a 20MB hard disk. Other configurations included a 40MB or 80MB hard disk and either 2MB or 4MB of RAM. Like the PowerBook 100, the 140 can accommodate up to 8MB of RAM. Unlike the 100, the 140 includes a microphone and sound-input jack.

The PowerBook 170

The PowerBook 170 uses a 68030 running at 25MHz. The computer was available in a variety of configurations, from one that includes 2MB of RAM and a 40MB hard drive to one that includes 4MB of RAM and an 80MB hard drive. The costliest 170 also included the internal data/fax modem that's an extra-cost option for other models. The 170's RAM is expandable to 8MB.

Speed aside, the 170's best attribute is its beautiful active-matrix display. Although it doesn't display gray shades (as does the PowerBook 180 display), it's still one of the better displays you will find in a portable computer.

The PowerBook 170 also uses the same kind of rechargeable NiCad battery as the 140, 145, and 160 models. To extend battery life, the 170 provides a power saver operating mode that slows the computer's processor from 25MHz to 16MHz and reduces the maximum screen brightness.



Macintosh Upgrades

Apple offers numerous upgrade kits that enable you to keep pace with the Mac family's rapidly advancing technology. In this section, we describe the upgrades available as of summer 1992. All the following upgrades require dealer installation, and require you to trade-in certain components, such as logic boards or floppy disk drives.

Upgrade or Replace?

The decision to buy a new machine or upgrade an old one isn't always easy. On the one hand, an accelerator board or other third-party upgrade may cost less and provide faster performance than an official Apple upgrade. But on the other hand, most Apple upgrades include new ROM chips whose features are often required by today's system or application software. You can buy a 68030 accelerator for a Mac SE, for example, but it will not be able to use System 7's virtual memory feature. If you upgrade an SE to an SE/30, however, you can use System 7 virtual memory. The new ROMs will also support a color monitor.

As a general rule, third-party upgrades often provide faster performance for less money, but Apple upgrades provide the benefits of new ROMs and less chance of compatibility problems. If you plan to sell your Mac someday, note that some people may be hesitant about buying a machine that has been souped up with a third-party accelerator. Also note that some upgrades may require that you buy new memory chips. Chapter 15 contains details on memory expansion issues.

Upgrades for the Mac SE

You can upgrade a Mac SE to an SE/30 using a Macintosh SE/30 Logic Board Kit which includes SE/30 logic board and chassis, or a Macintosh SE SuperDrive Upgrade Kit that includes 1.4MB high-density internal floppy disk drive.

Because the SE/30 was discontinued in 1990, the SE/30 logic board upgrade may become scarce or discontinued.

Upgrades for the Mac Classic

You can upgrade a Classic to a Classic II using the Macintosh Classic II Logic Board Upgrade that includes 2MB of RAM, system software, microphone, and new case. System software requires a hard disk that is not included with the upgrade. (If your Classic included an internal hard disk, you can use it.)

Upgrades for the Mac II and IIx

You can upgrade a Mac II or IIx to a Mac IIfx using the Macintosh IIfx Logic Board Upgrade Kit that includes IIfx logic board, or the SuperDrive Upgrade Kit that includes 1.44MB high-density internal floppy drive and SWIM disk-controller chip.

Because the IIfx cannot use SIMMs designed for other Macs, you also will need to buy new memory SIMMs. Given this and the fact that IIfx logic board upgrades aren't that easy to come by (few dealers stock them), you may consider adding a third-party accelerator instead, such as a Radius Rocket.

Upgrades for the IIcx and IIci

You can upgrade the IIcx to a IIci using the Macintosh IIci Logic Board Upgrade kit. You also may need to buy new SIMMs—the IIci requires faster memory chips than does the IIcx.

You can upgrade a IIcx or IIci to a Quadra 700 using the Macintosh Quadra 700 Logic Board Upgrade kit that includes 4MB of RAM, system software, microphone, and new case.

Upgrades for the LC

You can upgrade an LC to an LC II using the Macintosh II LC Logic Board Upgrade kit, which includes a new case.

Upgrades for the Quadra 900

You can upgrade a Quadra 900 to a Quadra 950 using the Macintosh Quadra 950 Logic Board Upgrade kit.



Ancient History: The First Macs

This section is for Mac historians, for anyone who's curious about the early Macs, and for anyone who owns or is thinking of buying one of the thousands of elderly Macs that, although now discontinued, are still willing to smile when you switch them on.

The 128K Macintosh

The original Mac was the machine that convinced the computer world of two things simultaneously: that graphics-and-mouse-based user interfaces represented the future of microcomputing; and that graphical interfaces needed far more memory and faster disks than the Mac provided.

These days, the original Mac is called the "128K Mac" in honor of the paltry amount of RAM it contained. In the early 1980s, 128K of RAM was quite a bit (no pun intended). The IBM PC shipped with 64K in 1981, and people looked at *that* as a vast expanse. But the Mac's graphical user interface demanded much more than 128K. Apple worked around the constraints by creating system software routines that would enable programmers to *segment* programs—to divide a program into chunks that could be loaded into and out of memory as necessary. Segmentation enabled the 128K Mac to run some relatively sophisticated programs, but at a snail's pace: loading program segments means making disk accesses, and the Mac's disk drive was no speed demon. (The 128K Mac contained one floppy disk drive capable of storing 400K. An external 400K floppy drive was also available.)

Although the 128K Mac lacked a SCSI port, some brave hardware manufacturers introduced hard disks for the machine. These pioneering hard drives connected to the Mac's relatively slow modem port. (Some drives connected to the floppy port—one such drive was manufactured by Quark, now a leading developer of desktop publishing software.) Performance was faster than a floppy, but barely. What's more, because the 128K Mac wasn't designed for a hard disk, you couldn't start it directly from the hard disk—you had to "jump start" it with a floppy, and then switch to the hard disk.

The Macintosh 512K

Apple released the 512K Mac—the Fat Mac, as it was often called—in November of 1984, a few months ahead of schedule, but not a moment too soon. The 512K Mac offered four times the RAM of the first Mac. This larger workspace meant that programs didn't need to rely so heavily on the Mac's segment-loading features. More of the program could reside in memory at once, and as a result, the Mac ran faster.

A more significant benefit came with the release of Andy Hertzfeld's Switcher, a program that enabled you to run more than one program and switch between them with a keystroke. A 512K Mac running Switcher could run two or three applications at once, depending on their size. Switcher was useful (if quirky) in its day; it's since been relegated to the history books by MultiFinder and System 7.

The Macintosh 512K Enhanced

When Apple introduced the Plus, it also introduced a lesser-known Mac that walked a dark alley between the 512K and the Plus: the 512K Enhanced. This Mac retained the 512K Mac's memory configuration, offering 512K of RAM with none of the RAM-expansion flexibility of the SIMMs used by the Mac Plus. But unlike the 512K Mac, the 512K Enhanced contained the same 128K ROMs as the Mac Plus, giving it the same performance benefits and the new HFS disk-management software. Also like the Plus, the 512K Enhanced included an 800K floppy disk drive.

The 512K Enhanced lacked the Plus' SCSI port, prohibiting it from exploiting the new generation of SCSI hard disks and other add-ons that were being introduced for the Plus. Several hardware companies, however, quickly introduced SCSI port kits that allowed you to add a SCSI port yourself. (Such kits are still available from firms, such as Computer Care and NewLife Computer.)

The 512K Enhanced was an unsteady stepping stone to the Plus. You could buy a 512K Enhanced and then upgrade to a Plus later for $799. If you had an unenhanced Mac 512K, you could "enhance" it for $299, and still retain the option to boost it to a Plus later.

Because it has the same ROMs as the Plus, the 512K Enhanced is the least obsolete of the ancient Macs. Still, we don't recommend buying one. Even if you found one for a few hundred dollars, you would spend several hundred dollars adding a memory upgrade and SCSI port—and you can buy a brand-new Mac Classic for less.

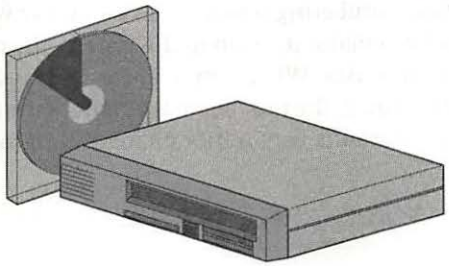
CHAPTER

5

INSIDE THE SYSTEM FOLDER

WHAT'S INSIDE

- A closer look at the software that enables the Mac to run
- Version numbers—what they mean and why they're important
- The purpose of each file in the System Folder
- Control Panels and system extensions
- How the Mac uses printer drivers to communicate with specific printers
- The software Apple provides for updating your system software
- The key differences between recent system software releases



The System Folder is what holds the fundamental software that transforms a box of parts into a Macintosh. Knowing what goes on inside the System Folder can help you diagnose problems, customize and fine-tune your system for better performance, use disk space more efficiently, and remain up to date with the latest system software. In this chapter, we will open the System Folder and examine its contents.

The information in this chapter applies to System 7 and to System 7.1, an upgrade to System 7 that appeared late in 1992. System 7.1 is very similar to System 7; we note the differences later in this chapter. If you're using System 6, you may want to refer to Appendix A for details on the differences between your version and System 7.

Finally, throughout this chapter and this book, you will sometimes see the word *system* appearing with an initial capital letter ("System"), and sometimes in all-lowercase letters. That isn't an inconsistency. The phrase *the Mac's system files* refers to all of the files in the System Folder. By contrast, the phrase *the System file* refers to the one file named System.



System Version Numbering

By storing most of the Mac's system software on disk, Apple can add features, fix bugs, and improve performance without requiring Macintosh owners to buy new ROM chips.

Like all companies that develop software, Apple uses *version numbers* to differentiate between each generation of its software. You can find out which version of the system software your Mac has in two ways.

You can choose About this Macintosh from the Apple menu when the Finder is active. This opens a window listing your system software version number as well as information about how your Mac's memory is being used (see figure 5.1).

You also can select the files named System and Finder in the System Folder and then choose Get Info from the Finder's File menu (see figure 5.2).

As you can see, the version numbering scheme uses a number with a decimal portion. When Apple makes a major revision to the system, the number to the left of the decimal point increases. When Apple makes minor changes to fix bugs or support a new Mac model, the number to the right of the decimal point increases. If a new release contains very minor changes, you might find two decimal points, as in 7.0.1.

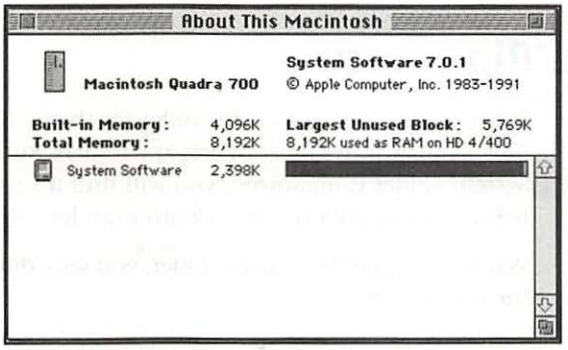


Figure 5.1: The About This Macintosh window.

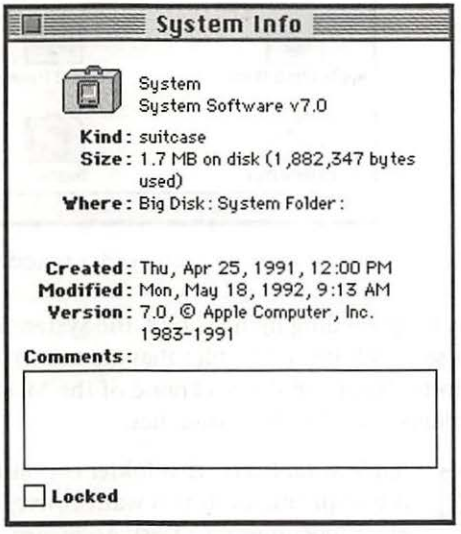


Figure 5.2: Version numbers in System Info window.

Another potentially confusing point is that all the files in the System Folder may not have the same version number. Apple may make major revisions to some files without changing others. To avoid confusing users with a slew of different version numbers, Apple groups the files under the umbrella of a single number, such as System 7 or System 7.1. Most of the time, that's the only system version number you need to concern yourself with.

The Big Picture

When you open the System Folder for the first time, you might feel like you have stepped into a maze of files and folders. But once you understand how the System Folder is organized, you will find it's actually pretty straightforward. Before we embark on our in-depth tour, let's step back for the big picture.

When you open the System Folder, you see a directory window that resembles the one in figure 5.3.

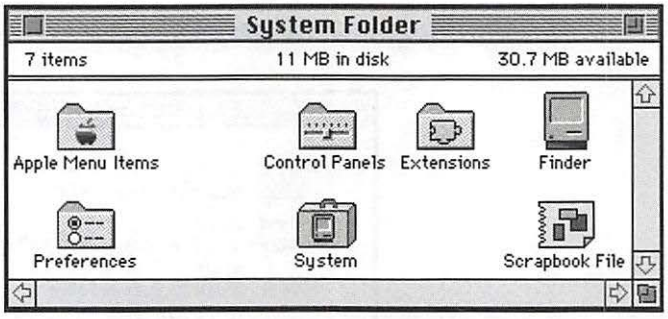


Figure 5.3: An open System Folder in icon view.

As the preceding figure shows, the System Folder contains several files, as well as several folders. The files that are not within folders, the System file and the Finder file, form the backbone of the Mac's system software. As for all those folders, each holds related files.



Apple Menu Items. This folder contains items whose names appear in the Apple menu. If you want convenient access to a particular program, document, or Desk Accessory, put the item (or an alias of it—see Chapter 8) in this folder.



Startup Items. This folder contains items that you want the Mac to open automatically when it starts up. If you always run a certain program or open a specific document after you start your Mac, for example, you can create an alias for the item and store the alias here.



Fonts. This folder contains the type fonts whose names appear in your programs' Font menu. The Fonts folder is present in System 7.1 and later versions. In System 7, most fonts are stored directly within the System file. You can read more about this in more detail in the next chapter.



Preferences. This folder contains the *preferences files* that many programs create as they run. If you change certain settings in a program,

such as the font it uses for new, untitled documents, the program will probably save your settings in a preferences file within this folder. As you see later, the Finder uses its own preferences file.



Control Panels. This folder contains Control Panels that are small programs that enable you to adjust and customize the Mac's operation.



Extensions. This folder contains extensions, which are those files that often load into memory during startup and add features or capabilities to the Mac.



PrintMonitor Documents. This folder is a temporary storage place for files that are waiting to be printed by the Mac's background printing software.



The Finder and System Files

As mentioned previously, the files named Finder and System are the key players in the disk-based portion of the Mac's operating system. The file named Finder, as you can probably guess, holds the software for the Mac's Finder.

The System file performs a dual role (see figure 5.4). It contains portions of the system software that aren't in ROM, and it contains *system resources,* such as sounds and, in system versions preceding 7.1, fonts. These resources generally are available to all application programs. When you start a word processing program, for example, the program checks the resource area of the System file to see which fonts are available, and then lists those fonts in its Font menu. As described in the next chapter, you can install and remove fonts and sounds by dragging them into or out of the System file (or, in System 7.1, into or out of the Fonts folder in the System Folder).

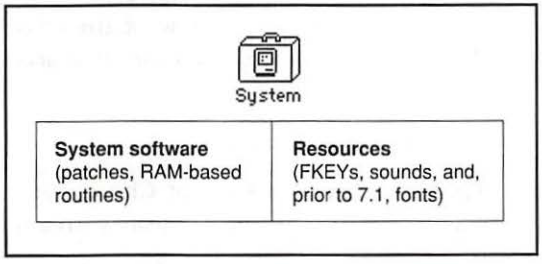


Figure 5.4: A block diagram of the System file's contents.

The System file also can accommodate a cousin to the Desk Accessory, the *function key*, or *FKEY*. FKEYs, like Desk Accessories, are small programs that are generally available in any application. Unlike Desk Accessories, FKEYs aren't

listed in the Apple menu. To run an FKEY, you must press a Command-Shift keyboard sequence. The Mac includes three FKEYs.

Command+Shift+1 and Command+Shift+2 eject the disk in the internal or external floppy disk, respectively. On a two-floppy Mac SE or SE/30, Command+Shift+1 ejects the disk in the lower drive and Command+Shift+2 jettisons the disk in the upper drive. On a two-floppy Mac LC, II, IIx, or IIfx, Command+Shift+1 ejects the disk from the left-hand drive and Command+Shift+2 ejects the disk from the right-hand drive.

Command+Shift+3 creates a screen *snapshot*, a file containing whatever appears on-screen when you press the key sequence. You can read more about snapshot files in Chapter 9.



A Closer Look at Extensions

You may recall from the previous chapter that expansion slots make a Mac more versatile by allowing you to add new hardware. System extensions provide this same benefit for the Mac's system software. Rather than releasing a major upgrade to the Mac's system every six months or so, Apple releases extensions that enhance System 7's capabilities. This modular approach to system software has another benefit—it enables you to pick and choose the extensions that your work requires, and thus tailor your system software to match your needs and your Mac's capabilities.

In this section, we take a closer look at the extensions that accompany System 7, and at some of the optional extensions that Apple has developed.

Chooser Extensions

As you may recall from Chapter 3, Chooser extensions are those files whose icons appear in the window of the Chooser Desk Accessory. This section describes the Chooser extensions that accompany System 7.

Printer Drivers

The most common form of Chooser extension is the *printer driver*, which enables the Mac to communicate with a specific type of printer.

As figure 5.5 shows, printer drivers act as intermediaries between a program that has something to print and the printer itself. The driver translates the commands that describe a document's appearance into the specific commands required by a given printer. You use the Chooser Desk Accessory to select the driver for your printer.

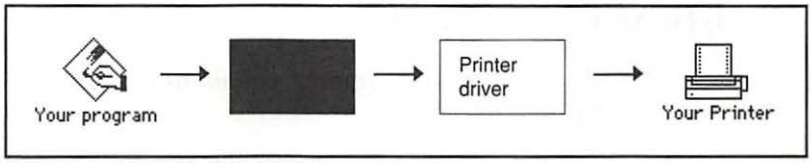


Figure 5.5: How a Macintosh program prints.

System 7's package includes eight printer drivers. If you buy a non-Apple printer, such as a GCC Technologies PLP II, chances are it will include a driver that you will need to install on your hard disk.

Following is a quick description of the printer drivers that accompany System 7. Depending on how the System 7 software was installed on your Mac, all of the icons may not appear in your Chooser window.

ImageWriter. For printing to the ImageWriter and ImageWriter II printers connected to the Mac's printer or modem port.

AppleTalk ImageWriter. For printing to ImageWriter II printers equipped with Apple's optional *AppleTalk* board. This board and driver work together to allow Macs attached to a network to share an ImageWriter II printer.

LQ ImageWriter. For printing to the ImageWriter LQ printer connected to the Mac's printer or modem port.

LQ AppleTalk ImageWriter. For printing to ImageWriter LQ printers equipped with Apple's optional AppleTalk board.

LaserWriter. For printing, via a network, to LaserWriters and other printers equipped with the PostScript page-description language.

Personal LaserWriter SC. For printing to Apple's non-PostScript Personal LaserWriter SC printer, connected to the Mac's SCSI port.

StyleWriter. For printing to Apple's StyleWriter ink-jet printer, connected to the modem or printer port.

Personal LaserWriter LS. For printing to Apple's non-PostScript Personal LaserWriter LS printer, connected to the modem or printer port.

Chapter 8 contains more information on these printers and their drivers.

The AppleShare Extension

The Chooser extension named AppleShare enables you to connect to a shared hard disk using System 7's file-sharing features. We will examine these features in detail in Chapter 12.

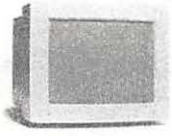
Other Extensions

Here's a quick look at the other extensions you're likely to find lurking in your Extensions folder.

The *QuickTime* extension enables the Mac to, among other things, display, create, cut, copy, and paste digitized video, sound, and animation. QuickTime is the foundation for the Mac's multimedia capabilities. The QuickTime extension is included with most QuickTime-supporting programs and also is available through user groups and online services. It's also included with System 7.1 and with Apple's QuickTime Starter Kit, which includes extra utilities and a CD-ROM disc packed with video clips you can use in your own productions.

To use QuickTime, you need a color Mac with a hard disk running System 6.0.7 or a later version. The 8-bit (256-color) video hardware built into most color Macs will do, but for the best image quality, you will probably want 24-bit video—the kind built into the Quadra family and available through expansion boards for other Macs. QuickTime also will run on the PowerBook family (except the 100), but color movies are little more than recognizable on their monochrome screens. (QuickTime 1.5 delivers much better results on monochrome screens.) As for RAM, 4MB is a reasonable minimum, but 8MB or more will deliver better performance when recording and saving movies. You will find more details on QuickTime in Chapters 3 and 12.

Caps Lock. This extension works only on Macintosh PowerBooks; it simply displays an arrow symbol at the right end of the menu bar when the PowerBook's Caps Lock key is active. This extension is helpful because a PowerBook's Caps Lock key doesn't remain down when the caps lock feature is active; without the extension, the only way to determine whether caps lock is active would be to type a few letters. You don't need this extension with a PowerBook Duo model; the Caps Lock key on the Duo keyboard lights when active.



TIP: For a chuckle, activate System 7's balloon help feature and point to this extension's icon. In the help balloon that appears, you will see the code names that Apple used for the PowerBooks when they were in development (see figure 5.6).

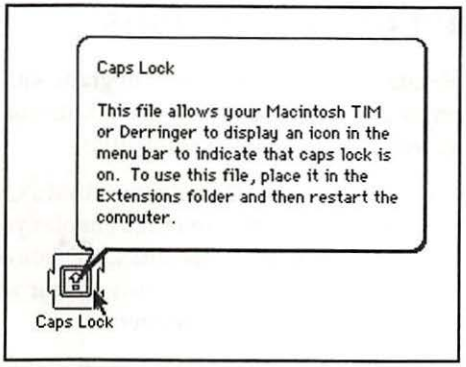


Figure 5.6: Someone forgot to change the code names.

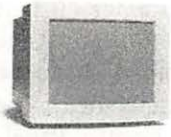
Alas, someone caught the error during System 7.1's development. System 7.1's help balloon for the Caps Lock extension contains the real product names.

File Sharing Extension. This extension loads some of System 7's file-sharing software into memory during startup.

Finder Help. This file isn't actually an extension, but contains the text that appears in the Finder's help balloons.

Network Extension. This extension works along with System 7's file-sharing software to enable you to specify when and how other users can access folders and disks that you make available through the Finder's Sharing command. It works together with two Control Panels: Sharing Setup and Users & Groups.

System 7 Tuner. This extension fixes some bugs in System 7, speeds certain tasks, such as disk and file copying, and improves System 7's performance during those times when free memory is low. The System 7 Tuner extension is part of Apple's System 7 Tune-Up package, released in early 1992. We take a closer look at the System 7 Tune-Up package later in this chapter.



TIP: If you're running System 7.1, you don't need System 7 Tuner; the enhancements that System 7 Tuner provides have been rolled into System 7.1.

Extra-Cost Extensions

Besides selling the System 7 upgrade kits we describe later, Apple offers some extra-cost extensions that add additional features to the Mac. These optional extensions include the following:

PC Exchange. If you use an IBM PC or compatible, you will want this extension. PC Exchange enables you to work with 3.5-inch DOS disks as if they were Mac disks. DOS directories appear as folders, for example, and documents appear with icons. We take a closer look at PC Exchange in Chapter 14.

At Ease. This extension creates a simplified Desktop for starting programs and opening documents, and it provides some basic security features. At Ease replaces the standard Finder Desktop with two on-screen cards: one labeled Applications and one labeled Documents. Each card contains program or document icons. You can open an item by clicking its icon just once—no double-clicking needed.

When At Ease is active, you can't rename or delete icons, nor can you open the System Folder or any Control Panels. A menu command enables you to access the full Finder, but you must first supply a password. You also can configure At Ease so that any new documents must be saved to a floppy disk instead of to the Mac's hard disk. This feature could appeal to schools that don't want students cluttering computer lab hard drives with their own files.

At Ease is designed primarily for home and educational use, but it has one attribute that makes it appealing for almost anyone. When you run under At Ease rather than the full System 7 Finder, you have roughly 200K more RAM available for running programs. It's also easy to switch between the Finder and At Ease. At Ease adds a Go To At Ease menu command to the Finder's File menu; simply choose it and the traditional Desktop surrenders to At Ease. Balloon help is still available when At Ease is active.



Control Panels

As mentioned earlier in this chapter, Control Panels are small programs that enable you to adjust system-related settings, such as the time and date of the Mac's built-in clock. Control Panels live in the Control Panels folder (within the System Folder); when you choose Control Panels from the Apple menu, the Mac switches to the Finder if necessary and then opens the Control Panels folder for you.

(Another name for a Control Panel is a *CDEV,* which is short for *Control Panel Device* and generally pronounced *SEE-DEV.* You may encounter this technical term for a Control Panel in programming books or in older Mac books.)

It's a bit easier to keep track of the Mac's Control Panels if you group them into the following categories.

- System settings—Control Panels that enable you to adjust various technical aspects of the Mac's operation.
- Interface customizing—Control Panels that enable you to customize the Mac's interface.
- Finder customizing—Control Panels that enable you to tweak the way the Finder displays icons and the contents of disks and folders.
- File sharing—Control Panels that enable you to activate and adjust System 7's file sharing features and monitor how your Mac's hard disk is being used by others.

Control Panels for System Settings

Let's look at each of the system-related controls panels that accompany System 7, and find out which Macs each is intended for. In Chapter 8, you find tips for using many of the Control Panels described here.



General Controls. This appropriately named Control Panel enables you to change basic system settings: the date, time, number of times a menu command flashes after you choose it, the current Desktop pattern, and the speed at which the insertion point blinks.



Keyboard. When you press and hold down a key, the Mac repeats that key's character. The Keyboard Control Panel enables you to change the *keyboard repeat rate*, the speed at which a key repeats. With a slow keyboard repeat rate, a small amount of time elapses between each repetition. With fast repeat rates, there's no delay between each repetition. The Delay Until Repeat setting enables you to govern how much time elapses after you have pressed a key until the key begins to repeat. The Keyboard Layout section enables you to switch between different *keyboard layouts*, or keyboard arrangements. The Keyboard Layout section is usually used to switch between layouts intended for different languages, but as you see in Chapter 9, you also can use it to customize the way your keyboard operates.



Mouse. This Control Panel enables you to adjust mouse and trackball settings. The mouse-tracking settings enable you to control how the Mac's on-screen pointer responds to mouse movements. When you choose the Very Slow setting, the pointer moves at a snail's pace—too slow for convenient navigation, but potentially useful for detailed drawing. The Very Slow setting is intended for use with a *graphics*

tablet, an input device that consists of a flat tablet and a pencil-like *stylus*. Graphics tablets are popular for electronic drafting and drawing applications.

The remaining tracking options are for use with a mouse, and control the relationship between mouse movement and the pointer's on-screen movement. The faster settings are useful if you have a large screen or if you don't have a lot of free desk space. The slower settings provide extra precision when you're drawing or moving items using a desktop publishing program; they're also handy if you have trouble accurately positioning the pointer. (For more background on mouse tracking, see Chapter 14.)



Memory. This Control Panel enables you to adjust the size of your Mac's *RAM cache*, which boosts performance by keeping recently used information in RAM, reducing the need to access a relatively slow hard disk. On some Macs, the Memory Control Panel offers additional options. It enables you to activate, adjust, and deactivate System 7's virtual memory feature; it enables you to activate or deactivate *32-bit addressing*, which enables certain Macs to access more than 8MB of RAM; and it enables you to create and adjust the size of a *RAM disk*, which is a portion of RAM that the Mac treats as a disk drive. (For more information about RAM caches and RAM disks, see Chapter 10.)



Startup Disk. When you start up a Mac, it scans the drives connected to it in search of a System Folder. The Startup Disk Control Panel enables you to override the order of that scanning process. When you click on the Startup Disk icon, the Control Panel displays an icon for each SCSI storage device in your system, highlighting the currently selected startup disk. To choose a different disk, click its icon. To deselect a disk, press Command while clicking its icon. (**Note:** Startup Disk works only with the Mac SE and later machines, and it's useful only if you have more than one SCSI storage device. And as mentioned earlier, a drive must contain a System Folder in order for the Mac to start from it. Chapter 14 contains more details on SCSI and the startup-scanning process.)



Monitors. This Control Panel enables you to view and change the settings that determine how many colors or gray shades a color Mac displays. If you have connected more than one monitor to your Mac, you can use Monitors to designate one monitor as the *main monitor*—the one on which the menu bar appears. You also can reposition the monitor outlines to correspond to the actual location of the monitors on your desk.

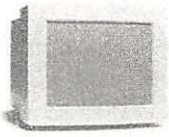


Map. This interesting Control Panel enables you to reset the Mac's clock when you move the Mac from one time zone to another, and it enables you to determine the distance and time difference between your location and others.

If you live in a major city, you can specify your location by typing its name, clicking Find, and then clicking Set. (The flashing dots on the map display represent places that Map knows about.) Map stores your choice in the Mac's parameter RAM, that battery-powered memory area that also holds the time, date, and other Control Panel settings.

If the Mac beeps when you click Find, it doesn't know about your city. Don't be offended; Apple's selection criteria for which U.S. cities got "on the map" seems a bit arbitrary to us, too. (Heid thinks the omission of his home town of Pittsburgh is inexcusable, especially since pint-sized Cupertino, California—Apple's home—is listed.) In any case, you can add a city to Map's internal list: type its name, latitude, and longitude, and then click Add.

If you move your Mac to a different time zone, use the Find button to locate a city in that time zone (or add the city as described above), and then click Set. The Map Control Panel resets the Mac's clock to reflect the time zone to which you have moved.



TIP: To see an enlarged view of the world, press the Option key while clicking on the Map Control Panel. To see the time difference rather than the time zone, click on the words "Time Zone" below the Map display.



Portable/PowerBook. As you might guess, these Control Panels work only on PowerBooks and the original Macintosh Portable. The Portable Control Panel enables you to specify how much time can elapse before the computer and its hard disk go to sleep. On PowerBooks equipped with an internal telephone modem, you also can specify whether the computer should use the internal modem or an external modem connected to the modem port. The PowerBook Control Panel appeared in late 1992 and replaced the Portable Control Panel. The PowerBook Control Panel performs the same basic jobs as its predecessor, but it's a bit easier to use.



PowerBook Display. This Control Panel, included with System 7.1, enables you to configure a PowerBook or PowerBook Duo to save battery power by turning off screen backlighting after a specified period of inactivity (between one and five minutes). Press any key or

move the trackball to restore backlighting. If you have an external monitor attached to your PowerBook, you also can use this Control Panel to activate the video mirroring mode, in which the contents of the external monitor and the PowerBook display are identical.



Brightness. This Control Panel enables you to adjust the screen brightness on the Mac Classic and Classic II.



Cache Switch. This Control Panel works only on the Mac Quadra series; it enables you to disable the built-in caches of the 68040 processor to enable the Quadra to run programs that violate certain Apple programming guidelines. Note that disabling the caches slows the Quadra dramatically.

If you have an AppleCD 300 CD-ROM drive, you have the *Apple* CD Speed Switch Control Panel. As mentioned in the preceding chapter, the AppleCD 300 provides faster performance by spinning the CD at double speed. If you want to play standard audio compact discs (which don't work at the faster speed), you need to use this Control Panel to slow the CD to *standard speed.*

Control Panels for Interface Customizing



Color. The Color Control Panel enables you to change the color in the selected text that appears as well as the color used in window title bars. If you would rather see selections in shocking pink and windows in chartreuse, this is the Control Panel for you.



Sound. The Sound Control Panel enables you to adjust the speaker volume and choose one of five sounds as the current *alert sound*—the tone you hear when you click outside of a dialog box or commit some other no-no. This Control Panel takes advantage of the Mac's capability to play digitally recorded sounds. On Macs that include microphones, you also can record your own sounds by clicking the Add button. (For more information about the Sound Control Panel, see Chapter 9.)



CloseView. The CloseView Control Panel enables you to enlarge a portion of the Mac's screen image up to 16 times. CloseView's primary purpose is to make the Mac's screen easier for visually impaired users to read, but it can be useful in precision drawing or desktop publishing applications because it enables you to zoom in for a closer view.



Easy Access. This Control Panel modifies the Mac's keyboard-driver software to enable you to type multi-key sequences (such as Command+Q or Shift+Option+G) with one hand and also to control

the mouse pointer from the keyboard. As indicated by its wheelchair-on-the-screen icon, Easy Access is designed to assist people who might have trouble typing multi-key sequences and moving the mouse. It's also useful for making precise adjustments in the pointer's position.

Easy Access' *Sticky Keys* feature simplifies multi-key sequences. To activate Sticky Keys, press the Shift key five times. When Sticky Keys is active, you can type multi-key sequences by typing their keys sequentially. Rather than pressing Command and S simultaneously, for example, first press Command, and then S. Press Shift five times to turn off Sticky Keys.

Easy Access' *Mouse Keys* feature enables you to use the keypad to move the mouse pointer. (Note that Mouse Keys controls the mouse *pointer,* not the blinking insertion point that appears when you're typing or editing text. Many word processing programs use the keypad's 2, 4, 8, and 6 keys to move the insertion point down, left, up, and right.) Mouse Keys is not available on PowerBooks because they lack numeric keypads. To activate Mouse Keys, press Command+Shift+Clear. Subsequently, the keypad's keys move the pointer. Pressing the 5 key is like clicking the mouse button. Pressing 0 (zero) is like holding the button down, while pressing the decimal-point key is like releasing the button. Pressing Clear deactivates Mouse Keys and restores the keypad to normal operation.

Backgrounder: When Does a Control Panel Act Like an Extension?

If you think about it, there's one big similarity between extensions and certain Control Panels. Consider Easy Access, the Control Panel that, among other things, enables you to move the mouse pointer using the keyboard's numeric keypad. Part of the Easy Access Control Panel loads into the Mac's memory at startup time, and is always watching your typing, on the alert for the key sequences that activate the sticky keys or mouse keys features.

But wait—how can a Control Panel load software into memory during startup? Isn't that what extensions do? Yes, and there's the similarity. Like an extension, a Control Panel can load software into memory during startup. That's because a Control Panel can have a snippet of software attached to it called an *INIT resource.* When the Mac starts up, it scans the Control Panels within the System Folder. If any Control

continues

continued

Panels contain INIT resources, the Mac loads their software into memory. (The CloseView Control Panel also has an INIT resource. During startup, it loads CloseView's screen-enlarging code into memory, where it's ready to be summoned by the CloseView Control Panel.)

As it turns out, INIT resources are the keys to loading software into memory during startup. System extensions, Chooser extensions, and Control Panels—all can have INIT resources, and thus, can load software into memory during startup.

When starting up, System 7 follows a specific order for loading INIT resources. First, all extensions in the Extensions folder are loaded in alphabetical order. Next, Control Panels with INIT resources are loaded, in alphabetical order, from the Control Panels folder. Finally, any extensions or Control Panels located in the top level of the System Folder (that is, not within any folders) are loaded. Like extensions, Control Panels that have INIT resources do nibble away at your Mac's free memory—and there's a chance that they can conflict with each other or with extensions. When you're troubleshooting a startup problem or just trying to save a little memory, don't restrict your attention to extensions. Consider your Control Panels, too.

Control Panels for Finder Customizing

System 7 includes a Control Panel that enables you to customize the way the Finder displays directory windows and one that enables you to create descriptive, color-coded labels that you can assign to disks, files, and folders.



Views. The Views Control Panel enables you to control the appearance of Finder directory windows as well as how much information appears in them. You can change the type size used for icon names (handy if you find the normal 9-point type too small), you can align icons automatically when you drag them (great for neatness freaks), and much more. Your settings are stored in the Finder Preferences file, located within the System Folder's Preferences folder.



Labels. This Control Panel enables you to create descriptive text labels whose names appear in the Finder's Label menu. You can assign a label to an icon by selecting the icon and then choosing the desired label name. If you have a color Mac, you also can associate a color with a label. Clicking on a label's color in the Labels Control Panel displays the color wheel dialog box, where you can change the color of that label.

Control Panels for File Sharing

We look at System 7's file-sharing Control Panels in detail when we explore the Mac's file-sharing features in Chapter 12. Until then, here is a quick overview.



Sharing Setup. Enables you to turn file sharing on and off and control other basic network settings.



Users & Groups. Enables you to create a list of users who you allow to connect to your Mac's shared disks or folders, as well as specify what kinds of access privileges those users have, such as whether they can delete files from your hard disk.



File Sharing Monitor. Displays a list of the users connected to your Mac as well as a gauge that displays the amount of file-sharing activity taking place.



Auto Remounter. This PowerBook-oriented Control Panel accompanies System 7.1, and enables you to specify that shared disks are re-mounted automatically (made available on the Desktop) after you wake up the PowerBook. This Control Panel is handy if you use a shared disk at the office—when you return to the office after using the PowerBook on the road, simply connect to your network. Auto Remounter remounts the shared disk automatically.



Adding Control Panels and Extensions

The Control Panels discussed here aren't the only ones a System Folder can contain—not by a long shot. Many software developers and Mac programming hobbyists have created Control Panels and extensions that perform some very useful jobs or provide some amusing diversions.

We look at some of these Control Panels and extensions in later chapters. For now, we concentrate on the process of installing them in your System Folder. It's actually very simple. Just drag the file to the *closed* System Folder icon, and the Mac displays a message telling you that the Control Panel or extension needs to be stored in the Control Panels or Extensions folder.

(Curious about how the Mac knows where to put what? You can find the answers in the sidebar, "About File Types and Creators.")

If you need to install a Control Panel or extension in a folder other than in the one System 7 thinks it belongs, drag it to the open System Folder directory window. An old, pre-System 7 extension may not work if it's stored in the Extensions folder, but instead, must reside in the top level of the System Folder. To install such an extension, open the System Folder's icon and then drag the

extension to the open directory window. You do not see any of the dialog boxes shown earlier; instead, the Finder dutifully stores the extension at the top level of the System Folder.

Backgrounder: About File Types and Creators

Have you ever wondered how the Mac knows which program to start when you double-click on a document? Or how the Finder knows that Control Panels belong in the Control Panels folder, while extensions belong in the Extensions folder? Or why your PageMaker documents don't show up in Microsoft Word's Open dialog box?

The answer to these mysteries is the *file signature*—information that identifies a file as well as the program that created it. A file signature has two components. The *type* is a four-character code that identifies the file. A Control Panel's type is *CDEV*, a system extension is an *INIT*, and a Chooser extension is an *RDEV*. When you drag a file to the System Folder's icon, the Finder examines the file's type code. If the type is CDEV, the Finder knows it's working with a Control Panel and prompts you to store the file in the Control Panels folder.

The *creator* is a four-character code that identifies the program that created the file. A Microsoft Word document has a creator code of *MSWD*, for example. When you double-click a document, the Finder consults the creator code to determine which program to start in order to open that document.

Most of the time, you don't need to concern yourself with file signatures. The Mac keeps track of them for you behind the scenes. But in later chapters, you learn why knowing about types and creators can be useful, and you will learn how to change a file's signature.



Miscellaneous Files

The rest of the files in the System Folder don't fall into the extension Control Panel, or printer driver categories, but perform important jobs nonetheless.



PrintMonitor. This file is stored in the Extensions folder, but it's actually an application program. One of the Mac's most useful features is its capability to print in the background—that is, while you continue to work. The PrintMonitor application makes background printing possible. System 7 scans a folder (PrintMonitor Documents) within the System Folder constantly, looking for a printer *spool file* that is created when you use the Print command (assuming that you

activated the Chooser's background printing option). A spool file contains the data that would otherwise go directly to the printer if background printing was not turned on. When System 7 finds a spool file, it starts PrintMonitor, which communicates with the printer in the background, sending it spool files, downloading fonts, reporting error messages, and deleting spool files after they are printed.

PrintMonitor also enables you to defer printing to a later time and rearrange or remove pending print jobs (see figure 5.7). If something goes wrong during printing—the paper jams or someone turns the printer off—PrintMonitor can get your attention by flashing its icon over the Apple menu, displaying a dialog box, or both, depending on your preferences.

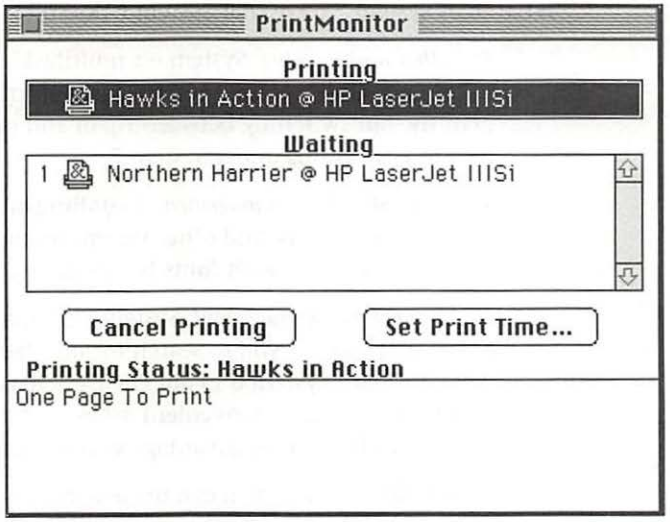


Figure 5.7: Print Monitor's window.



Clipboard File. This file, which may not always be present in your System Folder, can contain the contents of the Mac's Clipboard. When you cut or copy a large amount of data, an application can optionally store it on disk rather than in the Mac's memory. If it elects to store it on disk, it saves it in the Clipboard File.



Scrapbook File. This file contains the information that you paste in the Mac's Scrapbook Desk Accessory.



Note Pad File. This file contains the text you type in the Note Pad Desk Accessory.



Keeping Up-to-Date

In this section, we look at what's involved in keeping your System Folder up to date, and we examine the key differences between recent versions of the Mac's system software.

Upgrading to System 7

All of today's Macs ship with System 7 installed on them. But thousands of Macs are still chugging away under older system software versions, such as 6.0.7 or 6.0.8. If your Mac is among them, should you consider upgrading to System 7? Definitely. Should you do it? Not without reading this section first.

What does System 7 have that System 6 doesn't?

Smoother multitasking. System 6's multitasking software, called MultiFinder, does enable you to run multiple programs simultaneously, but switching between them and managing their windows isn't as easy as it is under System 7.

Streamlined system management. Installing and removing fonts, Desk Accessories, sounds, and other system resources is much easier in System 7. Working with fonts is especially easy in System 7.1.

Streamlined file management. System 7's Finder provides a Find command that enables you to search for misplaced files—it's much more powerful than System 6's Find File Desk Accessory. The alias feature enables you to have convenient access to frequently used files while still being able to take advantage of folders.

File-sharing software. You can make part or all of a hard disk available to Macs or IBM PCs on a network, making it easier to move files between co-workers. And you don't need a huge network to benefit from file sharing; even if you have only two Macs, you will find it an easy and efficient way to move files around.

Virtual memory. To add virtual memory to System 6, you need a third-party utility, such as Connectix Corporation's Virtual.

Publish and subscribe. This dynamic data-exchange mechanism, introduced in Chapter 3, is not available in System 6.

TrueType fonts. As you learn in the next two chapters, System 7's TrueType fonts improve the Mac's WYSIWYG display and enhance the output of inexpensive printers, such as the Apple StyleWriter and Personal LaserWriter LS.

A better-looking interface. On color Macs, windows have an attractive, three-dimensional look to them, and icons, scroll arrows, and other interface elements are better looking, too. This may not be the most compelling reason in the world to upgrade, but it's a plus.

Balloon help. This memory-jogging feature isn't reason enough to upgrade, either, but again—it's a plus.

Clearly, there are many good reasons to upgrade to System 7 (and that wasn't even a complete list). Here are two more:

It's cheap. Upgrading to System 7 is the least expensive way to add new features to your Mac and improve its capabilities. Apple's System 7 Upgrade Kit, which include disks and in-depth manuals, retails for $99 (and is often discounted). Many dealers and user groups let you copy the new system disks at no cost if you provide your own floppies. If you already have System 7, you can upgrade to System 7.1 for even less.

System 7 enables you to take full advantage of the latest software. When Apple released System 7, software manufacturers began taking advantage of its new features in their programs. If you don't upgrade your system to keep pace, you may not get the most out of that new whiz-bang program you just bought. Indeed, you may not be able to run it at all.

Reasons Not to Upgrade

Although there are good reasons to upgrade to System 7, there are also some cases where it may make more sense to stay put—that is, to continue running System 6.

- Your Mac has only 2MB of RAM. Apple says System 7 runs with 2MB of RAM, and technically, that's correct. But the trouble is, System 7 all but fills that 2MB, leaving little left to run programs. Don't upgrade to System 7 unless your Mac has at least 4MB of RAM.
- You don't have more than one Mac and you have mastered System 6. If the previous overview of System 7's niceties didn't impress you, you may be better off sticking with System 6.
- You use older programs or extensions that aren't compatible with System 7. System 7's terrific new features aren't worth much if the programs you rely on crash. Don't upgrade to System 7 unless your software is compatible with it.

Checking Compatibility

How can you tell whether your programs are compatible with System 7? The best place to start is with the Compatibility Checker software that accompanies the System 7 upgrade kit. (It's on the disk labeled Before You Install System 7.) You may want to get a copy of the Compatibility Checker from a dealer or user group before buying the full update package. That way, you won't have to invest anything except time to determine whether System 7 is for you. The Before You Install disk also contains an overview of System 7's new features.

Compatibility Checker scans your hard disk and compares the files it finds against a built-in database assembled by Apple and based on information supplied by software developers. When Compatibility Checker is finished running, it creates a report that summarizes its findings (see figure 5.8).

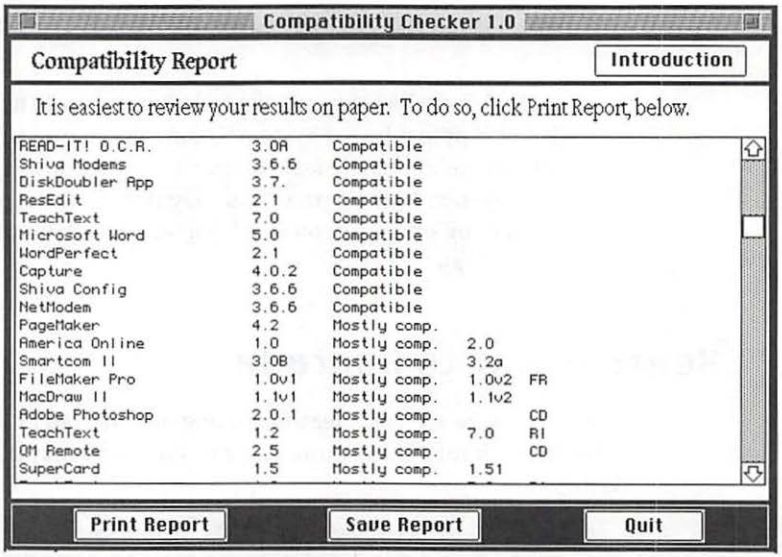


Figure 5.8: A typical Compatibility Checker report.

The Compatibility Checker may report that a program will run under System 7 if you deactivate one of System 7's features, such as file sharing, virtual memory, or 32-bit addressing. Or, it may report that the program will not run at all. If that is the case, you should not upgrade to System 7 until you upgrade your other software to System 7-compatible versions. If you find the upgrades too expensive, you may simply want to wait. Remember, running the latest, greatest system version isn't as important as having a reliable computer that does what you need it to do.

We have presented quite a few caveats in this section, and we hope they haven't soured you on the notion of upgrading to System 7. The fact is, System 7 has proven to be very reliable as well as compatible with most programs.

Upgrading to System 7.1

System 7.1, released in late 1992, adds three key features to System 7.

Easier font management. As you see in the following chapter, all fonts are in the Fonts folder. Adding and removing fonts is also faster than in earlier versions.

CPU support files. Prior to System 7.1's release, Apple often would need to release a system software update when it released a new Mac model. When the Quadras and PowerBooks appeared, Apple released System 7.0.1, for example. These updates were required to take advantage of the ROM chips and features built into the new hardware. With System 7.1 and later versions, Apple will simply create a CPU support file that plugs into the system software during startup and enables it to support the new machine.

Easier language and country localization. System 7.1 is designed to enable easy switching between various languages and text-input schemes. On one level, this is significant for Apple because it makes it easier to create new system software versions for use in other countries. On another level, it can be useful to you if your work involves numerous languages. When you have a *script* extension in your System Folder, a new menu—the Keyboard menu—appears in between the Application and Help menus. You can switch between various script systems, such as English, Cyrillic, and Greek, by choosing the desired system from the menu.

If you're using System 7.0 or 7.0.1, should you upgrade to System 7.1? Yes—if your programs and extensions are compatible with 7.1. Generally, programs that run with System 7.0 and 7.0.1 should work fine with System 7.1, but to be sure, run the System 7.1 Compatibility Checker before upgrading.

Switching Back to System 6

In the end, the best way to test compatibility with System 7 is to simply install it and try out your favorite programs. If they don't run properly, you can always reinstall System 6. Don't try this acid-test method when you're on a deadline or otherwise desperate to use your computer—you may need to spend a few hours swapping floppies and installing system software and fonts.

It's also possible to install both System 7 *and* System 6 on the same hard drive. This approach requires more disk space, but it does enable you to start up under the system version you need for the task at hand. You learn how to install both system versions in Chapter 11.

Which System for Which Mac?

Table 5.1 shows which system versions Apple recommends for which Macs.

Table 5.1: Recommended system versions for each Macintosh model.

	System software version					
	6.0.5	6.0.7	6.0.8	7.0	7.0.1	7.1
Plus	•			•	•	
Classic		•	•	•	•	
Classic II				•		
SE	•	•	•	•	•	
SE/30	•	•	•	•	•	
LC		•	•	•	•	
LC II			•	•	•	
IIsi		•	•	•	•	
II, IIcx, IIci, IIfx	•	•	•	•	•	
IIvi, IIvx						•
Quadra 700					•	
Quadra 900					•	
Quadra 950					•	
Macintosh Portable		•				
PowerBook 100					•	
PowerBook 140, 145					•	
PowerBook 170					•	
PowerBook 160, 180						•
PowerBook Duo 210, 230					•	

The Installer

To install system software, you use a utility that's aptly named Installer. When you start Easy Install the Installer dialog box appears (see figure 5.11).

In most cases, you can use the Easy Install button, which automates the installation process. If you want to install only certain portions of the system software—perhaps to save disk space—you can click Customize to access the dialog box. When you select an item, a description appears at the bottom of the dialog box.

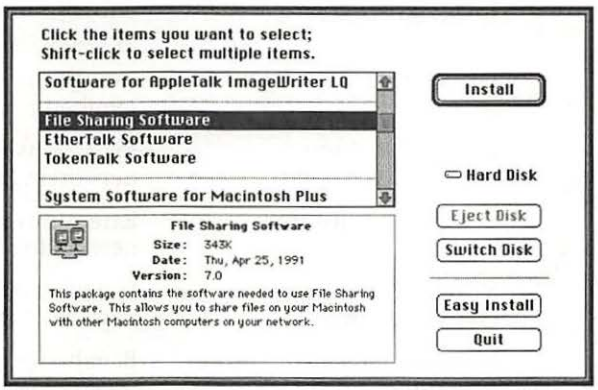


Figure 5.9: The Installer's Custom Install dialog box.

Table 5.2 lists the options available in the Custom Install list.

Table 5.2: Custom Install options.

Option	What it Installs
System Software for any Macintosh	System software that runs on any System 7-capable Mac
Software for all Apple printers	Printer drivers for all Apple printers
Software for LaserWriter	Printer driver for PostScript printers
Software for Personal LaserWriter SC	Printer driver for Personal LaserWriter SC
Software for ImageWriter	Printer driver for ImageWriter and ImageWriter II dot-matrix printers
Software for AppleTalk ImageWriter	Printer driver for ImageWriter II dot-matrix printers equipped with optional network card

continues

Table 5.2: Continued

Option	What it Installs
Software for Personal LW LS	Printer driver for Personal LaserWriter LS laser printer
Software for StyleWriter	Printer driver for StyleWriter ink-jet printer
Software for ImageWriter LQ	Printer driver for ImageWriter LQ dot-matrix printer
Software for AppleTalk ImageWriter LQ	Printer driver for ImageWriter LQ dot-matrix printer equipped with optional network card
File Sharing Software	Extensions and Control Panels required for file sharing
EtherTalk Software	Extensions required to use EtherTalk networking hardware
TokenTalk Software	Extensions required to use TokenTalk networking hardware
System software for (various models)	System software that works only on a selected Macintosh model
Minimal Software for any Macintosh	Bare-bones system software that works on any Macintosh model
Minimal Software for (various models)	Bare-bones system software that works only on a selected Macintosh model

Backgrounder: How Installer Works

To determine which software to install, Installer uses a special document called a *script*. Just as a movie script tells the actors what to say and when to say it, an Installer script tells the Installer which software to install and where to install it. When you select one of the options in the Customize dialog box, for example, the Installer reads its script to determine how to modify your System Folder, and then makes the modifications.

Another important part of Installer's job involves adding certain system routines to your system disk's System file, a process called *patching*. During startup, the Mac loads the patches into a special area of memory called the *system heap*. Patching the System file is a technique Apple uses to ensure that, from the system software standpoint, all Macs have a consistent set of basic features and capabilities.

Why bother? Consider the alternative. Apple introduces a new Mac containing expanded ROM chips with new system routines that greatly enhance the user interface. Developers want to create software that uses these new routines, but if they do, thousands of older Macs that lack the new routines will not be able to run the new software. Thus, they don't take advantage of the new routines—or they slash their potential market by programming for the new machine only.

The patching process avoids this dilemna. It enables Apple to continue improving the Macintosh without leaving older Macs out in the cold. It enables developers to write programs that will run on any current Macintosh, and it enables owners of older Macs, such as the Plus, to run software that uses the newest system enhancements without having to upgrade their ROM chips. In short, patching creates a common ground that exists across the Macintosh family.

The Installer and Third-Party Products

Even if you don't use Installer to install system software, you're still likely to encounter the utility as you travel in the Macintosh world. Apple makes the Installer utility available to third-party companies, which can create their own scripts to enable you to install their wares.

Creating an Emergency Startup Floppy

If your Mac has a 1.4MB SuperDrive floppy drive, you can create a floppy disk that contains a stripped-down version of System 7 that you can use to jump-start your Mac if a hard disk problem develops. It's a good idea to have an emergency startup floppy on hand.

To create an emergency startup floppy on a single-drive Mac, first click the Installer's Customize button and then scroll to the bottom of the item list until you reach the "minimal software" entries. Select the Minimal Software for any Macintosh item and then click Eject. Now insert a blank high-density floppy disk and click Install.

You need to swap disks numerous times during the installation process. When you're finished, you have a floppy whose System Folder contains no Control Panels, printer drivers, or extensions; and a System file that contains just one font—9-point Geneva Italic. (The other fonts necessary to display the Mac's menu bar and dialog boxes are built into the Mac's ROM.) The floppy has about 180K free.

If you have two floppy drives, you can simply insert the blank high-density disk in the second drive and click the Switch Disk button.

Rather than selecting the Minimal Software for any Macintosh option, you can select the option for your specific Mac model. The disadvantage of this approach is that the floppy you create cannot start a different Mac model. If you have more than one kind of Mac, you need to create a separate startup floppy for each model.

Tips for Updating Your System

Generally, updating your system to the latest version is a straightforward process. But flies can enter the ointment. Following are some tips for keeping that ointment fly-free:

- Use the Installer. Don't just use the Finder to drag files from the update disks to your System Folder. If you do, your system does not update properly, and probably will not startup properly—or it may crash during use.
- Don't copy the Installer and its script to your hard disk. You may be tempted to do this so that the Installer will run faster; however, resist the urge. For a reliable installation, always run the Installer from its original disk (or, better yet, from a backup copy of its original disk).
- Make backups first. In case something goes wrong during the updating process, it's a good idea to back up your hard disk—or at least those files you cannot live without. (See Chapter 8 for more details on backing up.)
- Disable font and Desk Accessory extenders. AlSoft's Font/DA Juggler enables you to use fonts and Desk Accessories without installing them in System 7's System file. Using the Installer while one of these products is running can cause problems. If you're using these or similar products, disable them by dragging their files out of the System Folder and then restarting the Mac.
- Start up with the Install 1 disk. The best way to ensure accurate updating is to shut off your Mac, insert the Install 1 floppy disk, and then turn on the Mac. This approach ensures that you will not load any extensions from your hard disk that could interfere with the updating process.
- Update the PostScript printer drivers on any other Macs on your network. As you learn in Chapter 7, problems can occur if you mix different versions of the LaserWriter PostScript printer drivers on the same network. You can use the Installer on the Printing disk to update only the printer drivers.

What's On the System 7 Disks?

Generally, you don't need to worry about what's on the disks in the System 7 upgrade kit. The Installer utility knows, and always asks for the appropriate disks during the installation process. But if you want to simply reinstall a particular Control Panel or other file that you damaged or threw away accidentally, it helps to know where you can find it. Table 5.3 lists the contents of each of the 800K disks in the System 7 upgrade kit. The contents of the System 7.1 disks are slightly different.

Table 5.3: Contents of System 7 disks.

Disk Name	Contents	Notes
Install 1	Installer; script; system file	Start up with this disk when installing System 7
Install 2	Installation data; Apple File Exchange Folder	Apple File Exchange enables SuperDrive-equipped Macs to access MS-DOS–format disks
Install 3	Finder; TeachText; various extensions and Control Panels	The CloseView Control Panel is on this disk
Printing	Printer drivers; Backgrounder application; Installer	You can use the Installer on this disk to update printer drivers
Disk Tools	Apple HD SC Setup (hard disk utility) and Disk First Aid (repair utility—see Chapter 10)	This disk contains System 6.0.7; you can start up from this floppy.
Fonts	Type fonts	See Chapter 6
Tidbits	Network extensions; most Control Panels; Desk Accessories	
More Tidbits	Some fonts and printer drivers; LaserWriter Font Utility	See Chapter 8 for details on the LaserWriter Font Utility

Tuning Up System 7

In early 1992, Apple released a free update to System 7 called System 7 Tune-Up. The System 7 Tune-Up disk includes an extension called System 7 Tuner that fixes some System 7 bugs and improves System 7's memory efficiency. The

Tune-Up disk also includes new versions of the StyleWriter and LaserWriter printer drivers that are faster or fix various bugs or compatibility problems present in earlier versions.

The disk also includes the Installer and a script that enables you to install the tune-up software. When the software is installed, a bullet character (•) appears next to the version number in the About This Macintosh dialog box (see figure 5.10).

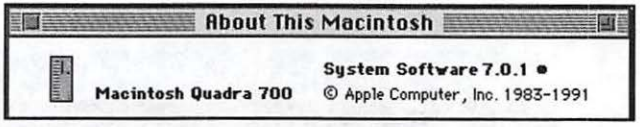


Figure 5.10: A bullet indicates the presence of the System 7 Tune-Up software.

Alas, the first versions of the System 7 Tune-Up package had some bugs of their own. These versions were distributed primarily through user groups and online communications services. To ensure that you have the latest version of the System 7 Tune-Up software, select the System 7 Tuner extension and choose Get Info from the Finder's File menu. The version number should be 1.1.1 or later. Do not install the tune-up if the tuner's version is 1.0 or 1.1.

CHAPTER

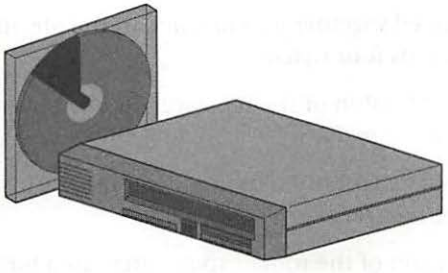
6

FONTS

WHAT'S INSIDE

- Basic typographic terminology defined
- The basics of Mac fonts
- How to add and remove fonts in System 7 and System 7.1
- How to manage, create, and customize fonts
- The technical structure of Mac fonts
- Troubleshooting font problems

Understanding the Mac's approach to fonts can help you use its typographic features more effectively and get the best results from your printer. This chapter looks at the Mac's type talents and sets the stage for the next chapter's tour of the Mac's printing features.



Font and Type Basics

Like any specialized field, the typesetting world has its own language. This section describes the terminology you will encounter as you work with fonts. If you're familiar with such terms as *typeface, ascender,* and *x-height,* you may just want to skim this section or skip on to the section "Mac Font Basics," later in this chapter.

Typefaces versus Fonts

First, let's clarify the difference between the terms *typeface* and *font.* A typeface is a unique design of uppercase and lowercase characters, numerals, punctuation marks, and symbols. A font is the implementation of a typeface in one size. Figure 6.1, which shows Times Roman in four different sizes, depicts one typeface, but four fonts.



Figure 6.1: One typeface in four fonts.

In the days of hot metal type, when different molds were required to cast different sizes of type, the distinction between *typeface* and *font* was important. In fact, the word *font* is derived from the verb *found*—to pour into a mold in a foundry. Today, the terms *typeface* and *font* are often used interchangeably.

Typefaces are often grouped together into *families.* In the Macintosh world, a type family usually contains four *styles:*

Roman. The upright version of the typeface. On the Mac, the roman style is called *normal* or *plain.*

Italic. A calligraphic variant often used for emphasis. This book uses italic to emphasize new terms.

Bold. A heavier version of the roman style, often used for headings.

Bold Italic. A bold version of the italic style.

You also may encounter a style called *oblique*, a slanted version of the roman style. That may sound similar to italic, but it isn't. As figure 6.2 illustrates, an italic style is a completely different rendering of a typeface, while an oblique style is simply a slanted version of the roman or bold style.



Figure 6.2: Times Italic versus Times Oblique.

Understanding this distinction is important because of the technique the Mac uses to display italic text. The Mac can use similar techniques to simulate other type styles, such as outlined and shadowed type.

Character Components

Figure 6.3 shows the primary components that form characters. It's the shape and combination of these and other components that give each typestyle its unique appearance and personality.

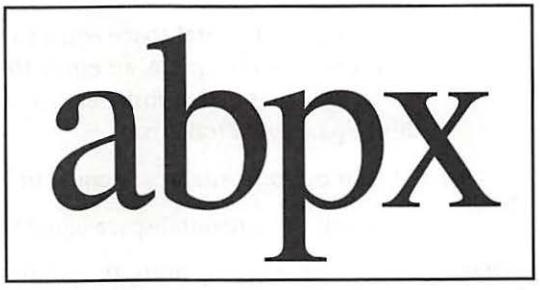


Figure 6.3: Components and characteristics of type.

These components and characteristics include:

Ascender. The portion of a character that extends above the tops of lowercase characters.

Bowl. The round portions of characters, such as *b, p,* and *d.*

Counter. The white space within a character that helps to define the character's shape.

Descender. The portion of a character that extends below the *baseline,* the imaginary line upon which characters rest.

Serif. Ornamental embellishments attached to the edges of characters that serve to lead the eye across a line of type. A typeface whose characters contain serifs (such as Times) is called a *serif typeface;* a typeface that lacks serifs (such as Helvetica) is described as *sans-serif* (without serifs). Serif typefaces are generally considered more legible and better suited to lengthy passages of text than sans serif fonts.

Stem. The vertical portion of a character.

X-height. The height of the lowercase characters (specifically, of the lowercase *x)* in a given typeface.

Measuring Type and Line Spacing

The typographic world also has its own units of measurement. They include the following:

Point. A unit equal to 1/72 inch. (Technically, a typographer's point is equal to .351 millimeters, so there are 72.27 points per inch. In the Macintosh, however, a point is exactly 1/72 inch.)

Pica. A unit equal to 12 points. Picas often are used to specify the width of columns.

Em. A unit of horizontal space equal to the square of the type size. In 10-point type, for example, an em is 10 points wide and 10 points high. In the typesetting world, em spaces are often used to specify the width of paragraph indents.

En. A unit of horizontal space equal to half of an em space.

Thin. A unit of horizontal space equal to half of an en space.

Of these common measuring units, the point is the most important. Points are used to specify the vertical size of type. In a 72-point typeface, for example, there are 72 points of space between the lowest descender and the highest ascender (see figure 6.4).

Points are also used to specify *leading*—the amount of vertical space between lines. Leading (pronounced *ledding)* is measured from baseline to baseline, as shown in figure 6.5. The term comes from the hot metal type era, when strips of lead were used to add space between lines.

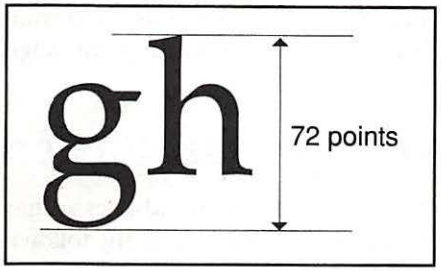


Figure 6.4: How type size is measured.

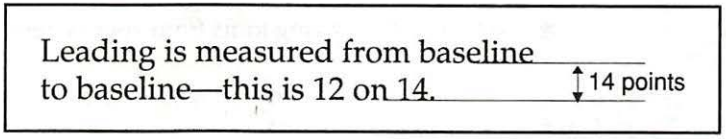


Figure 6.5: Leading is measured from baseline to baseline.

When specifying type size and leading, typesetters and designers write a fraction in which the type size is the numerator and the leading, the denominator. In figure 6.5, the text uses 12-point type and 14 points of leading. This combination is written as *12/14* and pronounced *twelve on fourteen* or *twelve over fourteen.*

Monospaced versus Proportional Fonts

On a typewriter, every character has the same width: a lowercase *i* uses as much horizontal space as an uppercase *M.* Fonts whose characters have the same width are called *monospaced* or *fixed-width* fonts.

Fixed-width fonts are fine for mechanical typewriter mechanisms, but they aren't as legible as *proportional* fonts—fonts whose character widths vary. Proportional fonts are easier to read and are preferred for publishing applications. Figure 6.6 compares fixed-width and proportional fonts.

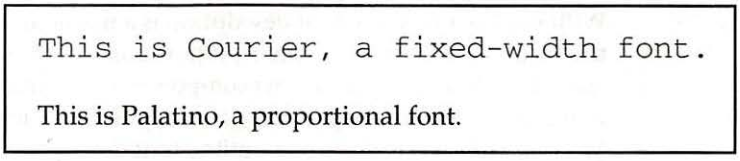


Figure 6.6: Fixed-width versus proportional fonts.

Even in proportional fonts, all the numerals and math symbols have the same width so that the decimal points align in tables. This is called *tabular spacing.*



Macintosh Font Basics

Now let's apply the type basics we have just covered to the Macintosh world. In this section, we look at the following:

- Mac's approach to fonts: bitmaps versus outlines
- Differences between bitmap and outline fonts
- Adding and removing fonts from your system

Font Structure

As you may recall from previous chapters, the Mac's fonts are a type of *resource*—a collection of data that programs can use when they're running. The font resources themselves can be structured in two very different ways—one is much more versatile than the other.

Bitmap versus Outline Fonts

One way to think of a font resource is as a description—a kind of recipe—that tells the Mac how to draw a given typeface in a given size and style. These font descriptions can take the form of *bitmaps* or *outlines*. You're likely to encounter both types of fonts as you use the Mac, so it helps to understand both approaches in order to use and choose fonts effectively.

In a bitmapped font, the font description specifies the exact arrangement of pixels that will form a character in a *given size*. With bitmapped fonts, a separate description is required to accurately render each size. As you may recall from Chapter 3, if a program needs a size for which no description exists, the Mac must create that size by altering, or scaling, an existing size. The results of that scaling process are usually chunky, awkward-looking characters.

With outline fonts, the font description is a mathematic recipe that describes the characters' properties: their proportions, the size of their bowls, stems, ascenders, descenders, and other components. Unlike a bitmap font, an outline font doesn't require a separate font description for each type size. Instead, the Mac (or a printer) can use one outline font description to create characters of any size.

To appreciate this difference, imagine that you have been given the job of describing the letter O using toy wooden blocks—bits. First, you arrange the blocks in the shape of an O, and then you note the arrangement and number of blocks required to form the letter. If you need an O of a different size, you must assemble a completely different arrangement of blocks. This is the bitmapped approach: the wooden blocks are screen pixels (see figure 6.7).

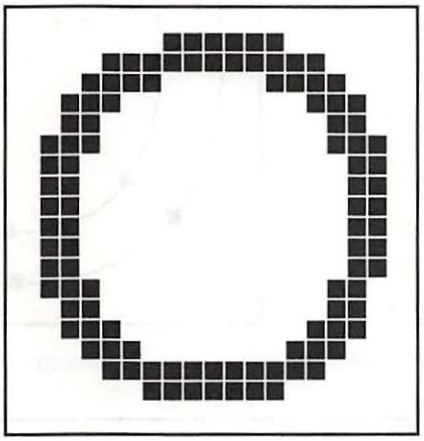


Figure 6.7: Describing an "O" using a bitmapped approach.

Now assume that you have been given the task of describing an O using the outline approach. This time, your tool isn't a set of blocks, but a fat rubber band. Because the rubber band describes the properties of the O—it's round—you don't need to create a separate arrangement of blocks for each size. To create a larger O, you simply stretch the rubber band proportionally. To create a stretched or compressed O (in type terms, an *expanded* or *condensed* O), you stretch the rubber band more in one direction than in the other (see figure 6.8).

Like a rubber band, the outline approach is flexible—but there's a catch. The Macintosh uses a bitmapped screen, so ultimately a character must be described as a bitmap. So, rendering a character from an outline description requires two basic steps. First, the Mac consults the outline description to learn the character's properties; and second, it constructs a bitmap from that description to create a character of the required size and proportions (see figure 6.9).

This process of building a bitmap from an outline description is called *rasterizing*, and it requires the Mac (or a printer) to perform numerous calculations that slow the display or printing of text. You can see this for yourself by typing a sentence, such as *The quick brown fox jumped over the lazy dog's back* and then reformatting it in a variety of fonts, sizes, and styles using both bitmap and outline fonts. When you're formatting with outline fonts, you will probably notice the text takes longer to appear.

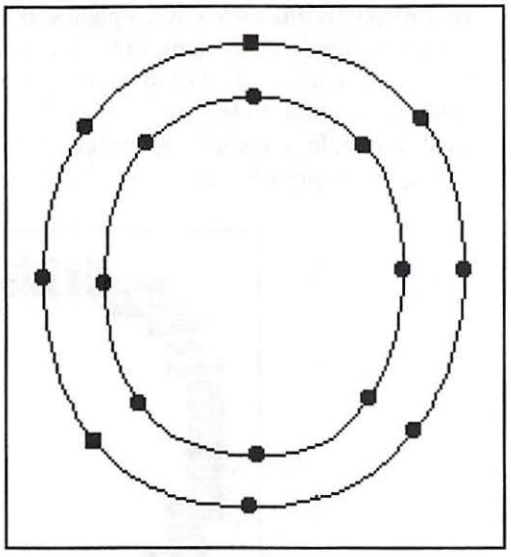


Figure 6.8: Describing an "O" using an outline approach.

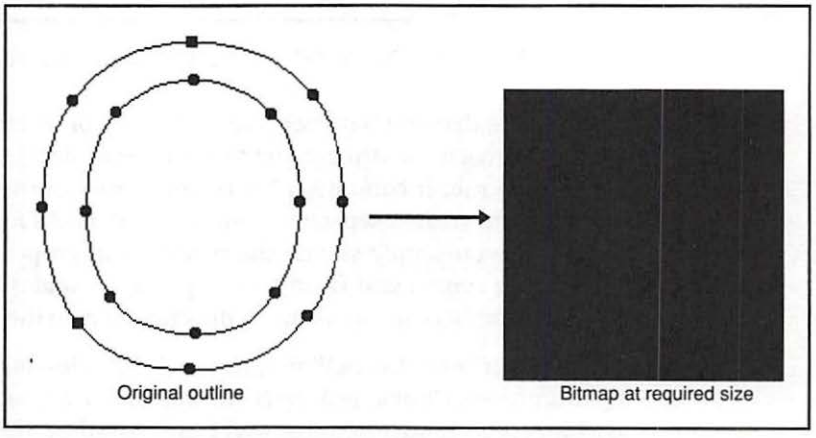


Figure 6.9: From outline to bitmap.

If outline fonts take longer to display or print, why use them? Two reasons:

Point #1. Unlike bitmapped descriptions, outline font descriptions are *resolution independent*—they aren't tied to a specific number of dots per inch. The character isn't described as a bitmap until moments before it appears (or prints). This flexibility enables one font description to work on any device, regardless of its resolution, and to take maximum

advantage of that resolution. Thanks to resolution independence, you can use the same font on a 72-dots-per-inch Macintosh video screen, a 300-dpi laser printer, and a 2540-dpi Linotronic imagesetter. We look at the benefits of resolution independence in more detail in the next chapter.

Point #2. Outline fonts can create sharp characters in a virtually unlimited range of type sizes. A computer or printer that uses outline fonts can generate text in virtually any size as well as expand or condense a font to create an entirely different look.

Another benefit of outline fonts surfaces in programs that enable you to view documents in varying degrees of magnification. (Different magnification views are most common in desktop publishing, presentation graphics, and drawing programs. Such programs enable you to view documents at, for example, actual size, half size, and double size.) Because outline fonts enable the Mac to create any size it needs, programs that offer different magnification scales are able to display sharp, distortion-free text in all their viewing scales.

Summing Up Bitmaps versus Outlines

The wood block-versus-rubber band example oversimplifies the technicalities behind bitmapped and outline fonts. But it does show the basic differences between the two approaches, which are summarized in Table 6.1.

Table 6.1: Summary of bitmap versus outline fonts.

Bitmap Fonts	Outline Fonts
Often require more storage space because a separate description is needed for each size	Efficient to store because one description can be used to generate any size
Resolution dependent—a given cannot be resized without distortion	Resolution independent—one font description can be used on any output device, whether screen, printer, or imagesetter
Fast to display and print; no extra processing required, provided a description of the required size is available	Can be slower to display and print because the outline must be rasterized—converted into bitmaps of the required sizes



Outline Font Variations

Within the outline font category are several more categories, or *formats*: TrueType fonts and PostScript fonts. Within the PostScript font category are three subcategories: Type 1 fonts, Type 3 fonts, and Multiple Master fonts.

The underlying mathematics behind each of these outline font formats is different; that is, each format takes its own approach to describing the characteristics of characters. Unless you plan to design your own fonts, you don't need to worry about understanding the nitty-gritty details of these font formats. Still, knowing the basics behind each format will help you to choose fonts that work best with your Mac and printer.

TrueType Fonts

For the first several years of its life, the Macintosh relied on bitmap fonts for its screen display. That changed when Adobe Systems introduced its Adobe Type Manager (ATM) system extension. ATM essentially teaches the Mac how to rasterize Type 1 PostScript fonts—the most popular type of outline font used with PostScript printers, such as Apple's Personal LaserWriter NTR and LaserWriter IIf and IIg. ATM was the first program to bring all the benefits of outline fonts to the Mac's screen and to non-PostScript printers, such as Apple's ImageWriter II, Personal LaserWriter LS, and StyleWriter. ATM was an instant success, and has become one of the most popular extensions in the Macintosh world. ATM also enlarged the market for Type 1 PostScript fonts by enabling these fonts to be used on non-PostScript printers.

Apple also has built outline font technology into System 7—TrueType. On the surface, TrueType and ATM are the same—both provide rasterizing software that enables the Mac to translate font outlines into bitmaps for the screen and for non-PostScript printers. Unlike ATM, however, TrueType does not rely on PostScript fonts—or on anything else to do with PostScript, for that matter. You can use TrueType fonts on a PostScript printer, but TrueType is designed for non-PostScript devices: the Mac's screen as well as Apple's non-PostScript printers. Apple also has licensed TrueType to Microsoft, which has built TrueType into Microsoft Windows versions 3.1 and later. You also can use TrueType with System 6.0.7 or 6.0.8 by adding the TrueType system extension to your System Folder.

TrueType versus PostScript Fonts

TrueType fonts have some advantages over PostScript fonts. Because TrueType is part of the Mac's system software, it's easier to install and remove TrueType fonts than it is to install and remove PostScript fonts, especially if you use System 7 rather than System 7.1. (We show this shortly.) When you add a TrueType font, it's available immediately; when you add a PostScript font, you must restart the Mac in order for ATM to recognize the new font. Also, for some technical reasons we explore in the next chapter, TrueType fonts have the capability to look better than Type 1 fonts at small sizes (below 12-point).

When using a PostScript printer, however, TrueType fonts have some drawbacks. Because TrueType knows nothing of PostScript, the Mac's LaserWriter printer driver must perform some technical gymnastics in order to print a TrueType font on a PostScript printer. This usually translates into longer printing times and can result in memory shortages on some PostScript printers. We examine this drawback in detail in the next chapter.

PostScript Fonts

PostScript fonts are the most widely used fonts in the Mac world, thanks to the popularity of ATM and PostScript printers. But not all PostScript fonts are identical; there are several types of PostScript fonts, and each comes with its own set of technicalities. In this section, we look at the types of PostScript fonts and spotlight the differences between each.

Type 1 Fonts

Type 1 fonts are the most popular kind of PostScript font. These are the fonts that are built into the ROM chips of PostScript printers, such as Apple's LaserWriter IIf and IIg. Type 1 fonts are also the most popular format for *downloadable* fonts—fonts stored on your Mac's hard disk and transferred to a PostScript printer's memory during a print job. Adobe Systems and most other font developers sell fonts in Type 1 format.

In a Type 1 font, the mathematical outlines are structured in an efficient way that enables Type 1 fonts to use disk space and printer memory sparingly. Type 1 fonts are also compatible with Adobe Type Manager—ATM can read the Type 1 outline and create a bitmap for the screen or for a non-PostScript printer.

Type 3 Fonts

Type 3 fonts, sometimes called *user-defined* fonts, are much less popular than Type 1 fonts. Some font developers sell Type 3-format fonts and you may find some free Type 3 fonts floating around in user's groups and on online information services, but generally, Type 3 fonts play second fiddle to Type 1 fonts. (By the way, there is no such thing as a Type 2 font. Type 2 was reserved for a font technology that never panned out.)

Because Type 3 fonts don't use the special encoding techniques present in Type 1 fonts, they're generally larger than equivalent Type 1 fonts. This means they use more printer memory and take longer to print than Type 1 fonts.

But the Type 3 format allows for certain effects that aren't available in Type 1 fonts. A Type 3 font can contain a gray fill—characters outlined in black but filled in a gray shade. A Type 3 font also can contain complex characters that are, in fact, PostScript illustrations. Using font-editing software discussed later in this chapter, you can create a Type 3 font whose characters are pictures—your company logo, for example.

Multiple Master Fonts

Adobe's Multiple Master font technology is actually a variant of the Type 1 font format, but Multiple Master fonts have so many unique features that they deserve a special discussion of their own.

With Multiple Master fonts, you can create a limitless number of font variations from a single typeface. Rather than having only three type weights—light, medium, and bold—from which to choose, for example, you can generate any weight ranging from ultra-light to extra-bold. Similarly, rather than having only condensed, normal, and expanded styles, you can generate any width—from ultra-skinny to bloated, including any width in between.

Each of these style variations is called a *design axis*. Most Multiple Master fonts offer at least two axes:

- *Weight*, which governs lightness or boldness
- *Width*, which controls condensation or expansion

In a Multiple Master font, each end of each design axis has a *master design*. The weight axis has light and bold masters, for example. All other weights in between are generated, or *interpolated*, from these masters.

The Multiple Master format allows for two additional axes:

- *Optical scaling* provides masters designed for small type sizes as well as large ones. As you see shortly, Multiple Master's support for an optical scaling axis represents a major milestone in typographic history.
- *Style* controls the actual design of the type face. A Multiple Master font with a style axis may enable you to generate sans-serif, small serif, medium serif, or large serif fonts—or anything in between.

Optical Scaling Details

Some background may help you understand why optical scaling is so significant. With hot metal type, a separate mold was cut for each point size, and type designers made subtle adjustments to letter spacing, character proportions, and weight so that each size would be as legible as possible.

When phototype and digital type became popular, however, it became common practice to create one master font and then scale it to the size required. In early phototype equipment, scaling was performed by lenses that moved back and forth to magnify or reduce the image of the characters in a font master that was essentially a film negative. In digital typesetting equipment (including laser printers), scaling is performed by scaling the font outline mathematically. In either case, legibility of small type is impaired because the small sizes are actually scaled-down versions of a larger size. Put another way, in the type world, one size does not fit all—more accurately, one master does not fit all sizes.

The optical scaling axis brings the legibility advantages of separate masters to the digital typographer. In Adobe's Minion Multiple Master typeface, five things happen as the type size increases:

- The space between characters, the *letterfit,* decreases.
- The spaces within characters, the *counterforms,* close up.
- The serifs become finer.
- The overall weight of the type becomes lighter.
- The x-height becomes smaller.

Working with Multiple Master Fonts

In the ideal world, application programs would be aware of Multiple Master fonts and enable you to directly stretch, scale, and otherwise modify characters. That ideal world doesn't exist at this writing. To generate new fonts from

Multiple Master outlines, you must use a utility called Font Creator, which is included with each Multiple Master package. Font Creator enables you to adjust each design axis to create the desired effect, and then create a font with those characteristics (see figure 6.10).

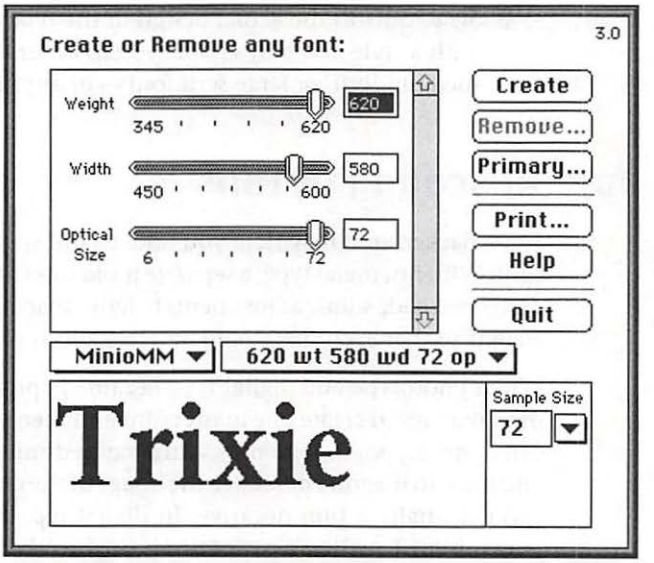


Figure 6.10: Modifying a Multiple Master font with Font Creator.

There are two other points regarding Multiple Master fonts:

- They gobble up printer memory. Because of the complexity of the Multiple Master format, Adobe recommends you have at least 3M of printer RAM.
- They may not print on PostScript clone printers. These printers use PostScript software created by firms other than Adobe. The Multiple Master format uses several advanced PostScript techniques that stump many non-Adobe PostScript printers. (PostScript clone printers include Microtek's TrueLaser, Everex's LaserScript LX, and the Xante AccelaWriter series of upgrade boards.)

We discuss printer memory and PostScript clone issues in more detail in the next chapter.

Choosing a Font Format: PostScript versus TrueType

If you plan to purchase a large number of fonts, you will often need to choose between the PostScript and TrueType camps. Which font format should you choose? As a general rule, if you will be printing your final output on a PostScript printer, choose PostScript fonts. Although TrueType fonts can be printed on a PostScript printer, the process can be slow. (We'll explain why in the next chapter.) Also, the selection of PostScript fonts and utilities is larger.

If you're not using a PostScript device—or if a given font isn't available in PostScript format—by all means use TrueType fonts. Although the Mac font world would be simpler if there was only one outline font standard, the fact is that PostScript and TrueType fonts can generally coexist peacefully.

Table 6.2 summarizes the pros and cons of TrueType, Type 1, Type 3, and Multiple Master fonts.

Table 6.2: Comparing font formats.

	Pros	Cons
TrueType	Easiest to install and remove; under System 7, no additional software required for smooth on-screen text at any size	Fewer fonts to choose from; printing on PostScript devices can be slow; requires System 6.0.7 or later; fonts can take longer to display on-screen
Type 1, Type 3	Generally provide best output quality on PostScript laser printers; compatible with Adobe Type Manager; compatible with system versions prior to 6.0.7. Can contain gray fills and other effects	Requires ATM in order to produce smooth on-screen text in any size; more cumbersome to install and remove
Multiple Master	Support for multiple design axis enables tremendous versatility; Optical scaling axis optimizes character appearance and spacing as size changes	Fonts can be large and slow to print. Fonts can be large; at least 3MB of printer memory recommended

Font Files and Icons

When you acquire a new font, its file will have one of a number of different icons. Each icon indicates a different type of font file:

TrueType outline font. This file's icon shows several different-sized capital A's, indicating that a TrueType font can generate any size.

Bitmap font file. This file has a single capital A to indicate that the font file contains a bitmapped description for only one size. A bitmap font file will usually have the size in its name—for example, New York 24 or Venice 14.

Suitcase file. A suitcase file has an icon that looks like, yes, a suitcase. These files can contain more than one font, size, and style.

PostScript font file. A PostScript font outline may have any of a few different icons, depending on the font vendor or on the program used to create the font. To use a PostScript font file, you also need a corresponding bitmap font for the System file (or the System 7.1 Fonts folder). We describe why this is necessary in the next chapter.

If you double-click on a TrueType or bitmapped font file, the Finder displays a window showing a sample of the font, as shown in figure 6.11. Note that a TrueType font sample shows several sizes, while a bitmapped font sample shows only the size represented in that file.

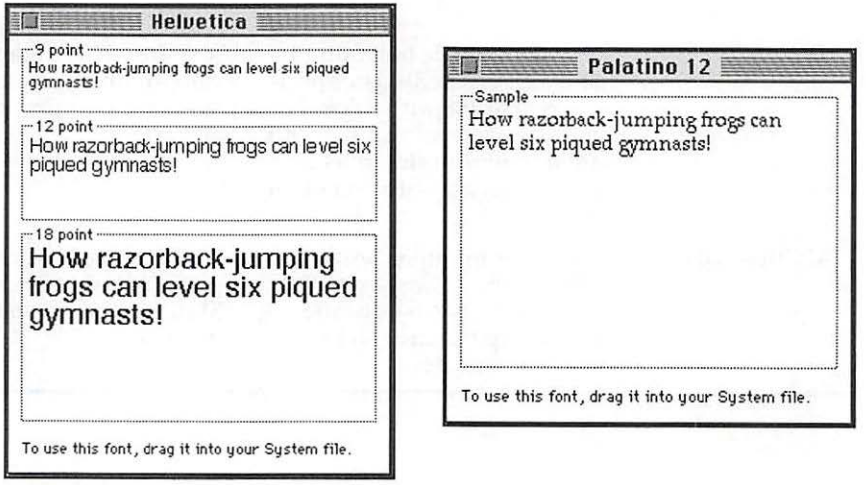


Figure 6.11: A TrueType font sample (left) and a bitmapped font sample (right).

If you double-click on a suitcase file, a window opens listing the fonts contained in the file. As figure 6.12 shows, this window is very similar to the standard directory windows that the Finder uses to show what's on a disk or in a folder.

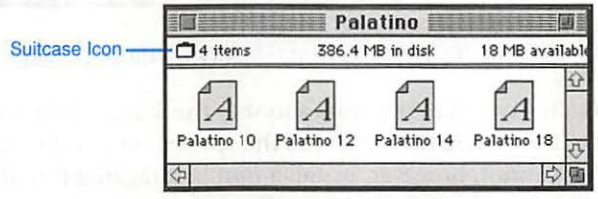


Figure 6.12: An opened suitcase file window.



Adding and Removing Fonts in System 7

You can use the Finder to add and remove fonts from the System file. You may want to add fonts when you acquire a new printer or just to spice up your typographic life. You may want to remove some fonts when you're running low on disk space or you simply grow tired of a given typeface.

In this section, we show how to add and remove fonts under System 7. In the next section, we describe these processes for System 7.1. For details on adding and removing fonts in earlier system versions, see Appendix A.

Adding a Font

Before adding a font, you must quit any programs that you previously started. (This step is necessary because most Mac programs check to see which fonts are installed when you start the program.) Then, simply drag the font file to the System Folder icon. A dialog box appears asking if you want to install the fonts (see figure 6.13). Confirm the dialog box, and the Mac installs the fonts in the System file.

If you want you can start an application and check its Font menu or dialog box to verify that the font is installed. Or simply open the Key Caps Desk Accessory and check its menu.

You also can add more than one font at a time by selecting each font file and then dragging to the System Folder icon. Chapter 3 shows how to select multiple files.

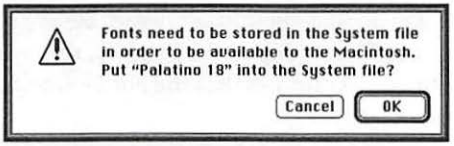


Figure 6.13: To install a font, click OK when the install dialog box appears.

As alternatives to dragging a font to the System Folder icon, you also can drag it to the System file icon, or to the opened System file window (see figure 6.14). You cannot, however, install a font by dragging it to the open System Folder window. If you try, the Mac will simply move the font into the top level of the System Folder—the font will not be installed in the System file and therefore will not be available to your programs.

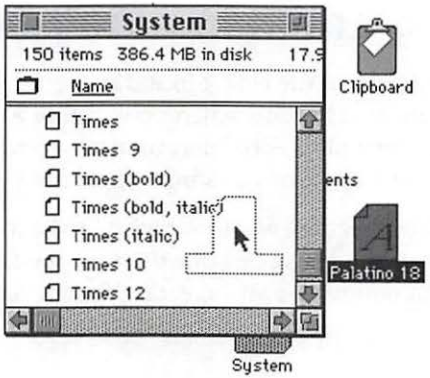


Figure 6.14: You can install a font by dragging it to the open System file window.

Removing Fonts

To remove one or more fonts, first quit any open application programs or desk accessories. Next, open the System Folder and then open the System file. A directory window appears listing the fonts that are installed. Select the font or fonts you want to remove, and then drag to the Trash. If you don't want to throw the fonts away (perhaps you will want to reinstall them later), drag to the desktop or to a disk or folder window or icon rather than to the Trash.

When you have finished removing fonts, close the System file window and the System Folder window.

Adding a PostScript Font

Adding a PostScript font requires two steps: installing the screen font using the techniques described earlier, and installing the printer outline font. Printer outline font files can be stored in the top level of the System Folder or in the Extensions folder (within the System Folder). Storing PostScript outline files in the Extensions folder helps avoid excessive clutter in the top level of the System Folder. (It doesn't do much for clutter within the Extensions folder, though.)

The Finder recognizes PostScript outline files. If you drag the outline files to the System Folder icon, the Finder asks if you want to store the files in the Extensions folder.

As mentioned earlier, to use a PostScript font file, you also need a corresponding bitmap font for the System file. If you're also using Adobe Type Manager, you need only install one bitmap font size—10 or 12 point, for example. With this approach, you will not waste a lot of disk space storing bitmaps that ATM can whip up for you on the fly.

Removing a PostScript Font

Removing a PostScript requires two steps: first, remove the bitmap font from the System file using the techniques described earlier, and then remove the PostScript font outline from the Extensions folder.



Adding and Removing Fonts in System 7.1

As mentioned in the last chapter, System 7.1 stores all fonts—whether TrueType, PostScript, or bitmap—within the Fonts folder (located within the System Folder). Thanks to System 7.1's Fonts folder, adding and removing fonts is easier and faster than with System 7.

Adding a Font in System 7.1

To add a font, simply drag the font file to the System Folder icon. A dialog box appears and asks if you want to install the fonts in the Fonts folder. If any programs or Desk Accessories are open, a second dialog box appears telling you

that the font will not appear in the currently running programs—you will need to quit the programs and start them again (you don't have to restart the Macintosh). Confirm the dialog box, and the Mac installs the fonts in the Fonts folder.

Removing a Font in System 7.1

To remove a font, first quit any programs or Desk Accessories that you previously started. Then, open the Fonts folder and drag the font out of the folder. As an alternative to opening the System Folder and then the Fonts folder, you may want to use the File menu's Find command to locate the font by typing its name. See Chapter 9 for more details on the Find command.

Trend: The Multilingual Macintosh

System 7.1 introduced some powerful font capabilities that make it easier to create versions of the Macintosh for a wide variety of languages. System 7.1 is better equipped to work with complex languages, such as Hebrew and Arabic, which operate by different rules (reading from right to left, for example), and languages such as Japanese or Chinese, which use thousands of characters.

One problem with supporting these languages involves accommodating the thousands of characters they require. The current standard for representing characters, ASCII (short for American Standard Code for Information Interchange), provides slots for just 256 characters—the maximum number that can be represented by one byte, and too few to represent languages such as Japanese, Chinese, and Korean.

System 7.1 addresses this problem. It's the first version of System 7 designed to work with *double-byte* fonts—ones that use two bytes to describe each character, allowing for up to 65,536 character positions. System 7.1 has numerous other features designed to make multilingual computing easier and to make the Macintosh available to a broader audience.



More About Suitcase Files

Like a real suitcase, a suitcase file is packed with baggage—one or more fonts. And like a suitcase, a suitcase file acts as a carrying case, a place to hold baggage until it arrives at its destination—a System file or the System 7.1 Fonts folder.

And who does the unpacking? The Finder. Under System 7, when you add a font that's stored in a suitcase file, the Finder moves it from the suitcase file into the System file.

In System 7.1 and later versions, this changes. The Finder doesn't move a font from a suitcase file, it simply moves the entire suitcase file to the Fonts folder.

Creating a New Suitcase File

Following are several reasons why you may want to create font suitcase files:

- To create a backup copy of the font combinations in your System file (a good idea)
- To store one or more fonts that you plan to remove from the System file, but may want to restore later
- To create a suitcase file that you copy to a different Mac to re-create the font and size combinations of your own System file
- To create a suitcase file that you will use along with a resource-management utility, such as Suitcase II or MasterJuggler (discussed shortly)

The Mac used to include a utility, Font/DA Mover, that enabled you to work with suitcase files. (Indeed, in the pre-System 7 days, Font/DA Mover was *the* program you used to install and remove fonts and desk accessories.) System 7's friendlier Finder eliminates the need to use Font/DA Mover to install or remove desk accessories. But the utility is still useful for the tasks we just mentioned.

Alas, finding a copy of Font/DA Mover that works with System 7 isn't easy. You need Font/DA Mover version 4.1 or later, and it isn't included with the System 7 disks. It is available on most online services, however, and you should be able to find a copy at a local user group. It's also included with some font-editing programs, including Altsys Fontographer.

If you cannot locate Font/DA Mover, don't give up—there's another way to create suitcase files, and in fact, it may be even easier than using Font/DA Mover. First, copy a suitcase file to your Mac's hard disk. (Several suitcase files are on the System 7 disk named Fonts.) Next, open the suitcase file and choose Select All from the Finder's Edit menu. Finally, drag the contents of the suitcase file to the Trash. Now you have an empty suitcase file to which you can add fonts. You will want to rename the suitcase file to reflect its new contents.



Managing Fonts

In this section, we spotlight a few utility programs that streamline working with fonts.

Resource-Management Utilities

You probably use certain sets of fonts for certain jobs. You may use Caslon and Univers for a weekly newsletter, Avant Garde and Myriad for brochures, and Palatino and Helvetica for in-house reports. If you're a publishing professional, you may use dozens of sets of fonts as you switch between jobs and designs.

The problem is, you may not have enough disk space to store all the fonts you use in your System file. Even if you do, having dozens of fonts installed makes for long, cumbersome Font menus, and it slows down the process of starting a program. You could add and remove each font as needed, but that means a lot of drudge work dragging icons into and out of the System file window.

The solution: a *resource-management* utility, such as Alsoft's MasterJuggler. This program enables you to work with fonts without having to install them in the System file. It was developed long before System 7 appeared as an alternative to grappling with Font/DA Mover. Because System 7's Finder makes it easy to add and remove fonts, many people thought resource-management utilities would go to that great Trash can in the sky. But they're still extremely useful for anyone who switches between sets of fonts frequently.

Creating and Using Font Sets

To streamline your typographic life with a resource-management utility, create suitcase files that hold the font combinations you use. To continue with the previous example, you may create a suitcase file named Newsletter Fonts containing Caslon and Univers, another named Brochure Fonts containing Avant Garde and Myriad, and a third named Reports Fonts containing Palatino and Helvetica.

After you create the font-set suitcases, you can use the resource-management utility to switch between each set in a flash. MasterJuggler also enables you to open and install fonts stored elsewhere, such as on a shared hard disk or network file server (described in Chapter 12). They also enable you to store your PostScript outline files on a shared hard disk or file server, where everyone on your network can use them—no need to copy the PostScript outline files to everybody's hard disks.

This type of program also enables you to work with sounds and FKEY resources without having to install them in the System file. It can *compress* fonts and sounds so that they use less disk space, and automatically *decompress* them when you use them.

Adobe Type Reunion

Commercial font packages from Adobe Systems and others usually include bitmap fonts for the typeface's stylistic variations—italic, bold, and bold italic. When you install a font family that includes stylistic variations, your Font menus list each style separately. Figure 6.15 shows a Font menu after the Futura family has been installed. Note that the four stylistic variants of Futura—light, book, regular, and bold—appear in the menu.

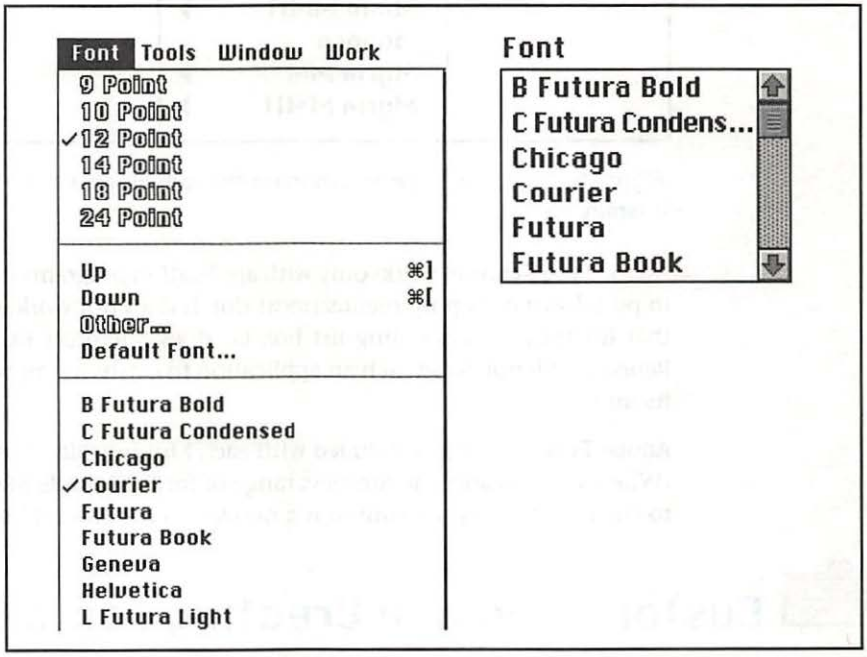


Figure 6.15: Style variations in a Font menu (left) and list box (right).

As figure 6.16 shows, font vendors use characters before the family name to enable you to differentiate between styles in programs that display fonts in list boxes (which aren't always wide enough to show the entire font name) rather than menus.

The problem with this approach is that it leads to lengthy Font menus that take a long time to scroll through. The Adobe Type Reunion system extension fixes this problem by uniting the style variations under the family name, which is a hierarchical menu. Rather than the Font menu listing four different styles of Futura, for example, it contains a hierarchical menu named Futura: when you open the Futura submenu, you see the four styles.

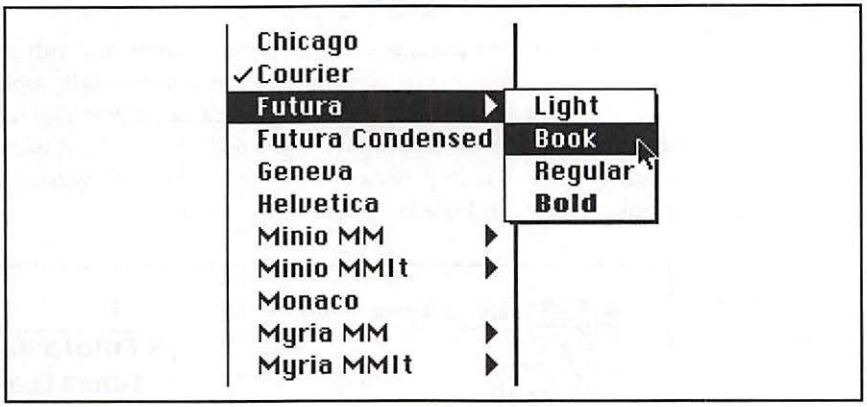


Figure 6.16: Adobe Type Reunion unites font styles under the umbrella of a family name.

Adobe Type Reunion works only with application programs that list their fonts in pull-down or pop-up menus (most do). It does not work with applications that list fonts in a scrolling list box (as does Microsoft Excel). Adobe Type Reunion will not cause such an application to crash; it simply will not tidy up its font list.

Adobe Type Reunion is included with each Multiple Master typeface package. (When you consider the limitless range of fonts Multiple Master enables you to create, Adobe Type Reunion is a necessity.) It's also sold separately.



Customizing and Creating Fonts

Creating a new font from scratch is an arduous process. Typically, a font designer begins with large, hand-drawn versions of each character that are scanned and then traced using a font-editing program. Next, the fledgling ciphers are touched up and their spacing is adjusted so that all character combinations look good in a variety of sizes. Then, the whole routine is repeated for the other styles in the typeface—usually italic, bold, and bold italic. The developer also may create an *expert set*—a set of special characters, such as fractions, ornamental *swashes,* and optically scaled SMALL CAPITALS that look better than the Mac's derived small caps. The entire process can take months.

Few people have the skill, time, or desire to create a new font and do a good job of it. Customizing an existing font, however, is another matter. It's easy to make adjustments to a font—change its character spacing or expand or condense the font to give it a new personality. (Apple has discovered the latter trick: its corporate font is a condensed version of Garamond.) You also can modify the appearance of individual characters—refine a letter or two to create a company logo, or create a special symbol to put at the end of articles in a newsletter or magazine. Some font-editing programs enable you to transfer scanned artwork into a font: press a key, and your company logo or your signature appears.

In this section, we briefly describe several font-editing programs. This isn't a complete roundup of font-editing software, but a sampler intended to illustrate the kinds of features font-editing and font-customizing programs provide.

Metamorphosis Professional

Metamorphosis Professional, from Altsys Corporation, is an ideal program for basic font customizing. With Metamorphosis Professional, you can type a short passage of text and then convert it into a PICT image (the most common format for image storage on the Mac—see Chapter 11). You can then paste the PICT image into a drawing or illustration program to modify it (see figure 6.17). You also can save the resulting text in a variety of graphics file formats for inclusion in another program's document.

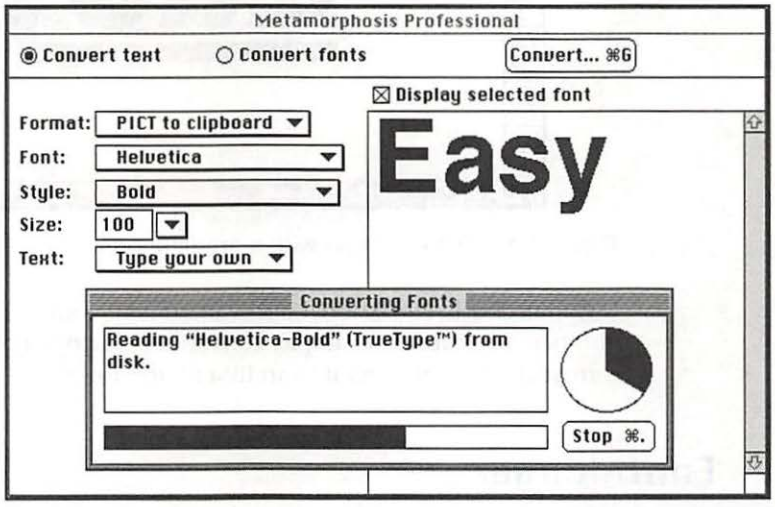


Figure 6.17: Using Metamorphosis Professional. Converting text to a PICT image.

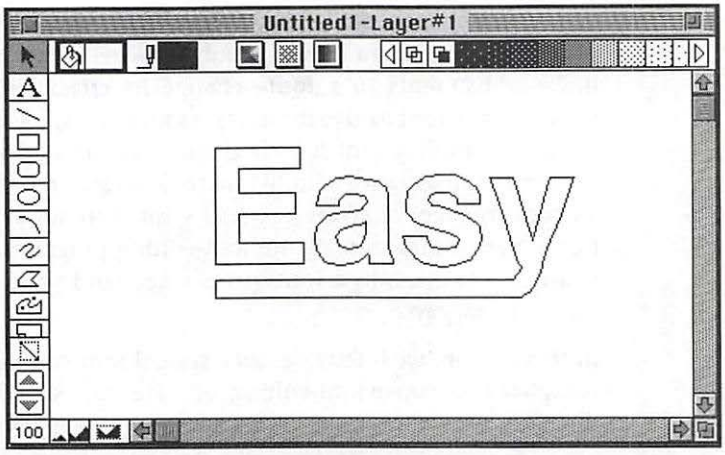


Figure 6.17: The resulting PICT image pasted into Claris MacDraw Pro, with the y altered.

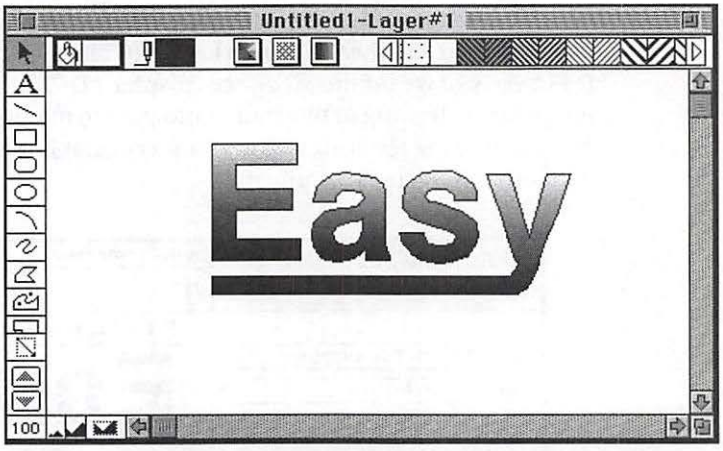


Figure 6.17: The PICT text with a gradient effect applied to it.

Metamorphosis Professional also can convert font files from one format to another. You can, for example, convert a PostScript Type 1 font to TrueType format and then transfer it to an IBM PC for use with Microsoft Windows 3.1.

FontMonger

FontMonger from Ares Software Corporation enables you to convert between font formats. FontMonger also enables you to move characters to different

locations on the keyboard—if the Mac's key sequences for opening and closing quotes (" ") tangle your tendons, you can move the quotes to different positions.

You also can use FontMonger to create real fractions, such as ½. As figure 6.18 shows, the process is so easy that there's no reason to use tacky pseudo-fractions, such as 1/2. (Remember that many font vendors sell expert sets that include fractions designed to match a given typeface.)

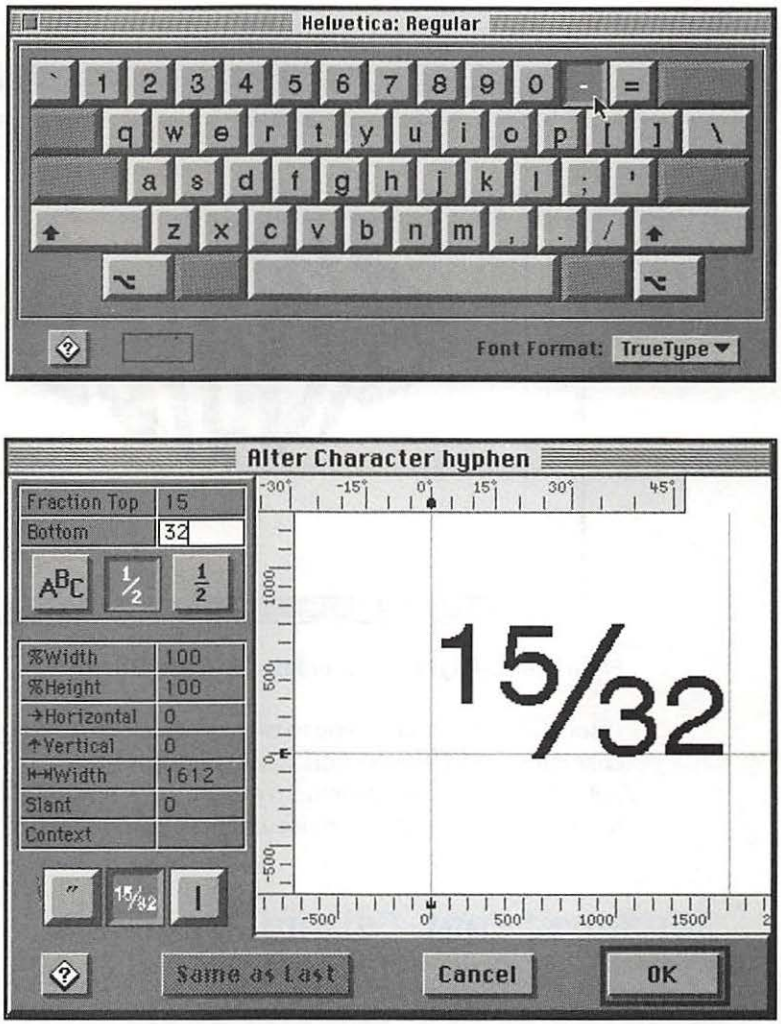


Figure 6.18: Making a fraction in FontMonger. Select the character position for the new fraction (top). Type the numerator and denominator in the appropriate boxes (bottom).

LetraStudio

Remember when we compared outline fonts to rubber bands earlier in this chapter? Letraset's *LetraStudio* enables you to stretch and reshape those digital rubber bands in an endless variety of ways. LetraStudio takes text created using a Type 1, Type 3, or TrueType font, and expands it; condenses it; attaches it to a curved or wavy baseline; and resizes it to fit within a shape (see figure 6.19). LetraStudio also can work with Letraset's proprietary font format, called LetraFont.

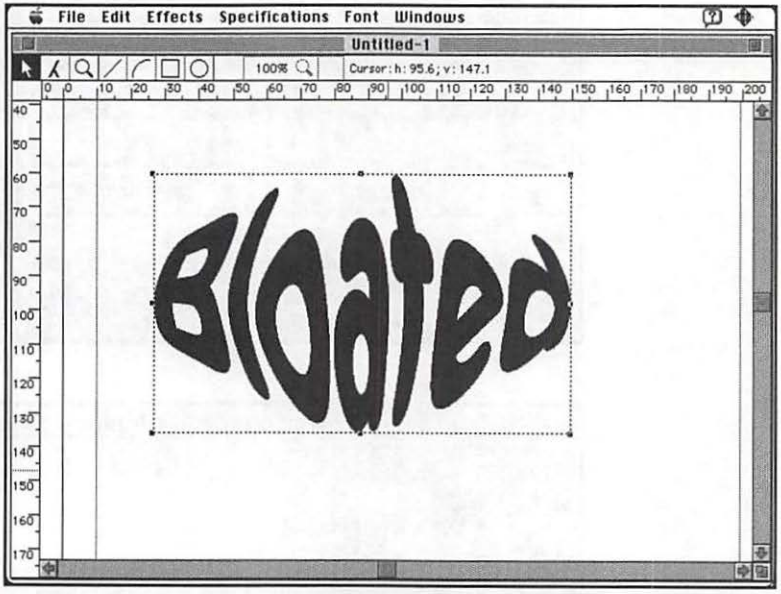


Figure 6.19: A type effect created in LetraStudio.

LetraStudio also enables you to tweak character spacing by dragging individual characters, which is a more direct, effective way to control spacing than publishing programs provide. You can save resulting effects in a variety of formats to include them in documents created in other programs.

Advanced Font-Editing Programs

Two advanced font-editing programs are Letraset's *FontStudio* and Altsys' *Fontographer*. Both are able to handle every aspect of the font-design process. Fontographer versions 3.5 and later even enable you to create and work with Multiple Master fonts. Both appear in figure 6.20.

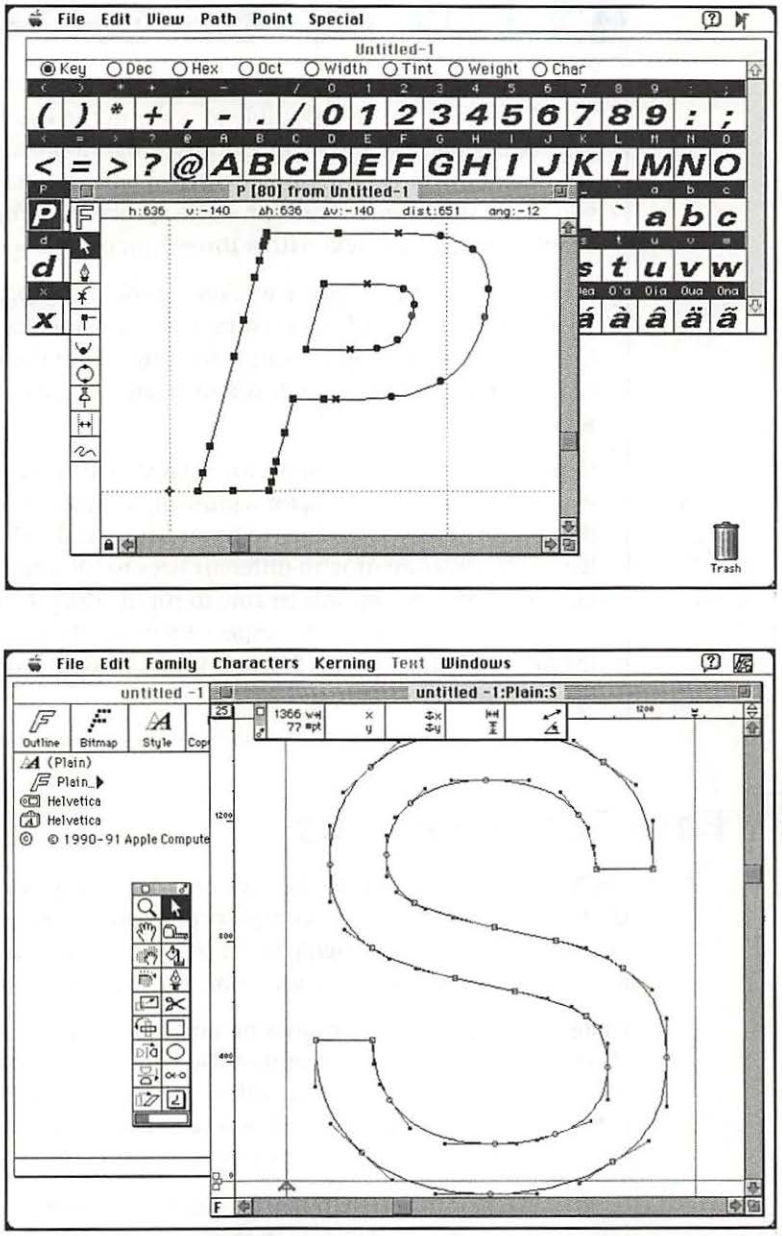


Figure 6.20: Altsys Fontographer (top) and Letraset's FontStudio (bottom).

Trend: More Ways to Modify Fonts

Programs such as FontMonger, Fontographer, LetraStudio, and TypeStyler have made it possible to perform the kinds of typographic gymnastics that used to require hours of darkroom and paste-up work. But one of the most intriguing developments in font modification involves the third dimension—or, more accurately, programs that enable you to create text with a three-dimensional look.

Pixar Corporation's Typistry was one of the first programs to enable you to create 3D text from existing fonts and apply a variety of surfaces—from woodgrain to marble to chrome—to the text. Typistry also enables you to animate the text and create QuickTime movies of the results.

In the future, look for support for 3D text to be built into the Mac's system software. Also look for a growing number of programs to support outline fonts' capability to be stretched and resized. Rather than having to experiment with different sizes to fill a column with a headline, for example, you will be able to simply drag the headline and resize it to fit. This will work especially well with fonts that provide the kind of optical scaling features found in some Adobe Multiple Master fonts.



Font Technicalities

The Mac makes switching fonts, sizes, or styles as easy as choosing a command. Under the hood, however, a complex set of events occurs. In this section, we examine what happens when you choose a font, style, and size; how the Mac's font resources are structured; and some font-related problems that can occur.

Understanding the technicalities behind Mac fonts can help you install and choose fonts as well as troubleshoot the font-related problems that can occur when you move a document to a different Macintosh. If you move documents between Macs on a network or if you send documents to a service bureau for laser printing or imagesetting, you may be especially prone to font troubles.

As thrilling as font problems are, if you would rather learn about the Mac's printing features now, feel free to skim or skip the rest of this chapter. When you want to learn more about fonts—or if the font gremlins strike—you can return to this section.

How the Macintosh Displays Text

The text you see on the Macintosh screen is the result of a joint effort of an application program and three components of the Mac's system software: QuickDraw, the Font Manager, and the Resource Manager. When you choose a font-formatting command, QuickDraw requests the desired font, size, and style from the Font Manager. QuickDraw doesn't ask for the font by name; instead, it uses a unique ID number that's assigned to each font and stored in the System file. That is, rather than saying, "I need Helvetica," QuickDraw says, "I need font ID 21."

When QuickDraw requests a given font, it also requests a specific style (plain, italic, bold, and so on) and a specific size. The Font Manager takes this information and uses the Resource Manager to load the appropriate font into memory. If the specific size or style isn't available (if no bitmap or outline description for it exists), however, the Font Manager must simulate, or *derive*, the font by altering the description of a font that does exist. Figure 6.21 illustrates the often-unattractive results.

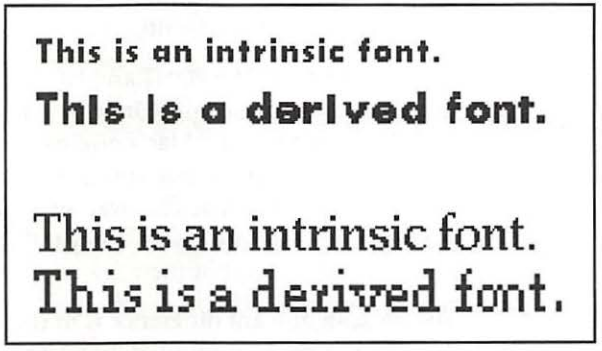


Figure 6.21: Intrinsic fonts versus derived fonts.

When you choose a style (such as italic) for which no intrinsic definition exists, QuickDraw derives the style by altering the intrinsic style. To create italics, for example, QuickDraw shifts the bits in the font to slant its characters. The bits above the baseline are skewed to the right, while bits below the baseline are skewed to the left.

Because derived styles will never look as good as their intrinsic counterparts, you probably will want to install the specific styles you use most often. As mentioned earlier, PostScript fonts sold by font vendors, such as Adobe Systems and Bitstream, usually include fonts for the various styles within a family.

Inside Font Resources

Four different types of resources play a role in the Mac's font-handling capabilities: *FOND, FONT, NFNT,* and *sfnt.*

FOND. The name FOND stands for *font family descriptor.* A FOND resource acts as an electronic table of contents for a given font family. The System file contains one FOND resource for every font family you have installed. If you have five fonts installed—Times, Helvetica, Geneva, Courier, and Monaco—your System file contains five FOND resources, for example. When an application program tells the Mac, "I need 24-point Times Italic," the Mac consults the FOND for the Times family in order to obtain the font's resource ID—that unique font-identifying number mentioned earlier. QuickDraw and the Resource Manager use this number to retrieve the font.

Knowing this, you can see how a FOND resource compares to a table of contents: just as you use a table of contents to locate a specific section in a book, the Mac uses a FOND resource to locate a specific font in the System file. And like each page of a book, each font has a unique number that identifies it.

FONT and *NFNT.* The FONT and NFNT resource types hold the bitmap descriptions that tell QuickDraw how to draw a given typeface. The FONT resource was the Mac's original font resource; the NFNT resource (commonly pronounced *en-font)* is a newer resource type; it appeared when the Mac Plus was introduced. Both resource types perform the same end result—they tell QuickDraw how to draw a given bitmap font—but their internal structures are different.

The most significant difference is in the way fonts are numbered. Apple's original font-numbering technique allowed for approximately 128 font ID numbers. That seems like a large amount, but remember that each style requires a separate number. Thus, if you install 10 font families, you actually use 40 ID numbers. In the Mac's early days, fonts rarely included intrinsic styles (that is, true italics and bolds rather than derived ones), so this limitation wasn't serious. As font vendors began supplying more and more font packages (each including its own intrinsic styles), it became clear that 128 ID numbers weren't enough. Many font vendors were forced to reuse ID numbers. The NFNT resource type uses a different numbering scheme that allows for roughly 16,000 ID numbers.

sfnt. An sfnt resource holds the outline data that describes a TrueType font. This resource type debuted with TrueType. The letters *sfnt* are short for *spline font.* The basic building block of TrueType outline fonts

are *quadratic Bézier splines*—that's mathematic jargon that refers to how the curves and end points that form each character are described by the font outlines.

Multi-Bit Fonts

NFNT resources also make possible *multi-bit fonts* for use with Macs that have grayscale or color monitors. Multi-bit, also called *anti-aliased*, fonts can make large sizes of text look much sharper; technically speaking, they improve the *apparent resolution* of text by displaying subtle shades of gray around a character's edges. At normal viewing distances, these gray shades serve to smooth the jagged character edges that normally appear in large sizes (see figure 6.22).

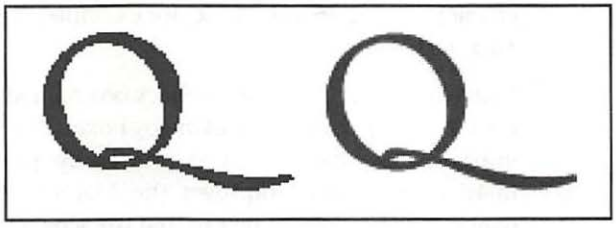


Figure 6.22: A character from a conventional bitmap font (left) and an anti-aliased version (right).

You can generate your own anti-aliased fonts using Letraset's FontStudio font-editing program. Letraset's LetraStudio special effects program also uses anti-aliasing.

Leading, Width, and Kerning Information

In addition to storing family names and bitmap descriptions, font resources contain components that tell the Mac what degree of vertical spacing (leading) and horizontal spacing to apply to the font.

The *auto-leading* portion of a font tells the Mac how much vertical space to place between baselines when an application program's auto-leading option is active. Most programs enable you to override the auto-leading option by specifying how much space you want between lines.

The *width table* lists the spacing for the characters in the font. The Font Manager passes the information in the width table to QuickDraw, which uses the width data to space the characters properly.

The *kerning table* contains information that programs can use to improve the spacing of certain letter pairs, such as To, Yo, and Ay. *(Kerning* involves removing space between two characters to improve their appearance and legibility.) Many programs (particularly desktop publishing programs) provide *automatic kerning* options that use kerning tables to determine how much space to remove between characters. Judicious use of an application's automatic kerning features can give a professionally typeset look to your documents. Many of the font programs described earlier in this chapter enable you to alter a font's kerning tables to suit your kerning preferences.

What's a Fractional Character Width?

The Mac Plus and later models can use fonts whose character widths are expressed in fractional values as well as in whole numbers. Rather than a given character being 16 units wide, for example, the width table may state that it's 16.5 units wide.

You may have encountered a check box named Fractional Character Widths in the Page Setup or Preferences dialog boxes of your programs. Checking this box improves the spacing of text printed by a laser printer, ink jet printer, or imagesetter. It also improves the Mac's WYSIWYG qualities by enabling QuickDraw to position text so that the screen more accurately reflects the way in which a printed document will appear.

Along with that second advantage comes a drawback. Screen pixels don't have fractional portions—the Mac cannot draw a letter 5.5 pixels wide. Thus, when a program uses fractional character widths, character spacing on the screen may appear irregular or tighter than it does when fractional widths are disabled. The irregularities are more obvious with small text sizes.

When Fonts Conflict

You have created a document that uses several fonts, and you have taken it to someone else's Mac so that you can print it there. Or maybe you have taken the document to a service bureau for high-resolution imagesetter output. In any case, when you open the document on the other Mac, it appears in different fonts. What has happened?

A *font numbering conflict.* When you install a font whose ID number is already in use by a different font, the Mac assigns a new number to the font you're installing. By itself, this renumbering process doesn't cause the problem. The problem often occurs when you're using an older application program that stores font numbers, rather than font names, in the documents it creates.

By way of example, here's why that's bad. Assume that you create a document containing the fonts Korinna and New Baskerville. Assume further that on your Mac, those fonts have ID numbers of 197 and 205, respectively. (These are the actual ID numbers assigned to Adobe Systems' Korinna and New Baskerville PostScript fonts.) When you save the document, the program stores those ID numbers, not the names *Korinna* and *New Baskerville*, in the document file.

Now assume that you're about to open the document on a different Mac. On this second Mac, Korinna and New Baskerville have different ID numbers because the numbers 197 and 205 were already in use by two other fonts—let's call them Sloppy and Tasteless. When you open your document, the application program requests font numbers 197 and 205. The result: your document appears not in Korinna and Baskerville, but in Sloppy and Tasteless.

Tips for Avoiding Font Conflicts

Generally, font conflicts are less common than they were when the first edition of this book was published. Still, conflicts can and do occur. Following are a few ways to avoid them:

- Use only one manufacturer's fonts. When you mix and match fonts from a variety of sources, the chances of ID number conflicts increase, since each manufacturer doesn't know what numbers other vendors have used. (Apple used to ask font vendors to register their font ID numbers with Apple, but no longer does.) If you stick with one firm's fonts, ID conflicts can still occur, but are less likely.
- If you want to print a document at a service bureau, create a PostScript print file rather than taking the actual document itself. The print file will contain the names of the fonts you used in the document. You need simply make sure the service bureau has those fonts installed on its laser printer or imagesetter. The next chapter shows how to create a PostScript print file.
- When you move your document to a different Mac, you can take your System file with it. This approach isn't ideal. If your System file is chocked full of fonts, it may be too large to fit on a floppy disk. What's more, the owner of the second Mac probably will not be receptive to having you replace his or her System file with your own.

CHAPTER

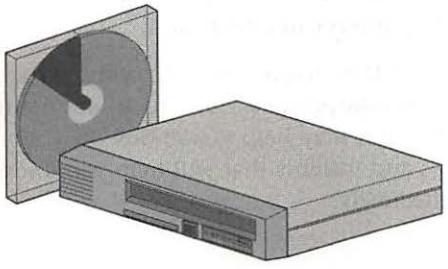
7

PRINTING

WHAT'S INSIDE

- The advantages of the Mac's approach to printing
- Types of Macintosh printers: dot matrix, ink jet, and laser
- How the ImageWriter II dot matrix printer operates
- How the StyleWriter and other ink jet printers work
- How LaserWriters and other laser printers operate
- Factors to consider when shopping for a printer
- Tips for using your printer more effectively

The Mac's sophisticated typographic capabilities would be worthless if you couldn't get your work from screen to paper. Fortunately, the Mac's printing features are up to the challenge. In this chapter, we tour the Mac's press room.





Macintosh Printing Overview

On computers without graphical operating environments, displaying a document and printing a document are two very different things. But with a graphical environment, such as the Mac's, displaying and printing are closely related. Because the Macintosh screen shows what a document will look like when printed, the processes required to display a document are similar to those required to print it. When you print a document, your application program performs many of the same processes involved in displaying the document on screen. The application program uses similar (in many cases, identical) QuickDraw commands to position text and graphics.

Printer Drivers

With printing, another component of the Mac's system software enters the picture: the printer driver. You may recall from Chapter 5 that printer drivers act as intermediaries between an application program and a specific printer. While printing, a program uses QuickDraw commands to describe a document's appearance, and a printer driver translates those QuickDraw commands into the codes and commands that a specific printer requires.

This division of labor eliminates the need for application programs to contain program code tailored to a specific printer. An application can use the same routines to print a document on an ImageWriter, an ink jet printer, a laser printer, a film recorder, or an imagesetter—each of which produces images in different ways, using different internal commands.

One way to understand this approach is to imagine that you're an ambassador at a United Nations session. You have to address a group that speaks dozens of different languages. You can't learn each one, so you speak the language you know, and interpreters translate your words into ones the attendees can understand.

In this scenario, the ambassador is the Macintosh, the attendees are a variety of different printers, and the interpreters are printer drivers. The Mac speaks in the language it knows—QuickDraw—and printer drivers translate the commands into ones that the printers can understand.

In the remaining sections of this chapter, we will examine specific types and models of Macintosh-compatible printers. If you're still shopping for a printer, you will find some advice that may help you choose. If you already have a printer, you will find tips and insights that will help you understand how it works and use it more effectively.

The ImageWriter II

Apple's ImageWriter II is a sturdy scribe that is as adept at printing graphics as it is at printing text. LaserWriter and StyleWriters, with their quiet operation and extra-sharp output, may grab the glory, but the ImageWriter II is the affordable workhorse of Apple's printer line. And it remains the preferred printer for certain jobs, such as printing mailing labels and printing on carbon and carbonless multipart forms.

This section is dedicated to giving the ImageWriter II its due. We will examine how the ImageWriter II operates and show how to get better performance and print quality from one.

Dot-Matrix Basics

The ImageWriter II is a *dot matrix* printer—it produces images by striking an inked ribbon with minute, moveable pins called *print wires*. Located in the printer's *print head*, these print wires are grouped together in a matrix; when a pin strikes the ribbon, the ribbon presses against the paper, printing a single dot. The printer produces images by controlling which pins strike the ribbon and which ones remain stationary (see figure 7.1).

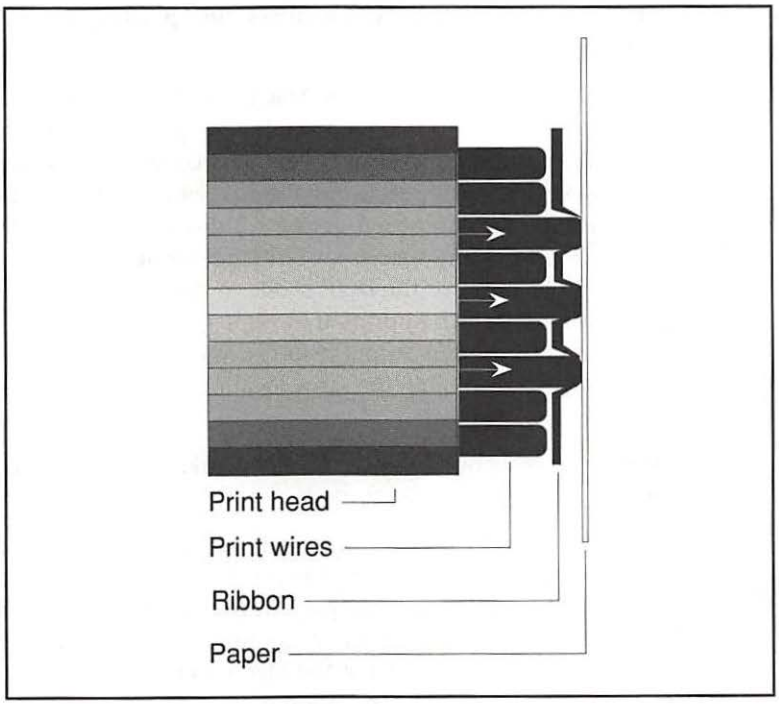


Figure 7.1: A dot matrix printer's pins strike a ribbon.

As you will see shortly, a dot matrix printer's *resolution*—the number of dots per inch it can produce on a page—depends partially on the number of pins in its print head and the size of the pins.

The ImageWriter and ImageWriter II

The ImageWriter was the Mac's first printer, introduced along with the original Mac in January 1984. Two years later, the ImageWriter was replaced by the ImageWriter II, which offers faster speed, more reliable paper handling, and higher resolution (both printers have 9-pin print heads, but the ImageWriter II's pins are smaller). The ImageWriter II also contains a single expansion slot into which you can install an AppleTalk board that allows multiple Macs to access one printer over a network.

When you have selected the Faster print-quality option, the ImageWriter II's resolution is 72 dots per inch (dpi) horizontally and 80 dpi vertically. In the Best quality print mode, its resolution doubles to 144 horizontal dpi and 160 vertical dpi.

Differences in Print Modes

The ImageWriter printer driver offers three printing modes: Draft, Faster, and Best.

> *Draft.* In Draft mode, the Mac doesn't send to the printer bitmap descriptions for fonts or graphic images that a document may contain. The printer receives only character codes and spacing information, and prints using its internal fonts, which have that ugly, computer-printer appearance. As figure 7.2 shows, when you print a proportionally spaced font in Draft mode, word spacing is irregular. Apple designed the Draft mode so that each word still begins where it will appear when printed in higher-quality modes. If you hold a page of draft-printed output over the Mac's screen, you can see that words appear at roughly the same locations on both the screen and the printed output.

Later in this section, you see how to work around the irregular spacing that results when you use Draft mode.

> *Faster.* In the Faster print mode, the Mac *does* send font and graphic bitmaps to the printer. When printing in this mode, a Mac application creates a bitmap of the page in the Mac's memory, and then transmits this bitmap to the printer. Because a bitmap image of a full page would use too much of the Mac's memory, the Mac's system software creates the bitmap in stages: It creates a bitmap for part of the page,

transmits it to the printer, discards that bitmap, and then repeats the process for the next portion of the page. (Incidentally, this printing technique is called *banding.)*

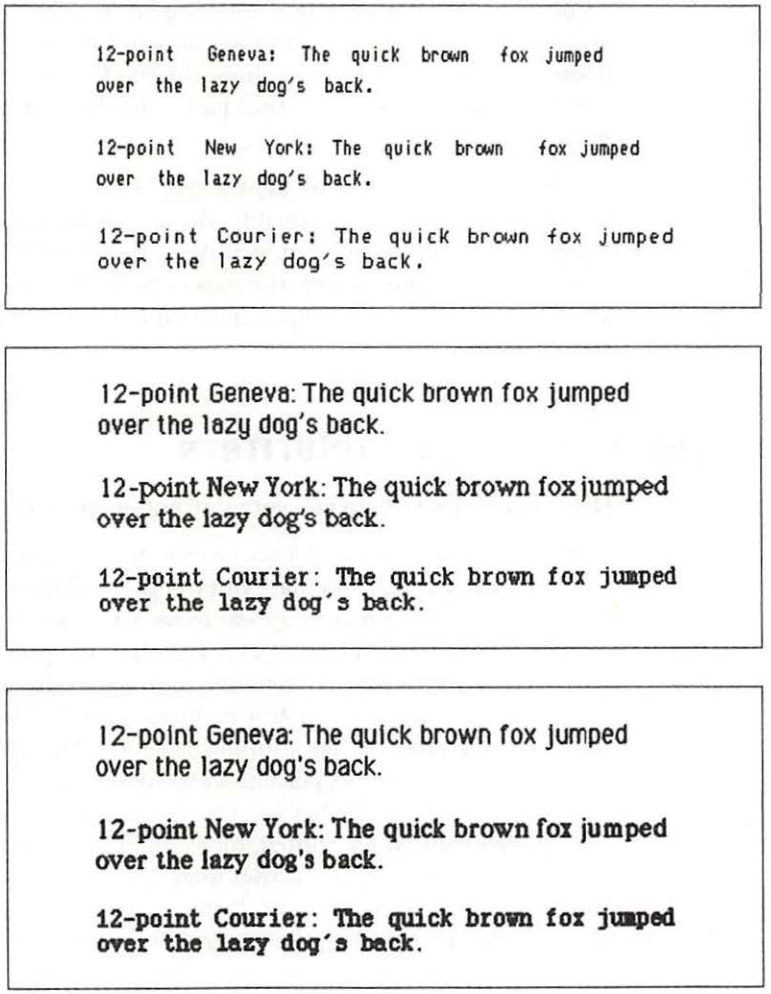


Figure 7.2: ImageWriter output three ways: Draft (top), Faster (middle), and Best (bottom).

Best. Best quality mode is similar to Faster mode in that the Mac uses banding to create and transmit a bitmap image of the page. In Best mode, however, the Mac creates a bitmap that's twice the size of the page, and then "plays back" the bitmap at half that size. Because larger bitmaps require more memory, the Mac must divide the page into more bands—47, to be exact.

This double-then-reduce approach requires the Mac to handle fonts differently. When you print an outline font in Best mode, the Mac generates a point size twice the size of the text on the page, and then it reduces (shrinks) the text by 50 percent. Because larger font sizes can convey typographic subtleties more accurately, this results in improved text quality. If the font you're printing isn't an outline font, the Mac looks for a bitmap font twice the required size. If it doesn't find a font of that size, the Mac looks for a size four times the required size. If it strikes out there, too, the Mac locates the next-best size and then scales it appropriately.

When you print in Best mode, the Mac's ImageWriter driver uses another technique to improve print quality: the print head makes twice the number of passes to print the document as it does in Faster mode. Before printing the second pass, the printer rolls the paper up slightly (about half a dot's worth). This causes the dots to overlap, filling in the edges of characters and improving the appearance of text.

Ten Tips For ImageWriters

Here are ten tips to help you get more out of an ImageWriter.

- *When to use the Tall Adjusted option.* If you print documents containing pictures pasted from MacPaint or other painting programs, you may notice that the images appear to be stretched vertically. This problem occurs because the vertical resolution of the printer and screen don't match: the screen's vertical resolution is 72 dpi, but the printer's is 80 dpi. Choosing the Tall Adjusted option in the Page Setup dialog box fixes the problem, but introduces a side effect: the printed document is approximately 13 percent wider than its screen counterpart. A line of text that's six inches wide on the screen will be roughly 6 3/4-inches wide when printed, for example. Selecting the Tall Adjusted option, however, also causes ImageWriter output to more closely match LaserWriter output. (Later in this section, we will provide another tip for using the ImageWriter to proof documents destined for a laser printer.)

- *Use fixed-width fonts for Draft printing.* When you want the fastest text printing, format a document in a fixed-width font, such as Monaco, and then print the document in Draft mode. Using a fixed-width font helps avoid the irregular word spacing that usually occurs in Draft mode. In our experience, 14-point Monaco produces the best-looking draft copy. But because Monaco isn't the prettiest font to look at on-screen, you may want to type and edit your document in a different font, save the document, and then switch to Monaco just before printing (choose Select All from the Edit menu, and then choose the Monaco font).

- *Use uniform-stroke fonts for Best quality printing.* Fonts with uniform stroke widths, such as Geneva, Monaco, and Courier, produce better results in the Best quality mode than do fonts whose stroke widths vary, such as New York. That's because uniform-stroke fonts are easier for the Mac to scale to the appropriate size. When the Mac scales varying-stroke-width fonts, the characters can take on a lumpy look.
- *If you must use bitmap fonts, install the proper font sizes for Best quality printing.* Because the Mac looks for and reduces larger type sizes to print bitmap fonts in Best mode, be sure your System file contains the sizes you will need for best results. Table 8.1 shows the sizes required for Best quality bitmap-font printing on an ImageWriter I and II. (Remember that this does not apply to outline fonts, such as TrueType fonts or Type 1 PostScript fonts that are used with Adobe Type

Table 7.1: Font sizes required for best-quality ImageWriter printing of bitmap fonts.

To print this size	You need this size
9	18
10	20
12	24
14	28
18	36
20	40
24	48
32	48

- *Expanding your font library.* A large selection of TrueType-format fonts is available. If you use the Adobe Type Manager utility (described in the previous chapter), you also can choose from thousands of top-quality PostScript Type 1 fonts. If you use ATM, you can use your ImageWriter II to create proofs of documents that you will print on a laser printer or imagesetter. Because the ImageWriter's output isn't in the laser league, the fonts won't look as sharp as they will in their final form, but character spacing and line endings will match.
- *You can specify custom paper sizes.* Some application programs, including Microsoft Word 5.0, enable you to specify custom paper sizes for ImageWriter printing. This is handy if you frequently print on non-standard paper stocks, such as index cards. You also can modify the

ImageWriter driver itself to recognize non-standard sizes. For instructions, see the section "Creating Custom Paper Sizes" in Chapter 11.

- *How to get faster printing in Faster mode.* You can get faster printing in the Faster mode by pressing the Caps Lock, Shift, and Option keys while clicking the Print dialog box's OK button. Doing so causes the printer to print bi-directionally; normally, the printer prints in one direction only in the Faster mode. Some ImageWriter IIs may lack sufficient mechanical precision to print bi-directionally in Faster mode, however, and will produce slightly skewed output. (Note: The Mac "remembers" this setting by storing it in the printer driver; to revert to the normal Faster printing mode, press the Command key while clicking the Print dialog box's OK button.)

- *Paper feeding options.* The ImageWriter II accepts a $225 *sheet feeder* that eliminates having to hand-feed page after page. A less-expensive alternative to hand-feeding is to use *fanfold*, also called *pin-fed*, paper. Fanfold paper is a single, long sheet of paper that's perforated and folded to lie in a stack. The left and right edges of the sheets have perforated strips containing holes that are grasped by sprockets in the printer. After printing a document, you separate the sheets and tear off the perforated strips. To cleanly remove the strips, fold them back and forth a few times before tearing. Even then, many papers leave little nubs behind, each a dead giveaway that the document was printed on fanfold paper. To get cleaner edges, use a high-quality fanfold paper with finer perforations. Computer and office supply houses are good sources for such stock, which often has names like "satin edge" or "clean perf."

- *Avoid lengthy Best printing sessions.* Because of the extra passes required for Best printing, the ImageWriter's print head can overheat and be damaged. The original ImageWriter I is especially prone to this problem. To avoid a hot head, print only a couple of pages at a time in Best quality mode, and give the printer a rest for a minute or two between each run.

- *Use older ribbons for Best quality printing.* Because Best quality printing requires two passes of the print head, a new ribbon can produce text that's too dark, with the round portions of characters, such as *e* and *a* filled in. Because an old ribbon contains less ink, it can often produce cleaner type in Best mode (see figure 7.3). Many ImageWriter users like to "rotate" their ribbons: use a new ribbon for Draft and Faster quality, then reserve it for Best quality mode as it ages. Store unused ribbons in zip-top plastic bags to keep their ink from drying out. And because inked ribbons dry out over time, don't stockpile ribbons; buy only a few at a time.

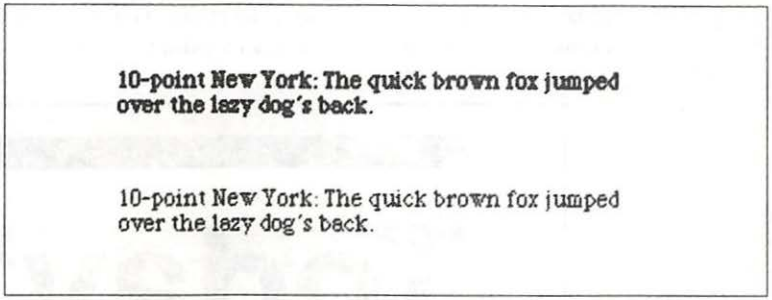


Figure 7.3: Best quality with a new (top) and old (bottom) ribbon.

Incidentally, several companies sell ribbon re-inking kits that allow you to squeeze more mileage out of a ribbon. Some users also stretch a ribbon's life by carefully disassembling the ribbon cartridge, spraying the ribbon inside with a bit of WD-40 lubricant, and then gluing the cartridge back together. We don't recommend these techniques. You may save a few dollars on ribbons, but you risk damaging the printer's print head as the ribbon wears and lint and dust from it collects on the print wires.



Ink Jet Printers

When we wrote the first edition of this book in 1989, no Macintosh-compatible inkjet printers were available. Since then, ink jet printers have taken the Macintosh world by storm by providing laser printer-like output quality for a fraction of the price. Ink jet printers have drawbacks—they're slow and their ink is prone to smearing—but their low cost makes them the printers of choice for someone who wants that laser look but can't justify the cost of a laser printer.

Ink Jet Basics

Rather than using an inked ribbon and print wires to produce output, an ink jet printer uses a disposable cartridge containing several dozen microscopic nozzles that spray extremely fine streams of liquid ink. Besides making the printer much quieter than its dot matrix counterparts, this scheme allows for much finer resolution. The ImageWriter II, for example, has a maximum resolution of 144 dots per inch (dpi), while an Apple StyleWriter can print 360 dpi.

An ink jet printer's output still doesn't compare to a laser printer's, however. Look at a page closely and you can see ragged character edges caused by ink seeping into the paper fibers (see figure 7.4). Scanned images and dense black

areas can have a mottled look to them. Handle that output gently when it comes out of the printer—the ink can smear in its first few seconds on the page.

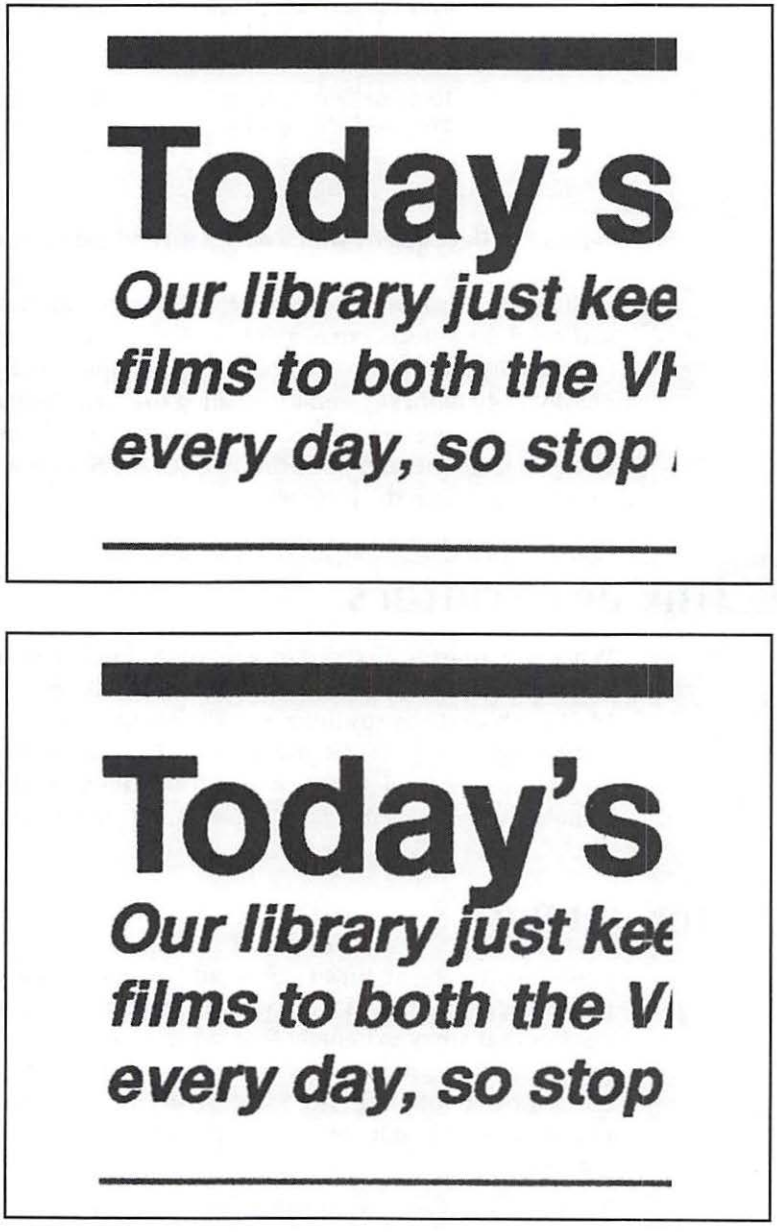


Figure 7.4: Ink jet output (top) and laser printer output (bottom).

Ink jet printers also tend to be finicky about paper. Output quality varies dramatically depending on the quality of paper you use, and most printers can't handle heavy card stocks or feed multiple envelopes automatically.

Still, it's hard to argue with an ink jet printer's low price. A laser printer costs at least $1000, but Apple's StyleWriter retails for $399. In a nutshell, ink jet printers are ideal for people with laser tastes but dot-matrix budgets.

The Apple StyleWriter

The Apple StyleWriter is one of the smallest ink jet printers available for the Macintosh. Shown in figure 7.5 alongside a Macintosh Classic II for size comparison, the StyleWriter tips the scales at less than 8 pounds. It's small enough to carry on trips along with a PowerBook, although it doesn't run on batteries.

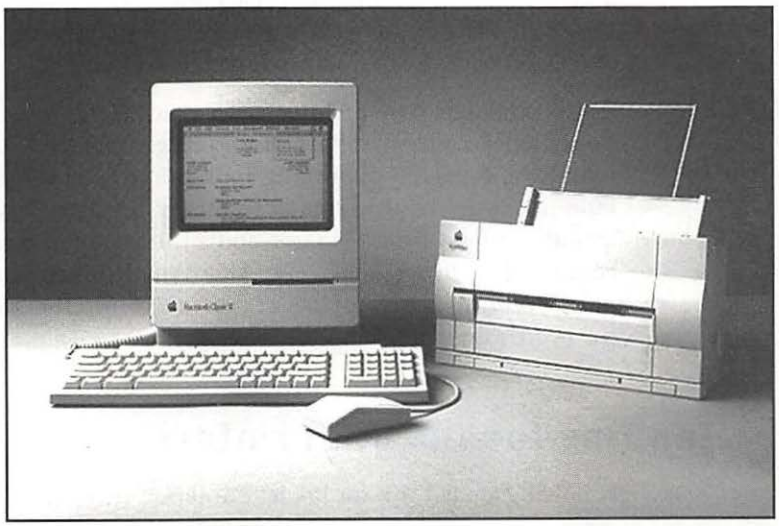


Figure 7.5: The Apple StyleWriter printer (John Greenleigh photo courtesy Apple Computer, Inc.)

The StyleWriter's disposable ink cartridge lasts for approximately 500 pages. The printer connects to the Mac's modem or printer port, and includes a detachable cut-sheet feeder that holds up to 50 sheets of paper. The printer also offers two manual-feed slots: one on the back for printing on envelopes, transparencies, and heavy paper stocks, and one of the front for feeding standard paper.

The StyleWriter includes 39 fonts—the Times, Helvetica, Helvetica Narrow, Courier, Chicago, Avant Garde, Bookman, Zapf Chancery, Zapf Dingbats, Monaco, New Century Schoolbook, New York, Palatino, and Symbol families—in TrueType format. The StyleWriter is also compatible with Adobe Type Manager; used with ATM, the StyleWriter can print any of the thousands of available PostScript Type 1 fonts.

Other Ink Jet Printers

Another popular inkjet printer is Hewlett-Packard's DeskWriter, which produces 300-dpi output. The DeskWriter is bigger and bulkier than the StyleWriter, but it has advantages of its own. It's roughly twice as fast, its ink is less prone to smearing, and it provides a LocalTalk connector that enables you to share the printer with other Macs on a network. The DeskWriter includes four outline-font families: Compugraphic versions of Helvetica, Times, Courier, and Symbol. An optional font pack includes seven additional families. The DeskWriter is also compatible with TrueType fonts and Adobe Type Manager. The DeskWriter C also can produce color output.

If you think big, you might consider GCC Technologies' WideWriter, which prints 360-dpi output on sheets measuring as large as 17 by 22 inches—ideal for drafting and tabloid-publishing applications. The WideWriter uses a Canon-built inkjet mechanism similar to that of the Apple StyleWriter. The printer includes Adobe Type Manager and 21 Type 1 PostScript fonts, and is also compatible with TrueType. The WideWriter connects to the Mac's modem or printer port, and also provides a LocalTalk connector that enables you to share the printer on a network.

Ten Tips for Ink Jet Printers

Following are ten tips for ink jet printers.

- *Sharing a StyleWriter (or other serial printer) on a network.* The StyleWriter isn't designed to be shared on a network, but you *can* share it using a utility called ShadowWriter, from Gizmo Technologies. (ShadowWriter 2.0 and later versions actually enable network sharing of any serial printer, including an ImageWriter II without Apple's AppleTalk expansion card and the Apple Personal LaserWriter LS.) You probably wouldn't want to use a sluggish StyleWriter as the sole printer on a large network, but you might not mind sharing one with one or two other people—provided they're patient.
- *Use the latest StyleWriter driver.* Apple has made improvements in the StyleWriter driver that speed up this sluggish little scribe. StyleWriter driver versions 7.2.2 and later are roughly three times faster than the

original StyleWriter driver, and they support background printing. To check your driver's version number, choose the Page Setup or Print commands—the version number appears near the upper-right corner of the dialog box, to the left of the OK or Print buttons.

- *Printing PostScript output using a PostScript emulator.* Because ink jet printers don't use Adobe Systems' PostScript, they deliver inferior results when used with PostScript illustration programs, such as Aldus FreeHand and Adobe Illustrator. You can bridge that gap, however, by using *PostScript emulation* software, such as Custom Applications' Freedom of Press or TeleTypesetting's T-Script. A PostScript emulation program resides on your Mac's hard drive and acts as an intermediary between your programs and a non-PostScript printer. When you print a document, the emulator saves on disk the PostScript instructions from the LaserWriter driver. The emulator's interpreter then takes over, translating the file into instructions your printer can understand. Versions of Freedom of Press and T-Script are available that work with dozens of ink jet and dot matrix printers.

- *Choosing paper.* Ink jet printers are vulnerable to variations in room temperature and humidity, so the best way to find the ideal paper is to experiment in the room where you will be printing. When you find a paper that works well, stock up. Many DeskWriter users swear by 24-pound Classic Crest in the Solar White color. Apple recommends the same paper for its StyleWriter. Many HP DeskWriter users report good results from Pro-Tech Laser Bond White (catalog number 94161), from James River Corporation (800/521-5035).

- *Print on the correct side.* Regardless of the paper you choose, you will get better results if you print on the correct side. Because of the way paper is made, each side of a sheet has different characteristics. The correct side to use for printing is the *felt* side, which is smoother than the *wire* side. Most paper manufacturers indicate the felt side on the label attached to the paper's wrapper. If you have removed the paper from its wrapper (a bad idea, since it exposes the paper to humidity), you will need to print some tests. The side that gives the sharpest results is the felt side. If you're using watermarked bond, hold a sheet up to the light—if the watermark's text or design is reversed, you're looking at the wire side. (This felt-versus-wire side issue applies to laser printing, too, but print quality doesn't degrade as dramatically if you laser-print on the wire side.)

- *Protect ink cartridges during air transport.* If you will be taking to the air with your ink jet printer, beware—the low air pressure in a jetliner can cause ink to pump out of the nozzles in an ink jet cartridge. To avoid this messy problem, carry only new, factory sealed ink cartridges on

an airplane. If you must carry an already-opened cartridge, remove it from the printer and store it in a sealed plastic bag.

- *Refilling ink cartridges.* Ink jet ink cartridges don't cost that much—about $20—but you can lower your printing costs even more by refilling ink cartridges using a syringe and a washable fountain pen ink, such as Shaeffer's Skrip and Mount Blanc. We don't recommend this practice—it can be messy and you could, in theory, damage the printer and void its warranty. But so many ink jet printer owners swear by this practice that we had to pass the information along. Most refilling gurus say a cartridge is good for two or three refills.

- *Cleaning ink cartridges.* If you notice your output taking on a fuzzy appearance, your ink cartridge may need cleaning. To clean a StyleWriter cartridge, first turn the printer's power off. Next, press *and hold down* the Ready switch (on the left of the printer). While still pressing the Ready switch, turn the printer back on. Finally, release both switches. You may hear some clicking sounds as the cartridge is cleaned—this is normal. To clean a DeskWriter cartridge, press the printer's Prime switch.

- *Using the StyleWriter's cousin with the Mac.* Canon's BJ-10ex printer uses the same print mechanism as the StyleWriter. (Canon builds the StyleWriter mechanism for Apple.) Unlike the StyleWriter, the BJ-10ex can run on batteries. The BJ-10ex is designed for IBM PCs, but you can use it with the Mac by buying GDT Softworks' PowerPrint, which includes a cable and printer driver. See the next chapter for more details on PowerPrint.

- *Colorizing your black-and-white inkjet.* Most inkjet printer vendors sell only black ink cartridges. If you want to add some color to your output, consider the color ink cartridges sold by Graphic Utilities (800/669-GRAF). The firm offers a variety of colors for the StyleWriter and HP DeskWriter.



Laser Printers

Not long ago, laser printers were refrigerator-sized beasts that only big corporations and government agencies could afford. Today, you can buy a laser printer that fits on your desk for under $1,000.

Laser printers have evolved dramatically since we wrote the first edition of this book. In 1989, most printers cost several thousand dollars; today's new generation of so-called personal laser printers costs between $1,000 and $2,500. In 1989, most printers provided basic 300-dpi output and didn't deliver coarse results when printing grayscale scanned images. Many of today's printers provide sophisticated *resolution enhancement* technologies that enable

them to print sharper-looking output and more attractive grayscale images. Prices are falling while capabilities are improving—a combination that's hard to argue with.

In this section, we explore the basic concepts behind laser printing, the components in a laser printer, the types of laser printers available for the Mac, new technologies that improve output quality, and how to get more out of a laser printer.

First a note about terminology. Laser printers are so named because their print mechanisms contain a laser. Some printers that are conceptually identical to a laser printer, however, don't actually contain lasers. Technically, the term *page printer* is more accurate than *laser printer* these days. But because the majority of page printers do contain lasers—and because far more people are familiar with the term *laser printer*—we'll stick with the familiar.

Laser Printer Basics

The following two components work together to give a laser printer its talents:

- The *print engine* is the photocopier-like mechanism that feeds the paper and produces images on it.
- The *controller,* the brains of the duo, is the component that accepts an application's printing instructions and governs the print engine accordingly in order to produce the document.

In nearly all laser printers, the controller and engine are housed within the same case. But some low-cost printers, which include GCC Technologies' PLP series and Apple's Personal LaserWriter LS, use the Mac as the controller. As you see shortly, this reduces the printer's cost, but at the expense of versatility and performance.

Print Engines

A print engine translates the controller's instructions into hard copy. The print engine's design determines several factors:

- The printer's resolution—the number of dots per inch the printer can produce. A printer's controller also can influence resolution, but the major factor in determining resolution is the mechanical precision of the engine.
- The output quality. Variations in engine design can have impact print quality. One type of engine may produce richer, darker black areas than another, for example.

- The printer's *duty cycle*—the number of pages that you can print before having the printer overhauled. Duty cycles are often rated in pages per month—if you exceed a printer's rated duty cycle by overworking it, you may be asking for mechanical problems. (Don't worry if a big project forces you to overwork your printer now and then, though—today's laser printer engines are extremely reliable.)

Doesn't the print engine also determine printing speed? Only partially. In the Mac world, most people print documents containing graphics and a variety of type styles and sizes; as a result, a printer's controller is often the component that determines overall performance. Unless you're printing typographically simple documents (such as manuscripts in the Courier font) or multiple copies of a single page, the speed of most Mac-compatible laser printers is determined by the performance of the controller, not the engine. We will discuss performance issues in greater detail when we examine printer controllers.

Print Engine Components

The primary components of a laser printer's engine include the following:

- A light-sensitive *rotating drum* or *belt*. In most laser printers, the drum or belt is disposable; you replace it after several thousand copies.
- A low-power *laser assembly*, aimed at the photosensitive drum or belt through a series of lenses and mirrors.
- A reservoir containing a supply of *toner*, a fine plastic powder. Toner is coated with a polymer that causes it to acquire a negative electric charge. Some printers use a two-component system comprising toner and another powder called *developer*.
- Wires called *charging coronas*, which carry high voltages and electrically charge the drum as it rotates, and the paper as it travels through the engine. As you will see shortly, this charging process enables the toner to be transferred to the paper.
- A *fusing assembly*, which uses heat to melt the toner particles and adhere them to the paper.

Print Quality Issues

Many engine-related factors influence the appearance of laser output, but the most important factors are the resolution of the print engine and the techniques used by the printer's controller to produce fonts. In this section, we will examine these factors and provide some guidelines for assessing laser print quality.

Resolution

We've said it before, but it bears repeating: the more dots per inch a printer produces, the better the result. More dots per inch enable a printer to more accurately render the subtleties of typographic fonts and to minimize the "jaggies" when printing graphics. Figure 7.6 illustrates this point. It shows standard 300-dpi output, resolution-enhanced 300-dpi output, and 600-dpi output. In particular, notice the relative absence of the jagged character edges in the resolution-enhanced 300-dpi output and in the 600-dpi output. (All samples are enlarged 200 percent.)

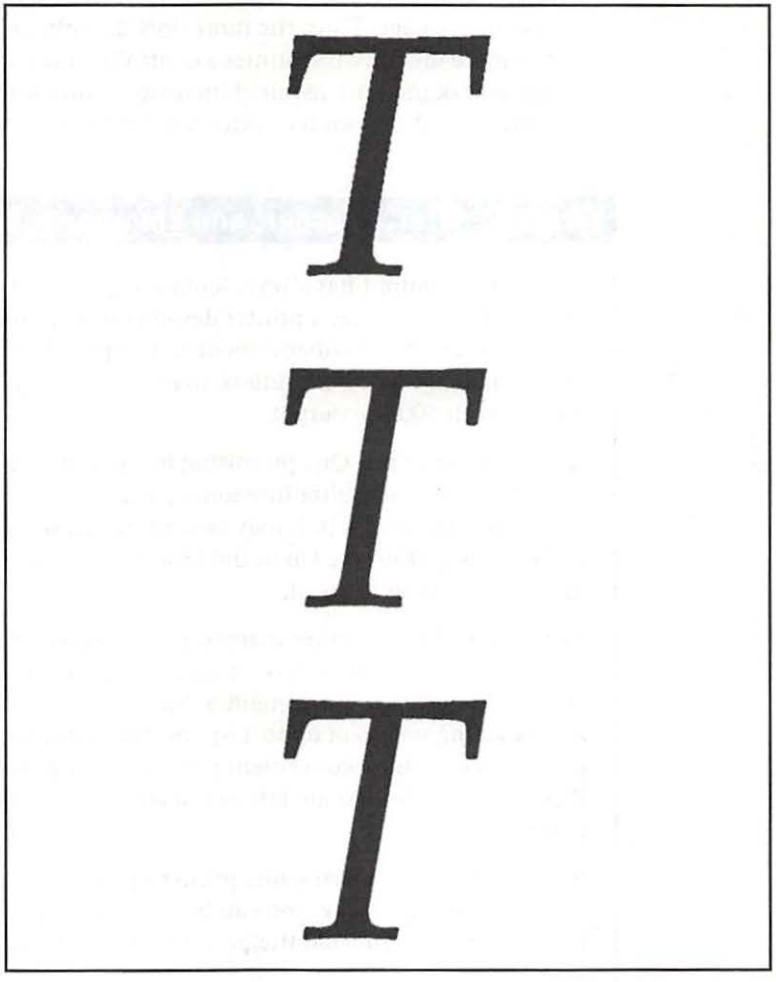


Figure 7.6: Top: 300-dpi output; middle: resolution-enhanced 300-dpi output printed by an Apple LaserWriter IIg; bottom: 600-dpi output produced by a QMS PS-815MR.

Print resolution is governed by the following several factors:

- The design of the print engine. Some print engines are designed to produce 300-dpi; others are built for 400- or even 600-dpi.
- The design of the printer's controller. Some controllers provide special circuitry that finely controls the engine's laser to produce smoother character edges and, in some cases, better-looking grayscale images. Printers containing such controllers include Hewlett-Packard's LaserJet IIIp and IIIsi and Apple's LaserWriter IIf and IIg.
- Memory economics. In printers that use the PostScript page-description language, one bit of printer memory is required for each dot on the page. Thus, the more dots the printer produces per inch, the more memory the printer's controller must contain. And the amount of memory required increases dramatically as resolution climbs—and the printer's price tag climbs along with it.

Trend: Faster, Sharper, and Cheaper Laser Printers

Laser printer output has always looked impressive, but it's getting even better as more laser printer developers make use of higher resolutions and resolution-enhancement techniques. While 300-dpi used to be the standard for laser printers, many of today's printers provide 400- or even 600-dpi output.

And it isn't over yet. One promising technology still on the horizon uses fiber optics and ultra-fine toner particles to provide resolution of over 1200 dots per inch. It may be a while before this technology makes its way from the lab to the local dealer, but the high-resolution handwriting is on the wall.

Not only are lasers getting sharper, they're also getting faster. Most personal printers used to have 4-page per minute engines, but many are providing 6- or 9-ppm engines. Many printers designed for offices are providing speeds of up to 17-ppm. Many printers provide multiple paper trays for more convenient paper handling. And today's fast, RISC-based controllers are taking full advantage of these high-speed engines.

But the best news is that while printer capabilities are improving, prices are falling. Today, you can buy a heavy-duty, 17-ppm office printer for less than what the original (and slow) Apple LaserWriter cost.

How to Judge Print Quality

The output of any laser printer looks a lot better than dot-matrix output. But laser print quality can vary dramatically, even among printers that print the same number of dots per inch.

But what does *print quality* really mean? Asked another way, what constitutes good-looking laser output?

- Sharply formed characters, especially at small sizes. At 300 dpi, creating sharp text in small sizes (10 point and smaller) is a challenge that some printers meet better than others. As a general rule, printers that provide some form of resolution enhancement render small text better than do straight 300-dpi printers.
- Rich, solid black areas. The appearance of solid black areas can be important if you're printing illustrations, bar or pie graphs, and reverse type (white type against a black background). In the output of early laser printers, you could see the individual scan lines created by the printer's laser. (This shortcoming was especially apparent in the original Apple LaserWriter and LaserWriter Plus.) Today's printers generally produce excellent blacks.
- Grayscale images with fine dots and a good range of grays. We will examine grayscale-printing issues in detail later in this chapter.



A Print Engine Sampler

Dozens of laser printers are available for the Mac, but most of them use print engines made by only a few manufacturers, including Canon, Sharp, and Okidata. This section describes the most popular print engines and spotlights some printers that use them. By mentioning these engines, we're not implying that they're the best or only print engines available. They're simply the ones you will encounter most often in the consumer laser printer field.

Canon CX. The first mass-produced laser printer engine, the Canon CX is at the heart of the original LaserWriter and LaserWriter Plus. Other CX-based printers include the Hewlett-Packard LaserJet and LaserJet Plus and the QMS PS-800 and PS-800 Plus. (None of these printers are still in production, but hundreds of thousands of them are still in daily service and often show up in classified advertisements.) The Canon CX uses a disposable cartridge that contains both the imaging drum and toner supply.

Canon SX. The Canon SX engine replaced the CX, and is used in Apple's LaserWriter II series of printers, as well as in the Hewlett-Packard LaserJet III and the QMS PS-815 and PS-815MR. The QMS PS-825 uses Canon's TX engine, which provides two paper trays. Like the CX engine, the SX uses a disposable cartridge containing the imaging drum and toner supply. The cartridges themselves, however, are not interchangeable. An SX cartridge contains enough toner for approximately 3500 pages. Many printer vendors have recycling programs for spent SX cartridges.

Canon NX. This industrial-strength engine is used in Hewlett-Packard's LaserJet IIIsi and QMS' PS-1700. It prints 17 ppm, includes two 500-sheet paper trays, and accepts an optional *duplexer*—an add-on that enables the printer to print on both sides of a sheet of paper. Tipping the scales at over 100 pounds, this is one of the biggest and most rugged engines you will find in the personal computer laser printer world.

Canon BX. This newer Canon engine provides 600-dpi and can print on pages as large as 11 by 17 inches. It's used in the QMS PS-860 and HP LaserJet 4M.

Sharp JX-9701. This engine, available in 9- and 16-ppm form, is used in several printers from Texas Instruments and Dataproducts. It uses three consumables: a toner cartridge good for approximately 6000 pages; an OPC cartridge that lasts for 30,000 pages; and developer that lasts for 30,000 pages. This engine is also available with one or two paper-supply trays.

Okidata 400 and 800 series. These compact engines are used in Okidata's own printers as well as in GCC Technologies' PLP and BLP series. The engines are available in 4- and 8-ppm form; the 8-ppm version also can accept a second paper tray. This engine uses a bank of *light-emitting diodes* (LEDs), not a laser, as its light source. Consumable components include a toner supply that lasts for 2,500 pages, and a drum good for 15,000 pages.

Casio LCS-130. This compact, light-duty engine is used in Qume's CrystalPrint series of printers. The LCS-130 engine uses *liquid-crystal shutter* (LCS) technology rather than lasers. In an LCS engine, the light source is a halogen lamp; pulses of electricity open and close an array of over 2000 liquid-crystal shutters, each 1/300 of an inch in diameter, to expose the drum. Proponents of LCS technology say it's superior because it requires fewer moving parts (it doesn't require a rotating mirror, for example) and provides greater precision and sharper images at the edges of pages. The truth is, LCS printers haven't been around long enough to prove claims of superior reliability. What's

more, because they don't use lasers, LCS-based printers cannot take advantage of the new resolution-enhancement techniques that are so popular today.



Laser Printer Controllers

Without a controller, a laser printer is little more than a mutant photocopier. The engine moves the paper, but the controller is in the driver's seat. In the Macintosh world, a laser printer's controller plays a large role in determining a printer's text- and graphics-printing capabilities. This section examines laser printer controllers. We discuss the types of controllers used in Mac-compatible laser printers and how a controller's design influences printing capabilities, networking features, and performance.

Controller Basics

The Mac and most other computers use a *raster* display, in which screen images are composed of hundreds of horizontal lines. Laser printers work similarly. Rather than inscribing scan lines on a video monitor, however, a laser printer draws them on the photo conductive surface of the engine's drum or belt. A letter-sized page of 300-dpi laser printer output contains over 3300 scan lines. Because laser printers are raster devices, their controllers are often called *raster-image processors*, or *RIPs* for short.

A controller's job is to accept printing commands from an application program and control the engine's exposure and paper-handling mechanisms accordingly. The most basic difference between controllers concerns the type of commands they use.

- PostScript printers, such as the LaserWriter IINT and NTX use Adobe System's PostScript page-description language. In a PostScript printer, the controller is a powerful computer unto itself, containing a 68000 or 68020 microprocessor, two or more megabytes of memory, and ROM chips containing printer fonts stored in outline form. The controller and engine are usually housed in the same case.
- QuickDraw printers, such as the Apple Personal LaserWriter LS and GCC Technologies' PLP II and PLP IIs, use QuickDraw commands. These printers use the Mac as the controller; when you print a document, the Mac performs many of the tasks that a PostScript printer's controller performs. This approach has important performance ramifications that we discuss later in this chapter.

PostScript Controllers

In the Mac world, most laser printers use controllers built around Adobe System's PostScript page-description language. You will find PostScript lurking within Apple's Personal LaserWriter NTR and LaserWriter IIf and IIg, QMS's PS-815 and PS-815MR, Texas Instruments' microLaser Turbo, Dataproduct's LZR-960, GCC Technologies' BLP and BLP Elite, and NEC's Silentwriter Model 95, to name just a few. All of these printers are completely compatible with the Mac.

But what is *PostScript*? At its foundation, PostScript is a programming language. But unlike general-purpose programming languages, such as BASIC and Pascal, PostScript was designed specifically for describing the appearance of printed pages. (A variation of PostScript called *Display PostScript* is designed to describe the appearance of screen displays.)

PostScript was created by Adobe Systems' founders John Warnock and Charles Geschke. The language is similar to another language Warnock helped design at Xerox PARC called *JaM* (short for John and Martin; Martin Newell worked on the language with Warnock). A variation of JaM eventually became Interpress, Xerox's page-description protocol. Warnock and Geschke founded Adobe Systems in 1982; the first printer to use PostScript was the Apple LaserWriter, introduced in January 1985.



PostScript and Fonts

This section takes a closer look at how PostScript printers use fonts. We will look at the fonts built into PostScript printers, how you can supplement a printer's built-in fonts, how TrueType fonts fit into the PostScript world, and how PostScript controllers manipulate fonts internally.

Built-in Fonts

All PostScript printers include a selection of built-in outline fonts stored in ROM chips on the printer's controller board. These built-in fonts are called *resident* typefaces. Most PostScript printers, including Apple's, contain 35 resident typefaces in 11 font families:

- *Helvetica* with oblique, bold, and bold oblique (remember from the previous chapter that the oblique style is a slanted variation of the upright, or Roman, style)
- *Times* with italic, bold, and bold italic
- *Courier* with oblique, bold, and bold oblique

- *Symbol*, which contains various mathematical symbols and letters of the Greek alphabet
- *New Century Schoolbook* with italic, bold, and bold italic
- *Palatino* with italic, bold, and bold italic
- *ITC Bookman Light* with light italic, demi, and demi italic
- *ITC Avant Garde Gothic Book* with oblique, demi, and demi oblique
- *Helvetica Narrow* with oblique, bold, and bold oblique
- *ITC Zapf Chancery Medium Italic*
- *ITC Zapf Dingbats*

The original LaserWriter and some older printers, such as QMS' PS-800, contain only the first three font families. Some current economy-priced printers (such as the GCC BLP Elite) also contain a smaller selection of fonts. Some printers contain the aforementioned fonts and add additional ones.

Screen Fonts versus Printer Fonts

Before examining PostScript controllers in detail, we need to draw an important distinction between *screen fonts* and *printer fonts*. Screen fonts are the bitmap fonts the Mac uses to display text on its video screen; as the previous chapter showed, you install and remove screen fonts using the Finder (or, in earlier system versions, the Font/DA Mover utility). Screen fonts are only facsimiles of true typographic fonts; the limited resolution of the Mac's screen makes it impossible to convey the delicate serifs and subtle strokes of true typographic fonts.

Printer fonts are separate font descriptions that swing into action when you print a document, describing for the printer what various typefaces look like. As you may recall from the previous chapter, LaserWriters and other PostScript printers use outline fonts; these outline fonts are printer fonts.

Printer fonts are usually stored on ROM chips within a printer, although as you learn later in this chapter, they also can be stored on a Mac's hard disk and transferred to the printer when needed. As we just mentioned in the previous section, most PostScript printers contain 35 printer fonts.

When you use a printer containing corresponding printer fonts, the screen fonts don't appear in the final output; instead, the printer uses its own resident fonts. Thus, a screen font is like an understudy who plays an actor's part during rehearsals, but defers to the star in the final performance.

Downloadable Fonts

You can supplement a PostScript printer's resident fonts with *downloadable fonts*—outline fonts stored in your Mac's System Folder and transferred, or *downloaded*, into the printer's memory before use. A vast selection of downloadable fonts is available from Adobe Systems, Bitstream, Agfa, Casady & Greene, and others. The Type 1, Type 3, Multiple Master, and TrueType typefaces discussed in the preceding chapter are all examples of downloadable fonts.

When you purchase a downloadable PostScript font—a Type 1, Type 3, or Multiple Master font—you need to install the outline font file in the System Folder's Extensions Folder, and the bitmap screen font in the System file itself. If you're using the Adobe Type Manager utility, you need install only one bitmap font size; ATM will use the outline font file to generate other sizes for you.

Downloadable fonts can be downloaded automatically or manually. With automatic downloading, the LaserWriter driver shuttles the fonts into the printer's memory during the print job; you don't have to perform any special steps to use the fonts. One font takes roughly 20 to 30 seconds to download. After the print job, the LaserWriter driver removes, or *flushes*, the fonts from the printer's memory, freeing up that memory for other fonts.

Downloadable font files have names assigned to them by the font developer. Adobe's American Typewriter Bold downloadable font, for example, is named AmeriTypBol. *Never change these names.* If you do, the LaserWriter driver cannot download the font automatically. (Curious about how the LaserWriter driver knows which file to download? The name of the downloadable font file is stored along with the bitmap font's FOND resource, discussed in the previous chapter.)

How to Download Fonts

To download fonts manually, you need a font-downloading utility, such as Apple's LaserWriter Font Utility (included with System 7) or Adobe's Font Downloader (included with Adobe font packages). If you're using the Apple LaserWriter Font Utility, first be sure your printer is turned on and ready. Next, choose Download Fonts from the File menu. When the Download dialog box appears, click the Add button; the LaserWriter Font Utility displays an Open dialog box you can use to locate and select the fonts you want to download (see figure 7.7).

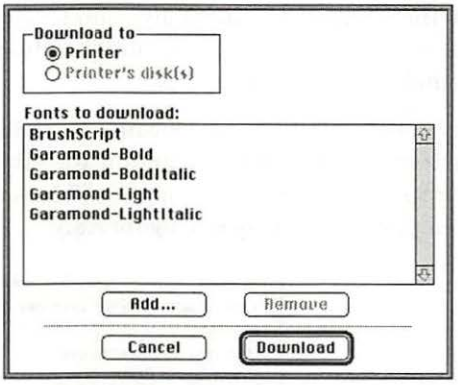


Figure 7.7: Selecting fonts to download.

After you select the fonts, click the Done button to close the dialog box, and then click the Download button. The utility keeps you posted during the downloading process and informs you if an error occurs.

As you can see, downloading fonts manually requires some effort on your part, but it has an advantage: manually downloaded fonts aren't flushed from the printer's memory after the print job. If you plan to use a specific font extensively, you can download it manually after switching on your printer. You will save 20 to 30 seconds on each subsequent print job containing that font. If you use several downloadable fonts extensively, the time savings really adds up.

You can even use the LaserWriter Font Utility to download TrueType fonts installed in the System file. After choosing the Download Fonts command, simply select the System file and click Add. Note that this adds every TrueType font in the System file to the list of fonts to download; if you don't want to download all the TrueType fonts, click Done to return to the font list, and then select the fonts you don't want and click Remove.

Downloadable Fonts and Memory

Downloadable fonts are stored in a reserved area of printer memory called *virtual memory*, or *VM*. A PostScript printer has a finite amount of VM available for downloadable fonts. The original LaserWriter offered approximately 200K of VM, room enough for about four downloadable fonts. Today's PostScript printers offer more memory and use that memory more efficiently. A printer with 2MB of RAM, for example, has between 400K and 500K of VM and can hold approximately eight downloadable fonts. (We say *approximately* in each case because the size of downloadable fonts varies according to the complexity

of the typeface. Incidentally, don't confuse a PostScript printer's virtual memory with the virtual memory features that System 7 provides; they're completely different entities.)

If you have Adobe's Font Downloader utility, you can find out how much VM your printer provides by choosing the Printer Font Directory command from the Special menu. The amount of VM available appears at the bottom of the font directory display (see figure 7.8.)

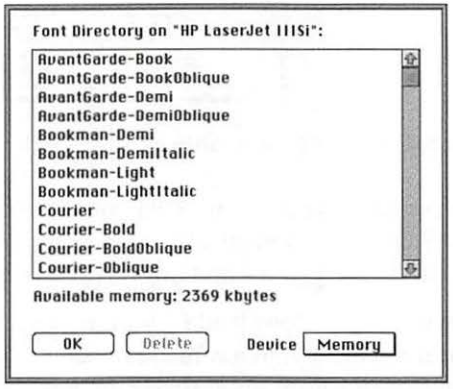


Figure 7.8: Determining available VM using the Adobe Font Downloader.

SCSI Font Storage

Some PostScript printers offer a SCSI connector that enables you to attach a SCSI hard disk to the printer. You can use the hard disk to hold downloadable fonts. When you store downloadable fonts on a printer hard disk, they need not be transmitted over AppleTalk; thus, printing times for documents containing downloadable fonts decrease significantly. Also, downloadable fonts stored on a printer's hard disk are available to all Macs on a network. Each Mac need not waste disk space storing the printer fonts. You can download fonts to a printer's hard disk using the Apple LaserWriter Font Utility or the Adobe Font Downloader.

The following printers are among those that accept an optional hard disk: Apple's LaserWriter IINTX, GCC's Business LaserPrinter, and Dataproducts' LZR-1260. Printers that include a hard disk as standard equipment include Agfa/Compugraphic's CG-400PS and P3400PS, Varityper's VT-600 and VT-600W, and the Linotronic series of typesetters.

How PostScript Handles Fonts

We mentioned before that PostScript fonts are stored as mathematical formulas called outlines. We also stated the primary benefit of font outlines: they enable the printer to create fonts in virtually any size, they use less storage space than a large selection of bitmapped sizes, and they enable the printer to create special text effects, such as condensed, expanded, and even rotated type, by simply interpreting the font outlines differently.

But the final step in printing a page involves creating a bitmap of the entire page in the printer's memory. When you print a document, the PostScript controller must translate font outlines into bitmaps that match the required type size and the resolution of the printer's engine. This outline-to-bitmap conversion process is among the most complex tasks a PostScript controller performs. Simplified somewhat, it works as follows:

- When a page calls for a character in a given size and orientation, the controller reads the outline description and generates a bitmap of the character in that size. During this process, the controller tweaks the shape of the character, adding and removing printer dots as needed, to produce the best-looking character possible at the engine's resolution. Each outline font contains special instructions called *hints* that make this optimization process possible.
- The controller stores the bitmap in a reserved area of printer memory called the *font cache*. The font cache keeps the character bitmap on the sidelines, so to speak. If that character is needed again later, the controller retrieves its bitmap from the font cache. According to Adobe, retrieving a character bitmap from the font cache is roughly a thousand times faster than recreating the bitmap from the original outline.
- The controller adds the bitmap to the page buffer, and continues interpreting the page description, generating font bitmaps as needed, and retrieving already-built bitmaps from the font cache when they exist.

The font cache is an important part of a PostScript printer's controller. If you're interested in some technical details on its operation, see the sidebar "Font Caching Details."

Technical Background: Font Caching Details

The font cache improves a printer's performance dramatically of printing documents containing a large variety of fonts, sizes, and styles. When the font cache fills, the controller discards characters on a least-recently used basis—the character bitmaps that were used least are flushed from the font cache.

The larger the controller's font cache, the more room there is for font bitmaps. When other factors, such as engine speed and processor type, are equal, a printer with a larger font cache will be faster than a printer with a smaller one. As a general rule, the more RAM a printer contains, the larger its font cache. If your printer accepts optional memory upgrades, you can expand its font cache by adding RAM. Adding memory also enables the printer to hold more downloadable fonts.

The ROM chips of most PostScript printers also contain prebuilt bitmaps of commonly used fonts and sizes. The LaserWriters, for example, contain the full ASCII character set in 10-point Courier, as well as letters, numbers, and common punctuation in 12-point Times and Helvetica. If a document requires these sizes, the controller retrieves the prebuilt outlines from ROM.

Most printers also build bitmaps for other sizes of Times and Helvetica in their spare time; that is, when they aren't processing a print job. This technique is called *idle-time font-scan conversion*. Font bitmaps created using this technique are stored in the font cache, just as if they had been generated for a specific document.

By the way, connecting a hard disk to a PostScript printer essentially enlarges the printer's font cache. When the printer's RAM-based font cache fills, the controller stores the characters that would otherwise be purged on the hard disk. Only when the disk-based font cache fills are its least-recently used characters purged. Generally, a PostScript printer divides a hard disk's capacity in half, using half for downloadable fonts and the other half as an extension of the font cache. If you attach a 20MB hard disk to a printer, for example, you give the printer the equivalent of a 10MB font cache. This is another good reason to attach a hard disk to a printer that provides a SCSI port.



More About Hints

We have mentioned that part of a PostScript controller's job is to optimize the appearance of each character to match the engine's resolution. Within each font outline are mathematical formulas, often called *hints* or *instructions*, that make this optimization possible. (You also might hear this optimization process referred to as *grid-fitting.)*

Hints are very important in the laser printer world. A 300-dpi printer may seem sharp, but its resolution isn't adequate to accurately render the subtleties of some fonts, particularly ones with delicate serifs (such as Baskerville) or line strokes whose widths vary slightly (such as Optima). By adjusting the position of the dots that form each character, hints enable a printer to produce the highest quality output possible, given the printer's resolution.

On the negative side, hints do compromise the design of a typeface because portions of characters need to be adjusted to fit within the printer's 300-dpi grid. As printer resolution grows, hints become less important because a higher-resolution printer provides a finer grid.

Special Typographic Effects

PostScript printers take advantage of the flexibility of font outlines to enable you to create text in virtually any size and orientation. PostScript can create text in any size from 1 point up to, according to Adobe, a character the size of the state of Rhode Island. (Rhode Island residents need not fear an invasion by such a colossal character. This upper limit represents PostScript's theoretical limits; no printer exists that could create it!)

Like the Mac itself, PostScript treats all elements of a page—text and images—as graphics. PostScript also provides a sophisticated array of commands, called *operators,* for rotating, scaling, shading, and otherwise manipulating graphics. Because text in PostScript is simply a type of graphic, PostScript printers can apply these operators to text to produce some remarkable effects. The most common PostScript effects are shown in figure 7.9.

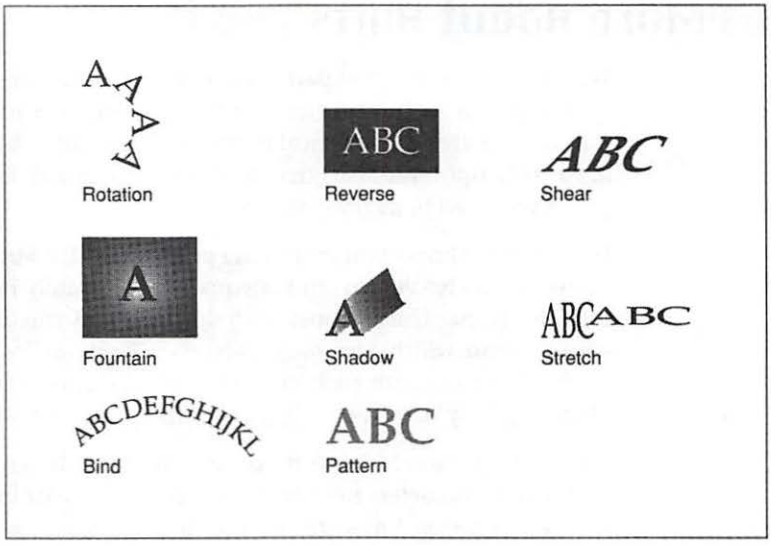


Figure 7.9: Common PostScript text effects.

Inside a PostScript Print Job

Each time you print a document to a PostScript printer, a complex series of events occurs.

- The Mac establishes a communications link with the printer; during this process, you see the `Looking for LaserWriter` message. (If you're running System 7 or System 6 MultiFinder with background printing activated, you don't see this or the following messages unless PrintMonitor's window is open.)
- The Mac checks to see if the printer contains Apple's custom PostScript *dictionary*, which adds new functions to the PostScript language that enable it to work better with QuickDraw. The dictionary also reprograms the printer to accept instructions from the LaserWriter driver, which transmits not standard PostScript commands, but a special shorthand that takes less time to transmit over a network. If the printer doesn't contain the dictionary, the Mac transmits it, and displays the `Status: Initializing printer` message. The dictionary remains in the printer's memory until the printer is switched off or reset.
- After the printer is initialized, the print job begins. The Mac's Print Manager works together with your application program and the LaserWriter driver to translate the QuickDraw commands that describe

the page's appearance into the PostScript shorthand that the printer has been programmed to recognize. This shorthand represents a computer program that the printer will execute in order to create the page. During this process, you see the `Status: Processing job` and `Status: Preparing data` message. If the page contains bitmapped graphics, such as MacPaint drawings or scanned images, the LaserWriter driver transmits the bits that represent the graphics.

- Meanwhile, within the printer's controller, the *PostScript interpreter* reads the program, interprets its instructions, and then creates a bitmapped image for the entire page in an area of the printer's memory called the *page buffer*. During this process, the interpreter may need to read the ROM-based printer font outlines in order to generate font bitmaps in the sizes required for the page. This process of converting the PostScript program into a bitmap is called *scan conversion*.

- The controller uses the resulting bitmap to govern the engine's imaging mechanism. After the page prints, the bitmap and the PostScript program are discarded.

PostScript's Advantages

Why use a programming language to describe the appearance of a page? Couldn't the Mac simply create the bitmap in its own memory, and then send it to the printer? ImageWriters and StyleWriters work that way; why can't laser printers?

Actually, they can. But PostScript's approach gives it far more printing flexibility. The PostScript approach—having the host computer create a program which is then interpreted by the PostScript controller—has several advantages.

Device independence. Because the Mac transmits PostScript to the printer rather than a bitmap for the page, your application programs need not know the resolution of the printer you're using. That means that you can use the same application programs to print the same documents on any PostScript printer, from a 300-dpi Personal LaserWriter to a 600-dpi QMS PS-815MR to a 2540-dpi Linotronic imagesetter. With a few minor exceptions, the only difference is increasingly sharper copy. (For information on those minor exceptions, see the section "Differences Between PostScript Printers," later in this chapter.)

Lower hardware overhead. Creating a bitmap for an entire page requires time and memory (for the latter, about 8 million bits, or one megabyte, for an 8-1/2 by 11-inch page, and even more for a legal-sized page). By handling the scan-conversion process and providing its own

page buffer, a PostScript printer frees the Mac's processor for other tasks and eliminates the need for the Mac to store huge bitmaps in memory or on disk.

Sharing potential. Because the PostScript interpreter and page buffer reside in the printer, you can attach multiple machines to the printer—a good way to make an expensive device earn its keep. Every PostScript printer contains ROM-based *print server* software that allows up to 32 machines to tap its talents. This print server software is what communicates with the Mac during the printing process.

Wide support. PostScript is supported on computers ranging from the Mac to the IBM PC to minicomputers and mainframes. If you equip your MS-DOS computers with LocalTalk network boards (described in Chapter 13), your PCs and Macs can access the printer across one network.

Flexibility. Because PostScript is a full-fledged programming language, it can be enhanced, or *extended*, to provide new features and functions. Using the font-editing programs we discussed in the preceding chapter, you can even alter PostScript fonts to create new typefaces.

PostScript's Drawbacks

For all their strengths, PostScript printers do have some drawbacks.

Cost. A PostScript controller is a powerful computer in its own right. Its microprocessor and all those RAM and ROM chips don't come cheap. And Adobe Systems charges licensing and royalty fees for its PostScript interpreters and outline fonts. As a result, a PostScript printer will always cost more than a QuickDraw printer.

Performance. A PostScript printer imposes fewer processing demands on the Mac, but it nevertheless takes some time to process pages in the printer itself. PostScript has always been criticized as being slow; today's PostScript interpreters are far faster than the original LaserWriter's, but few interpreters can keep up with their engines.

Differences Between PostScript Printers

All PostScript printers are compatible with the Mac and with each other. By saying that all PostScript printers are compatible with each other, we mean that you can print a given document on any PostScript printer and get the same results.

Well, almost. The fact is, there are differences between PostScript printers. The most significant differences include the following:

Processor. Some PostScript printers contain 68000 processors, while others contain 68020s, 68030s, or RISC processors. This difference shows up only on your stopwatch; 68000-based printers are generally slower than printers containing an 020, 030, or RISC processor.

PostScript versions. Adobe continues to improve its PostScript interpreters, and different printers contain different versions of PostScript. As a general rule, the later the version (that is, the higher its version number), the faster and more memory efficient the printer is. Some printers use PostScript Level 2, a new version of the PostScript interpreter that we will examine shortly.

Memory configuration. The original LaserWriter contained only 1.5MB of RAM; today's PostScript printers come with a minimum of 2MB, and some can hold a dozen or more megabytes. This disparity can work against you if you use downloadable fonts extensively. Assume that your office contains one printer with 4MB of memory, and another with only 2MB, for example. If you create a document using numerous downloadable fonts, you may be able to print it on the 4MB printer, but not on the 2MB printer. If you prefer the output quality of the 2MB printer—perhaps it provides some form of resolution enhancement—you will need to redesign the document and substitute resident fonts for some of the downloadable ones. The rule—when planning which fonts you want to use in a document, always work within the memory limitations of the printer that will produce the final copy.

Font configuration. If you print final copies of a document on a printer other than your own, verify that the final printer contains the same resident fonts as yours, or that the resident fonts it lacks are available in downloadable form. Again, the best policy is to design documents for the printer that will produce the final copy.

Engine resolution. Differences in print resolution can cause unexpected results when you print documents containing shaded areas, called *screens,* and fine lines, called *hairline rules.* A screen consists of a collection of dots; the more dots within the screened area, the darker the shade appears. The problem is that printers with different resolutions produce different-sized dots. A 300-dpi printer produces a dot 1/300 inch in diameter; a 2540-dpi Linotronic typesetter produces a dot 1/2540 in diameter. The result: when you print a screened area on a Linotronic, it appears much lighter than it does when printed by a 300-dpi printer. Hairline rules, which are one dot wide, also appear

lighter on imagesetter output for the same reason. The easiest way to avoid this problem is to use programs, such as Aldus PageMaker and QuarkXpress, both of which compensate for differences in printer resolution when printing screens and rules.

Bitmap smoothing capabilities. Of all PostScript printers, only Apple's contains routines for smoothing the rough edges of bitmapped (MacPaint-type) graphics. Smoothing can improve the appearance of some bitmapped graphics (see figure 7.10). Some application programs, including Aldus PageMaker, include their own smoothing routines, enabling them to print smoothed bitmaps on any PostScript printer. If you use applications that don't provide built-in smoothing, however, and if you prefer the smoothed look, consider an Apple PostScript printer.

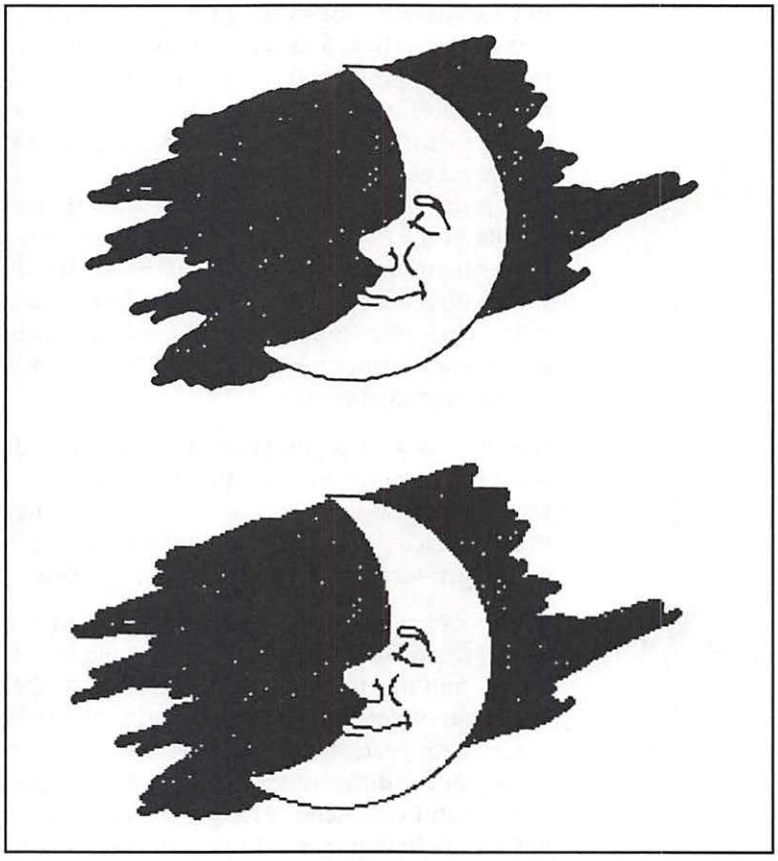


Figure 7.10: A smoothed bitmap and unsmoothed bitmap.

Emulation modes. Most PostScript printers can imitate popular non-PostScript printers. The most common *emulation mode* enables the printer to act like a member of the Hewlett-Packard LaserJet family. Some printers also can imitate a Hewlett-Packard plotter by providing support for the Hewlett-Packard Graphics Language (HPGL). Because these non-PostScript printers lack PostScript's versatility, an emulation mode will always turn a PostScript printer into something with inferior text- and graphics-printing features. Still, if you use MS-DOS software that doesn't support PostScript, emulation modes will at least allow you to take advantage of the printer's sharp copy and fast print engine. Some printers force you to flick switches to change operating modes or connectors, but many provide *emulation sensing*: if incoming data isn't PostScript, the controller switches to the appropriate emulation mode automatically. In these smarter controllers, all connectors are active simultaneously; when one begins receiving data, the others go on hold.

Interfaces. All PostScript printers provide a LocalTalk connector for use with Mac networks, and an RS-232C serial connector for use with other computers. Some printers also provide a Centronics parallel port for use with IBM PCs. Some high-performance printers also provide Ethernet network ports, which can accept data faster than a LocalTalk port. Ethernet is preferable to LocalTalk if you print large grayscale scanned images frequently.

Paper-handling features. Some printers provide dual paper trays that enable you to mix and match paper sizes and types. Linotronic typesetters use photographic film or paper rather than single sheets of paper. To enable users to take advantage of specific printer features, Adobe developed *Adobe printer descriptions* (APDs) files that contain information about a printer's features, from the number of paper trays it provides to its output resolution. Most printers that offer unusual paper-handling features or resolutions other than 300 dpi include an APD file. Application programs can read an APD and adjust their Page Setup and Print dialog boxes to reflect that printer's features. If the printer's resolution is other than 300 dpi, applications also can adjust the way they print hairline rules, screens, and halftones. Unfortunately, at this writing, only a few publishing and illustration programs support APDs. (APDs are also referred to as *PPDs—PostScript Printer Description* files.)

Some printers also include customized versions of the LaserWriter driver that enable you to access unique engine and resolution features. If you're buying a printer that offers dual paper trays or other unique features, be sure it includes a driver that enables you to take advantage of these features.

Shades of Gray: Halftoning Capabilities

Another important difference you may encounter between PostScript printers concerns their capability to print grayscale scanned images and gray shades (called *screens* in printing parlance). Like a printing press, a laser printer cannot print shades of gray. To reproduce a photograph, the printer must use a printing-industry technique called *halftoning*, in which the image is converted into dot patterns, with larger dots representing darker gray shades, and smaller dots representing lighter ones.

Halftones are described in terms of lines per inch (lpi); the more lines per inch a halftone contains, the less apparent the dots become, and the better the image appears. Newspaper halftones generally contain 65 lpi; high-quality magazine halftones usually have 120 or more lpi.

A laser printer produces halftones by combining printer dots into larger groups called *cells*. The greater a printer's output resolution, the better the quality of halftones the printer can produce because each halftone cell can be smaller. For a 300-dpi printer that doesn't provide any form of resolution enhancement, the practical upper limit is a 53-lpi halftone; a 600-dpi printer can produce 70- to 80-lpi halftones with 40–50 gray levels. Linotronics and other high-resolution imagesetters can produce 120-lpi halftones with about 100 gray levels.

Some printers, such as Apple's LaserWriter IIg, provide grayscale-enhancement features that finely control the printer's laser beam to yield higher-quality halftones. Apple's grayscale-enhancement technology is called *PhotoGrade*, and it out-grays all but the imagesetters: by finely controlling the printer's laser, PhotoGrade can produce 106-lpi screens containing 67 gray levels. The results don't approach the quality of imagesetter or conventional halftones, but they're still excellent. PhotoGrade also applies its talents to gray-shaded (screened) text and graphic shapes.

To accommodate the extra bits required to print 106-lpi screens, PhotoGrade requires a 4MB page buffer (that area of printer memory that holds the bits that become dots on the page); a 300-dpi printer normally requires only 1MB page buffer for letter-sized pages. Slightly more than 4MB are required to print PhotoGrade images on legal-sized paper. PhotoGrade also is built into Apple's LaserWriter IIf, but you need to expand the IIf's memory to at least 5MB in order to use it. Figure 7.11 shows portions of a 53-lpi halftone printed on an Apple LaserWriter IINTX and on an Apple LaserWriter IIg.

Because toner, engines, and printing environments vary, Apple has provided a way to calibrate PhotoGrade to provide the most accurate grays. You use an accompanying utility program to print a variety of test pages and then choose a command that tells the printer which you prefer. You also can change the printer's default halftone screen, choosing from five settings: 53, 75, 83, 106, and 150 lpi. The printer remembers your settings until you change them.

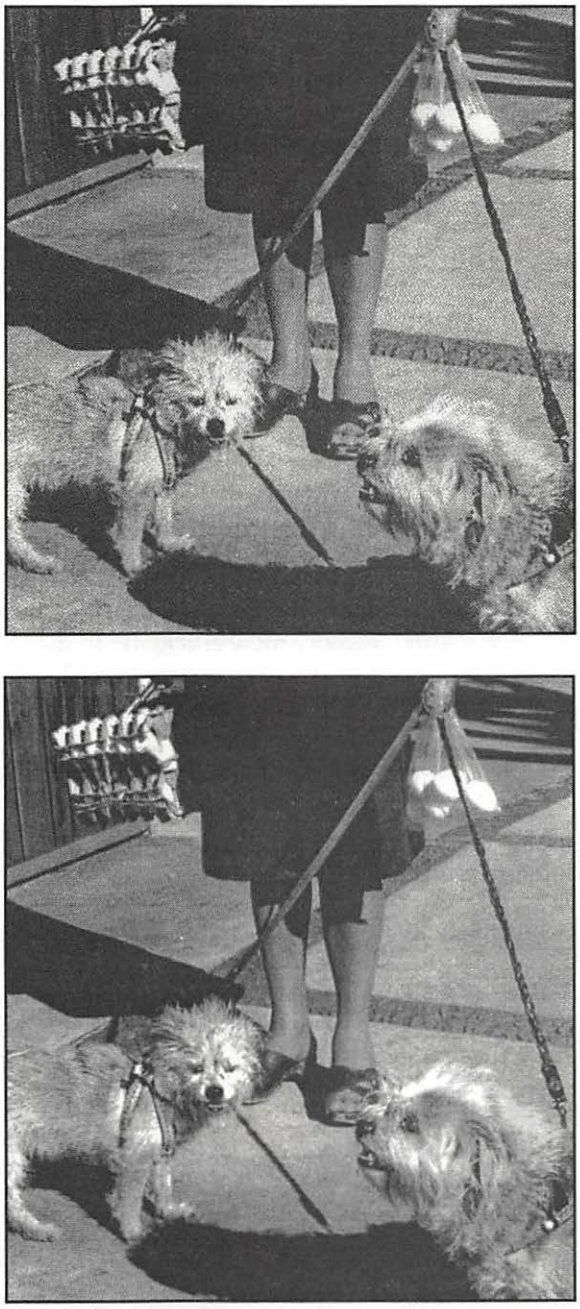


Figure 7.11: A standard 53-lpi halftone (top) and its PhotoGrade-enhanced counterpart, printed on a LaserWriter IIg (bottom).

PostScript Level 2

PostScript Level 2 has dozens of new features, many of which are geared toward imagesetters and the growing color printer market. But many of Level 2's enhancements also affect the monochrome page printer market. The following are among them:

Image decompression. A Level 2 interpreter can decompress images as it processes jobs. This enables you to conserve disk space and memory and reduce network traffic by storing and printing images in compressed form.

Forms caching. PostScript Level 2 can store, or cache, elements that repeat from one page to the next. This can speed printing dramatically because the interpreter need not process the elements' fonts and graphics for every page. A repeating element may be as complex as a tax form or as simple as a header in a word-processed report. Alas, application software developers will need to modify their programs before you can take advantage of forms caching.

Improved printer memory management. A Level 2 printer can allocate its internal memory more efficiently to match the job at hand, providing better performance. PostScript Level 2 also allows for better support of printer-specific features, such as multiple paper trays. But at this writing, support for this and many other Level 2 features isn't provided by Apple's print driver (the LaserWriter file).

PostScript Clones

In 1989, a new wrinkle formed in the issue of PostScript compatibility when several firms released printers containing non-Adobe PostScript interpreters. In these so-called *PostScript clones,* the interpreter is designed to act just like an Adobe PostScript interpreter—just as, in the MS-DOS world, a Compaq or Tandy computer is designed to act like an IBM.

It may surprise you, but IBM computers are easier to clone than a PostScript interpreter. As the preceding sections have shown, PostScript is an extremely complex language in which myriad factors interact in countless ways to produce a page of output. The only way for a clone developer to judge a PostScript clone's compatibility is to run test after test, making adjustments in the interpreter as needed. If you're a clone developer, the tricky part is determining when you have run enough tests. Every document is different, and thus creates a different state within the controller. A hundred documents may print perfectly, but as we've seen in our own work with PostScript clones, the hundred and first may crash the interpreter.

One measure of compatibility that clone developers use is to say their interpreters are *red-book compatible.* This means that the interpreter acts like an Adobe interpreter, as described in the red-covered book, *PostScript Language Reference Manual* (Addison-Wesley). Red-book compatibility is desirable, but it isn't a guarantee that a PostScript clone will print every document thrown at it.

Older PostScript clones could not use Type 1 downloadable fonts because the fonts' hints were stored in an encrypted format that only an Adobe PostScript interpreter could read. When Adobe published the specifications of the Type 1 font format, however, clone developers added Type 1 compatibility to their interpreters. Many clones still don't deliver the same high quality results as a true Adobe interpreter, however. And other compatibility problems can surface when printing complex fonts, such as Adobe Multiple Master fonts or the flashy display fonts sold by Letraset.

What advantages does a PostScript clone offer? Clones often are much faster than printers that use Adobe interpreters. Clones, such as Qume's CrystalPrint Publisher, use special processors called *reduced instruction-set computers*, or *RISC* for short. RISC processors are streamlined to perform common tasks more quickly than conventional processors, such as the 68000 and 68020.

But PostScript clones aren't always faster. In particular, they tend to be slower at printing bitmapped graphics, such as MacPaint drawings and scanned images. Adobe has optimized the way its interpreters handle bitmapped graphics so that even a RISC-equipped clone can't keep up.

You're also unlikely to notice the extra performance of a PostScript clone if you primarily print simple, text-oriented documents, such as manuscripts or legal contracts and briefings. When printing simple text documents, the printer's print engine becomes the most important performance-determining factor. An Adobe PostScript printer with a 10 page-per-minute engine will print a text-only document more quickly than a clone with a 6-ppm engine.

We feel that the jury is still out on PostScript clones. If your needs dictate a PostScript printer, you're probably better off with one containing a true Adobe interpreter.

TrueType Fonts and PostScript Printers

We mentioned earlier that TrueType fonts aren't tied to PostScript in any way. Fortunately, however, you can print TrueType fonts on a PostScript printer. Versions 6.1 and later of Apple's LaserWriter printer driver enable TrueType and PostScript fonts to coexist peacefully. Here's what happens when you print a document using LaserWriter driver version 6.1 or later:

1. First, the LaserWriter driver looks in the printer to see if the required fonts are located in its RAM or ROM or on a hard disk attached to the printer. If the fonts are found, the job proceeds.
2. If the fonts aren't present in any of those places, the LaserWriter driver looks in the System Folder for downloadable PostScript fonts. If they're found, they're downloaded and the job continues.
3. If the downloadable PostScript fonts aren't in the System Folder, the LaserWriter driver looks in the System file for TrueType outline fonts.
4. If the TrueType fonts are present, the driver queries the printer to determine if it contains the TrueType rasterizing software, which enables the printer to translate TrueType outlines into the sizes required for the job. If the rasterizing software isn't present in the printer, the driver downloads it to the printer's memory, where it remains until the printer is restarted or switched off. The TrueType rasterizer uses about 50K of printer memory, reducing the amount available for downloadable fonts. You will feel the crunch more if you have an older LaserWriter or the base models of Texas Instruments' microLaser PS17 or PS35, both of which contain just 1.5MB of memory.
5. When the driver is satisfied that the printer contains the TrueType rasterizer, it downloads the fonts themselves. The printer's controller then uses the TrueType rasterizer software to create the sizes needed.

There's one catch in this routine: the LaserWriter driver's TrueType rasterizer works only in printers containing 68000-family processors. If you print a TrueType font on a RISC-based printer, the LaserWriter driver must convert the font into a Type 1 PostScript font, which then downloads to the printer. This convert-and-download routine can be slow, especially when you print from Mac Classics, Pluses, or SEs. If you're buying a RISC-based printer that does not include the TrueType rasterizer, you may want to steer clear of TrueType fonts. Note that this recommendation does not apply to Apple's Personal LaserWriter NTR, which does contain the TrueType rasterizer.

Ten Tips for PostScript Printers

Here's a collection ten tips for PostScript printers.

Disabling the startup page. All PostScript printers print a startup page listing details, such as resident fonts, memory configuration, and current operating mode. In addition to listing vital statistics, the startup page shows that the printer's controller and engine are operating properly. It also wastes a sheet of paper each time you switch on the printer, however, and lengthens the printer's startup

process by the amount of time taken to describe and image the startup page. The easiest way to disable the startup page is to pull the printer's paper tray out an inch or two before or after you power up the printer. When the printer's activity light stops flashing, you can push the tray back in.

You can disable the startup page easily using Apple's LaserWriter Font Utility. Simply choose Start Page Options from the Utilities menu and click the Off button.

If you don't have the LaserWriter Font Utility but you do have Adobe's Font Downloader, follow these steps.

1. Use a word processing program to type the two-line PostScript program that appears in Figure 7.12.
2. Proofread it carefully and then save the program in text-only format.
3. Use the Adobe Font Downloader to transmit the file to your printer. To send the file, choose Download PostScript File from the program's File menu.

```
serverdict begin 0 exitserver
statusdict begin false setdostartpage end
```

Figure 7.12: PostScript program for disabling startup page.

The program disables the startup page by setting PostScript's dostartpage value to "false." This value is stored in a non-volatile area of memory called the *status dictionary*. To restore the startup page, replace the word *false* in the second line of the program to *true*, then download the program again.

Note that some printers also provide front-panel buttons that enable you to disable the startup page.

Understanding font substitution. Generally, you should avoid fonts such as New York, Geneva, and Monaco. These fonts don't have PostScript counterparts. When you print a document containing them, one of two things will happen, depending on whether the Page Setup dialog box's Font Substitution option is selected.

If font substitution is activated, the Mac substitutes Helvetica for Geneva, Times for New York, and Courier for Monaco. Because the fonts' spacing doesn't match that of Geneva, Times, or Monaco, however, the printed output will appear irregularly spaced. If font substitution is disabled, the Mac transmits the TrueType versions of the fonts to the printer.

Creating a print file. You can create a disk file containing the commands the LaserWriter driver transmits to the printer. To do so, select the PostScript File option in the Print dialog box. The Print button's name changes to read Save; when you click Save or press Return, you will get a standard Save dialog box that enables you to name the resulting PostScript file. (If you're using a system version prior to 7.0, you won't see the PostScript File option; instead, you must press Command+F within one second after okaying the Print dialog box. The Mac names the resulting file PostScript0. If you create additional print files, they're named PostScript1, PostScript2, and so on.) You can download the resulting print files to a printer using the Adobe Font Downloader's Download PostScript File command.

One use for this print-to-disk technique is to create a print file for subsequent printing at an imagesetting service bureau. Before using this technique, however, check with your service bureau for instructions on how to prepare documents for typesetting. Some bureaus prefer to work with original documents rather than print files.

Changing the printer's name. Using an Apple utility called *The Namer,* you can change your printer's name, which appears in the Chooser and on the startup page. If you have more than one printer, use The Namer to give each one a descriptive name, such as "1st Floor Printer" or "Accounting Printer." Printer names can be up to 31 characters long, but cannot contain the colon (:) or at-symbol (@) characters.

Avoiding LaserWriter driver conflicts. If you share a PostScript printer on a network, be sure that all Macs are using the same version of the LaserWriter driver. If they aren't, your network's users frequently will see error messages telling them that the printer will need to be restarted and reinitialized because it was initialized with an incompatible version of the LaserWriter software. If all Macs on your network use the same version of the driver, this problem will not occur.

Using the Precision Bitmap Alignment option. When you print a 72-dpi bit-mapped graphic (such as a MacPaint image) that you have pasted into another application, the LaserWriter driver scales it up to 300 dpi. Because 300 dpi isn't an even multiple of 72 dpi, the graphic can appear distorted. To avoid this distortion, choose the Page Setup command, click the Options button, and then choose the Precision Bitmap Alignment option. This option reduces the entire page by four percent (to 288 dpi), thus avoiding bitmap distortion (see figure 7.13).

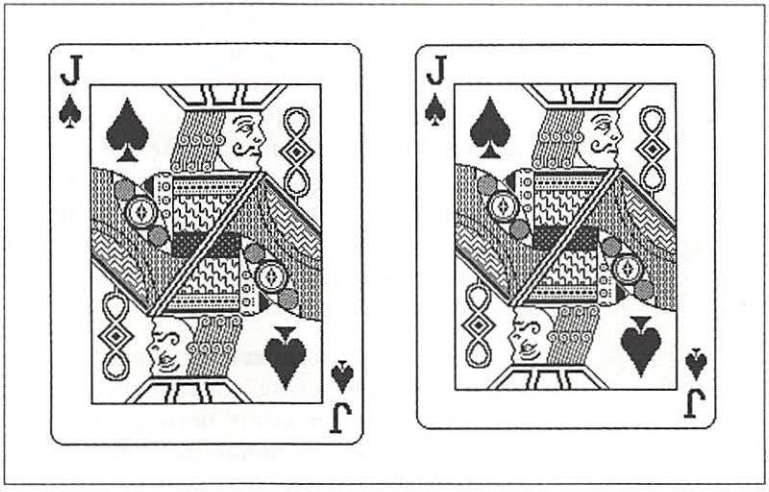


Figure 7.13: A bit-mapped image printed without Precision Bitmap Alignment (left) and with it (right).

Using more downloadable fonts. Tired of running out of printer memory when using downloadable fonts? If you don't mind longer printing times, you can use an unlimited number of downloadable fonts in a document. Choose the Page Setup command, click the Options button, and then choose the Unlimited Downloadable Fonts in a Document option. When this option is active, the LaserWriter driver flushes each downloadable font from the printer's memory when that font is no longer needed.

Sharing downloadable fonts on a network. We have mentioned that adding a laser printer hard disk eliminates the need to store downloadable fonts in every Mac's System Folder. If you use System 7's built-in file sharing or network file server software, such as AppleShare, you can avoid storing downloadable fonts on every Mac another way: the *Tactic Software's FontShare* utility. FontShare enables all the Macs on a network to access downloadable printer fonts stored on the file server. FontShare instructs the Mac to look for downloadable fonts in the file server volume that you specify if the fonts aren't found in your System Folder. You also can share downloadable fonts if you use a resource-management utility, such as Suitcase II or MasterJuggler.

Printing envelopes. Look in many laser printer-equipped offices, and you will probably notice a typewriter tucked in the corner with a stack of envelopes next to it. Most laser printers that have manual feed slots can accept envelopes, but formatting text for an envelope often seems like more trouble than it's worth.

The easiest way to print envelopes is to use a desk accessory called *Kiwi Envelopes*, available from on-line information services and through user's groups. With Kiwi Envelopes, you simply type (or paste from the Clipboard) the return address and addressee's address; Kiwi Envelopes automatically formats the text appropriately. (The latest version of Kiwi Envelopes is a commercial program and offers additional features, including a page-preview option and the capability to print postal service bar codes on envelopes.) If you print mailing labels extensively, you might consider a label printer, such as CoStar's AddressWriter.

Choosing paper. Laser printer engines are close cousins of photocopier engines, so you can generally use any paper designed for photocopiers. You will get better results, however, by choosing a paper designed for high-quality laser printer output, such as Hammermill Laser Print or Laser Plus. Both papers are identical, with one exception: Laser Plus contains a *wax hold-out,* a special coating on the paper's reverse side that enables you to apply rubber cement, spray adhesive, or graphic arts wax without it soaking through.

You also can print mailing labels on a laser printer if you choose your label stock carefully. Use labels specifically designed to be run through laser printers or photocopiers. Other types of labels can peel off as they travel through the print engine, or their adhesive can melt under the heat and pressure of the fusing rollers. Either way, you will develop a new appreciation for the phrase *gumming up the works.*

QuickDraw Laser Printers

PostScript printers don't have a monopoly on the Mac laser printer world. Some laser printers are available that don't use PostScript, but instead, rely on QuickDraw, the Mac's built-in library of graphics routines. They are *GCC Technologies' PLP series*, *Apple's Personal LaserWriter LS* and the now-discontinued *LaserWriter IISC* and *Personal LaserWriter SC.*

GCC Personal LaserPrinter

GCC's Personal LaserPrinter (*PLP*, for short) was the first non-PostScript laser printer offered for the Mac. Today's members of the PLP family include the 4-ppm PLP II and the 8-ppm PLP IIs. Although the PLP II printers aren't PostScript printers, they share the following with PostScript printers:

- They use outline fonts, giving them the capability to create a virtually unlimited range of type sizes. The PLP II includes 21 fonts; the PLP IIs includes 38.

- They use a font-caching mechanism similar to that of a PostScript printer.
- They include a selection of pre-built font bitmaps for often-used fonts and sizes.

The big difference between the PLP and a PostScript printer, however, is where the processing takes place. The PLP uses the Mac's memory and processor to perform the tasks that, in a PostScript printer, occur within the controller—tasks such as generating font bitmaps from the original outlines, caching font bitmaps, and generating the commands that control the print engine. Because the Mac handles these jobs, the PLP doesn't require its own processor and memory chips. Thus, it costs far less than a PostScript printer while offering nearly the same typographic versatility. If you use System 7, you also can share a PLP on a network. Figure 7.14 summarizes how the PLP processes print jobs.

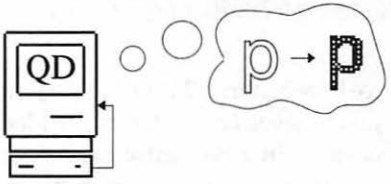
The PLP does have some drawbacks. It can be slow because its software must share processor time and memory with the program you're running. The faster your Mac and the more memory it contains, the faster the PLP operates. On Macs containing only 1MB of memory, the PLP often requires a two-step printing process which involves creating a disk file containing the print instructions, and then running a separate application program to produce the document.

The PLP series is also compatible with TrueType and Adobe Type Manager. Overall, the PLP is a second-best alternative to a PostScript printer. But if your budget prevents the purchase of a PostScript printer, a PLP deserves consideration. As your needs grow, you can have the printer upgraded to the PostScript-based BLP.

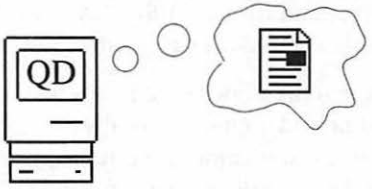
Apple Personal LaserWriter LS

The *Personal LaserWriter LS* is built around the Canon LX engine used in the Personal LaserWriter NTR. Like the Personal LaserWriter NTR, the LS does not include the 250-sheet paper tray found in Apple's LaserWriter II line; only a 70-sheet multipurpose tray is included, and a 250-sheet tray is an extra-cost option. The LS also eschews SCSI and LocalTalk in favor of a simple serial connection. The printer's controller board is simple, containing fewer than a dozen components, one being a custom-designed chip that manages a sophisticated compression scheme that enabled Apple to build just 512K of memory into the printer. (Other laser printers require a megabyte of page buffer memory.) The Personal LaserWriter LS includes 39 TrueType fonts and is also compatible with Adobe Type Manager.

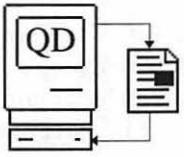
Step 1: The PLP driver reads font outlines from the hard disk and constructs bit maps in the sizes required for the page.



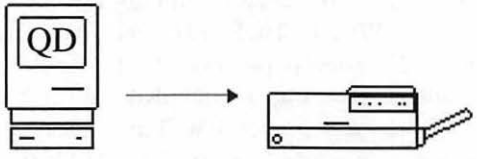
Step 2: The PLP driver works with QuickDraw to produce a bit-mapped image of the page in the Mac's memory.



Step 3: The PLP driver stores the bit map on disk as it's being prepared.



Step 4: The PLP driver transmits the bit map to the printer over the SCSI bus, timed to match the rotation of the drum in the printer's engine.



Step 5: The PLP's engine prints the page.

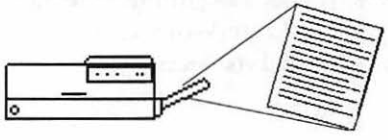


Figure 7.14: The way in which the GCC Personal LaserPrinter operates.

PLP or Personal LaserWriter LS?

So which QuickDraw printer is better? The PLP II and PLP IIs print-driver software provides more features than Apple's Personal LaserWriter LS driver. The PLP printers can enlarge or reduce output in 1 percent increments; the Personal LaserWriter LS can print at actual size (100 percent), 75 percent, and 50 percent. The PLP driver also includes a page preview option that enables you to view a page on-screen rather than wasting toner and paper.

Previous versions of the PLP software didn't support the background printing option of System 7 and System 6 MultiFinder, but versions 4.0 and later do. (Current PLP owners can upgrade to version 4.0 for a nominal fee.) And as mentioned earlier, if you use System 7, you can share a PLP with several other Macs on a network. You can't share a Personal LaserWriter LS on a network unless you buy a third-party utility, *Gizmo Technologies' ShadowWriter*. The PLP II series printers also can hold more paper—up to 250 sheets.

But the Personal LaserWriter LS isn't entirely out of the running. The GCC PLP II models connect to the Mac's SCSI port, and each provides just one SCSI port rather than the usual two. This can mean connection headaches if you have additional SCSI devices, such as an external hard drive or scanner. The Personal LaserWriter LS connects to the Mac's printer or modem port—a simpler scheme. (If your modem and printer ports are occupied already, you may want to buy a serial switch box to avoid having to detach and reattach cables.) The Personal LaserWriter LS also uses the superior Canon LX print mechanism that is easier to set up than the PLPs' Okidata engine.

Apple's Discontinued Laser Printers

Apple laser printer line has seen several generations, and early models often are available in the used market. Should you consider one? Here are some capsule looks at Apple's discontinued lasers and the upgrades available for them.

LaserWriter and *LaserWriter Plus*. These are bulky beasts, but their rugged, 8-ppm engines have proven themselves over the years. The LaserWriter's controller contains just 13 fonts and is very slow by today's standards. Xante Corporation sells an upgrade board that turns the LaserWriter or LaserWriter Plus (and many other printers) into a fast, 600-dpi PostScript clone.

LaserWriter IINT, IINTX, and *IISC*. All three use the Canon SX engine, and all three can be upgraded to the LaserWriter IIf or IIg. An Xante AccelaWriter upgrade also is available for these printers, but we prefer the true Adobe PostScript provided by the IIf or IIg upgrades.

Personal LaserWriter SC. This 4-ppm, Canon LX-based QuickDraw printer can be upgraded to the PostScript-based Personal LaserWriter NT (which, itself, has been discontinued).

Personal LaserWriter NT. This Canon LX-based PostScript printer was very popular when Apple replaced it with the RISC- and PostScript Level 2-based Personal LaserWriter NTR. An upgrade to the NTR is available. (Note that the Personal LaserWriter NT can't print Adobe Multiple Master fonts.)

When considering a used laser printer, you can gauge how heavily it's been used by determining how many pages it has printed. With PostScript printers, this is easy: the printer prints a page count on its startup page.

CHAPTER

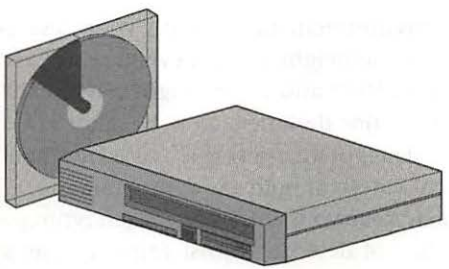
8

HARDWARE TIPS

WHAT'S INSIDE

- Health concerns—how to set up your Mac to create a healthy work environment
- Tips for connecting and disconnecting add-ons
- Take-care tips for keeping your Mac up and running
- How to attach your Mac to a sound system for better sound quality
- Tips for PowerBooks—extending battery life, transporting a PowerBook, coming to terms with the trackball, and more

One of the gaps that separates novice from master is a knowledge of the little tips and techniques that help you get the most from a computer. The next few chapters are a collection of these tips and techniques, starting with the Mac's hardware.



Healthy Computing

Hardware manuals tell you how to hook up cables and cords, and they often provide ventilation guidelines for keeping the equipment healthy. But what about *your* health? Paying attention to how your hardware is physically organized can make your computing time more efficient and less of a strain on your back, neck, wrists, ears, and eyes.

This chapter begins by examining some factors to consider when setting up your system with the goal of helping you create a comfortable, reliable, and efficient working environment.

Trend: Computer-Related Injuries on the Rise

Here is one trend we are not happy to report. Computer-related health problems are increasing. Most computer-related ailments are lumped into the broad category of *repetitive-stress injuries* (*RSI*), with the most common being *carpal-tunnel syndrome,* in which the nerve passing through the wrist becomes pinched by swollen tissue. According to Deborah Branscum's "Conspicuous Consumer" column in *Macworld* magazine, the caseload at the Repetitive Motion Institute (in San Jose, California) grew from 3500 patients in 1986 to 9000 in 1990—and most patients were computer users.

Carpal-tunnel syndrome often begins with a numbness of the hands and fingers. If ignored, it can progress into burning pain and permanent damage that can severely impair your hands—for life. Anyone is prone to an RSI, even if you have been using a computer for years.

That's the bad news. The good news is that many RSIs can be prevented by following a few simple rules and keeping your health in mind when equipping your workstation.

Desk and Chair Height

A comfortable working environment begins with your desk and chair. The height of a desk influences the height of the keyboard and also the angle at which you view the screen. Desk and chair height have no carved-in-stone rules, but architects and interior designers *do* have guidelines. According to *Interiors* magazine, the ideal height for a desk that is used for typing is 27 inches. The seat height for such a desk should be approximately 17 inches. This combination enables you to keep your wrists level when typing—an important posture that forms one line of defense against carpal-tunnel syndrome and other wrist-related injuries.

As for the chair, don't skimp and use a cheap one. Look for a chair that allows you to adjust seat height and tilt, and also the tilt of the back itself. Following are some guidelines for determining which chair is best for you:

- Your back should be angled backwards a few degrees to avoid constricting blood flow between your thighs and torso and to avoid excessive spine compression.
- Your thighs should be at a right angle to your torso.
- Your feet should be flat on the floor.
- Your arms and wrists should be level as you type.

If you have a chair with arm rests, avoid using them when you type if they force you to compromise this position.

If you're designing a new office, pay special attention to the science of human-factors engineering. Two excellent sources of information are *Anthropometry for Designers* (Van Nostrand Reinhold, New York, 1981) and *Interiors* magazine (1515 Broadway, New York, NY 10036). You also may want to read *Safe Computing* (Peachpit Press).

Stay Healthy: Limber Up and Take Breaks

One of the reasons why more and more computer users are suffering from physical ailments is simple: they work too hard. When you're using a computer, it's easy to lose track of time and become absorbed in your work. You don't have to stop periodically to insert a fresh sheet of paper or get up to sharpen a pencil.

The solution is to take breaks from the keyboard or mouse. Do something else for at least ten minutes every hour. Stand up to stretch. Every half hour or so, wave your arms and hands around to get the blood flowing.

A subtler reason computers are crippling users is that people don't prepare for the rigors of keyboarding. Stroking keys may not be as strenuous as moving pianos, but it does stress the delicate tendons and bones in your wrists, arms, and hands—especially if you type or use a mouse for hours at a time. An athlete wouldn't run a race without limbering up, nor should your hands sprint across the keyboard. Here are a few simple exercises you can perform. Spandex is optional.

- Clench your fist tightly, then open, fanning out your fingers. Repeat this procedure five times.
- Grasp the fingers of one hand and gently bend back the wrist. Hold for five seconds, then repeat for the other hand.

- Grasp the thumb of one hand and gently pull down until you feel the stretch. Hold for five seconds, then repeat for the other hand.
- Massage the inside and outside of each hand with the thumb and fingers of the other hand.

Screen Viewing Angle

Many people who use compact Macs, such as Classics, complain that the screen is too low, forcing them to unconsciously crane their necks until they ache. The solution is simple: angle the Mac upward slightly. Kensington Microware, Ergotron, and Basic Needs offer a variety of tilt-and-swivel bases for compact Macs.

For a less expensive alternative, visit your local hardware store and buy a package of rubber ironing board feet roughly 1 1/2-inches long and 1 inch in diameter. Two of them placed under a compact Mac's two front feet position the machine and the screen at a comfortable viewing angle. The weight of the computer keeps them in place.

As for Macs with separate monitors, most monitor manufacturers offer optional tilt-and-swivel bases for their wares; some even include them with the monitor. (Apple's Macintosh Color Display includes a tilt-swivel base.) Many computer-supply houses also sell swiveling monitor platforms that attach to desks with clamping mechanisms. The advantage of such a platform is that you can regain some desk space by swinging the monitor out of the way when you aren't using it.

Whether you need such a tilt-and-swivel monitor base depends in part on whether your monitor sits on top of your Mac. And that depends on where you put your Mac.

Accommodating the Biggest Macs

Many Mac II, IIx, and IIfx owners don't want to donate half of their desks to their computers, and understandably so. The solution is to put the machine on its side, on the floor. But do observe the following precautions:

- Leave space under the machine. The II, IIx, and IIfx have vents on both sides of their cases that must be unobstructed. The best way to place one of these Macs on the floor without suffocating it is to use Kensington's Macintosh II Stand. Kensington also sells extension cables for the monitor, keyboard, and mouse; depending on how far apart your machine and desk are, you may not need them.

- Position the machine with the power light closest to the floor. That way, the floppy disk drives will be within arm's reach and further away from the dusty floor, and you will be able to reach the machine's reset switch.

Accommodating Other Macs

You also can position a IIci, IIcx, or Quadra 700 to operate vertically—just remove and reattach the rubber feet as described in the manual. You don't need any special stands or brackets.

The IIvx, IIvi, and Performa 600 models are designed for horizontal operation, but they do work if positioned vertically. In fact, an engineering source at Apple tells us that the IIvx, IIvi, and Performa 600's internal cooling is actually improved if the machine is set on edge so that one set of vents is blocked.

Quieting Noisy Peripherals

ImageWriters and many external hard disks are whiners. If you're sensitive to noise, you can do something about it. To make a noisy printer less obtrusive, consider putting it in an *acoustic enclosure,* a large box lined with sound-absorbing material. Acoustic enclosures have openings for paper and cables, and most have see-through acrylic doors that enable you to visually verify that the printer is working properly. Enclosures for Apple ImageWriter printers are available from computer-supply houses, such as Global Computer Supplies and Inmac Corporation.

The best way to quiet an external hard disk is to get away from it. By using Apple's SCSI Cable Extender (Apple part number M0208), you can move an external hard disk farther away from your machine. A Cable Extender is a three-foot SCSI extension cord that connects between the SCSI System Cable (the cable that attaches to the Mac) and the SCSI device. You can attach numerous SCSI Cable Extenders to each other; just be sure the total length of all your SCSI cabling doesn't exceed 20 feet. Be sure to put the drive itself in a clean, well-ventilated area that isn't prone to spilled liquids or careless footsteps.

Fighting Screen Glare

Aside from reading the financial pages by candlelight, nothing leads to eye fatigue like glare on a computer screen. The screens of compact Macs have coatings that reduce glare, but they can still produce uncomfortably bright reflections if you have a window at your back. If you have a choice, it's better

to have the window in front of you; the natural light illuminates your desk, and you can periodically rest and refocus your eyes by looking out the window. If you cannot avoid a window at your back, consider a glare-reducing screen filter.

Incidentally, if your screen has a non-glare coating (those of compact Macs do), don't clean it using window cleaner or other strong cleaners. Cleaners damage the non-glare coating. Instead, wipe dust off the monitor with bathroom tissue or photographic lens-cleaning tissue. (Don't use facial tissue; many brands contain softening agents that cause smearing.) If you need to remove sticky fingerprints frequently, use cleaning solutions made for computer screens. Computer-supply houses, such as Global Computer Supplies and Inmac Corporation, sell CRT wipes—towelettes moistened with a gentle cleaning solution that, according to their manufacturers, also helps neutralize the static that attracts dust.

ELF Worries

A growing body of research suggests that video monitors, along with high-voltage power lines, motorized appliances, and even electric blankets, may give off a form of cancer-causing low-frequency *electromagnetic radiation*. Video screens have been blamed for a variety of other health ailments, from cataracts to miscarriages. Industry and government groups say that the evidence isn't conclusive yet; health and safety advocates say it is.

In any case, you can protect yourself easily. In measurements performed by *Macworld* magazine, ELF radiation dropped off significantly at an arm's length away from the front of the monitor, and several feet away from the back and sides. Stay an arm's length from the screen, and several feet away from the back and sides of other Macs in your office (even if you're separated from those Macs by partitions). You also may want to look for monitors that meet Swedish government specifications, which at this writing are the most stringent.

By the way, if you use a PowerBook, you need not worry about ELF radiation. The liquid-crystal display (LCD) screen in a PowerBook generates no ELF radiation.

Can a Mouse Carry Rabies?

No, but after reading this section, you may be afraid to even switch on a Mac without first preparing a will. We don't want to scare you, but we do want to make you aware of the possible health risks behind day-in, day-out computing. If you use the Mac on and off in the course of a business day, you need not fear

wrist injuries, cataracts, ImageWriter-induced deafness, or other health ailments. But if your work requires you to use the Mac constantly—for writing, page layout, illustration, or programming—or if a big deadline forces you to spend long hours at the machine, you should take the health issues we have raised seriously. The best news is that it takes only a few simple steps to avoid computer-related ailments.



Hardware Setup Tips

This section contains a collection of tips for setting up and taking care of your Macintosh hardware.

Mouse Care and Feeding

As it rolls, the Mac's mouse picks up lint and dust. Over time, the buildup of dirt on the mouse's rollers impairs its operation. The Mac's manual recommends cleaning the rollers with a cotton swab moistened with alcohol or tape recorder head cleaner, and suggests wiping the rubber ball clean with a soft, clean, dry cloth. Most computer retailers also sell mouse-cleaning kits.

The mouse for the Mac Plus and earlier models has plastic feet that can wear down over time and impair the mouse's action. If your mouse has sore feet, you can restore its vigor by attaching small felt pads to the feet. Many users also report good results using Velcro strips. Use the soft half of the Velcro pair, not the hooked half.

Surge Protectors and Power Conditioners

Many computer accessory manufacturers sell *power conditioners,* such as surge protectors, which attach between the Mac's power cord and a wall outlet and, according to their manufacturers, protect your hardware from voltage surges and also filter out line noise caused by air conditioners, power tools, and other electrically noisy devices. The fact is, the Mac's own power supply provides a great deal of protection and voltage filtering. Unless your Mac is tapped into the same circuit as an air conditioner or power tool, you're unlikely to encounter problems related to noisy power lines. Other add-ons, however, such as modems and external hard disks, may have lower-quality power supplies that aren't as forgiving.

A more common problem is a voltage *sag*; a momentary drop in voltage caused when a power-hungry device, such as an air conditioner, kicks in. Again, the Mac power supplies are fairly forgiving. Still, if you suspect that voltage irregularities are causing problems for you, consider an *uninterruptable power supply (UPS)*. UPSs connect between your computer and the power source, and contain batteries that kick in within milliseconds after a power outage. Most UPS systems provide between 10 and 20 minutes of standby power—more than enough time to save your work and shut down safely. UPS systems also provide voltage filtering and surge protection.

When shopping for a UPS, be sure to look for a unit that can deliver enough juice for your most important hardware—the Mac itself, the monitor, and any external hard drives. Also look for a unit that delivers true sine-wave AC output; some UPS systems provide square-wave output that can damage computer components.

Does the Mac Need Rest?

Speaking of power, you may wonder if you should turn off the Mac when you aren't using it or leave it on all the time. If your Mac lacks a hard disk, you can leave it on all the time, but you should turn the screen brightness down to avoid burning an image of the menu bar and other screen components into the video tube's phosphor. (The original Mac manual even suggested turning the brightness down and using the dimmed screen as a night light. For people who look forward to getting away from the Mac at the end of a long day, that suggestion may seem pretty gruesome.)

If your Mac has a hard disk, you should shut down your system if you aren't going to be using it for six to eight hours. Hard disks contain bearings that can wear out over time. If you use a removable-media drive, such as an Iomega Bernoulli drive or SyQuest removable hard disk, consider ejecting the media if you aren't going to use your Mac for some time. If you have a Bernoulli drive, you can use the Iomega Workshop program to specify a sleep time for the drive (after a specified period of inactivity, the cartridge spins down).

Saving Your Screen

As an alternative to turning the screen brightness down to avoid burn-in, consider a *screen saver*, such as Berkeley Systems' legendary After Dark. (If you have ever seen a Mac screen with toasters flying across it, you have seen After Dark in action.) Several free or shareware screen savers are also available through user's groups and online information services.

Do you really need a screen saver? Probably not. Today's monitors are much more resistant to burn-in than older units. Also keep in mind that a screen saver will use up RAM. These days, screen savers are more entertaining than they are essential.

Disconnecting and Connecting Add-Ons

The Mac's *Apple Desktop Bus* (*ADB*) connectors can cause a momentary short circuit when you attach or remove an ADB device with the power on. The resulting short circuit can damage the Mac's ADB circuitry. Turn off the power to your Mac before attaching or disconnecting an ADB device, such as a mouse or keyboard.

It's a good idea to always turn off your Mac and everything connected to it before disconnecting or connecting any add-ons. This is especially true of SCSI add-ons and external floppy disk drives.

A Word about External Floppy Drives

The following hardware tip is so well known that it is practically folklore. Still, we pass it along for newcomers. If you have an external floppy disk drive and a compact Mac, such as a Classic or SE, avoid placing the drive to the left of the Mac. The left side of the compact Mac's case contains the machine's power supply, whose transformers generate magnetic fields that interfere with the drive's operation, causing disk errors. The Mac SE and earlier machines are especially prone to this problem.

If you have a Mac Plus, also avoid setting the external drive on top of the Mac. You will obstruct the vents, and the heat given off by the Mac can cause the drive's mechanism to expand to the point where disk errors will occur. The best place for an external floppy drive is to the right of the Mac as you face the screen.

Power Supply Woes in Compact Macs

Power supply problems are common in the air-cooled Mac Plus (and in the archaic 512K and 128K). Indeed, service technicians we have talked with say that, in their experience, the most common repair performed on all Mac models is the replacement of the Mac Plus analog board (which contains the power supply).

Although other components can sometimes fail, too, the most common power supply problem is a burned-out *flyback transformer*, which supplies the high-voltage necessary to drive the computer's screen. If you have an air-cooled Mac whose screen image is jittery or seems to have shrunk, chances are that its flyback transformer or another power supply component is about to fail. You also may hear humming or clicking sounds coming from within the Mac's case.

What can you do? An Apple dealer will replace the entire analog board for approximately $200. As an alternative, you may want to have your Mac's existing analog board repaired. Total Systems Integration of Eugene (800/874-2288), rebuilds Mac power supplies and offers a heavy-duty rebuilding option you should consider if your Mac contains a memory upgrade or accelerator board. You may be able to find other firms in your area by asking around at local user's group meetings. Given the age of the Plus, however, you may simply consider buying a new Mac.

If your air-cooled Mac is still healthy, you can do the following two things to keep it that way:

Keep it clean. The dust that collects on electronic components acts as a blanket that traps heat. Cover the Mac with a dust cover when it isn't turned on, especially if you work in a dusty environment. (Never put a dust cover on a Mac that's still on.) Dust covers are available from several firms; visit a local dealer or check the advertisers index in Macintosh magazines. If your Mac is a few years old and it hasn't been covered, consider taking it to a dealer for a thorough cleaning. The dealer can check out its power supply at the same time.

Keep it cool. Don't obstruct the ventilation slots located on top of the Mac and at its base. Allow several inches of space around them so that air can circulate. If you're working in a hot environment, you may want to switch off the Mac if you won't be using it for several hours. Avoid turning it on and off too frequently, however; that can stress the power supply, too. You also may consider adding a fan, such as Kensington's System Saver. If the inside of the Mac is dusty, however, a fan is unlikely to help.

Although the Mac SE's power supply has a much better track record than that of the air-cooled Macs, some early SEs are prone to screen jitter and their fans are annoyingly loud. If your SE's serial number precedes F749xxxx, you can have its power supply (and fan) replaced at no charge by an authorized Apple dealer.

Fighting Dust in Other Macs

Although dust is particularly bothersome to an air-cooled Mac, it can be harmful to any model. If you have a modular Mac—one with expansion slots and an easily removable case lid—you may consider doing an occasional cleaning.

Disconnect all add-ons (with the power off, of course), and take the machine outside. Remove the lid and spray the inside with canned-air, such as Falcon's Dust-Off, available at photographic supply stores. Don't invert the can, or you will send a stream of ice-cold liquid freon into the Mac.

Many repair shops have air compressors they use to blow the dust out of a dirty Mac. If you're on friendly terms with a local dealer, you may ask if you can bring your machine in for a cleaning.



Wiring the Mac for Sound

The Mac's built-in speaker faithfully reproduces error beeps, but high-fidelity audio is another matter. If you use HyperCard stacks that play sounds, or if you use sound-oriented games or music programs, you deserve better audio quality. You can attach the Mac to an amplifier or stereo system by using inexpensive jacks and cables available at your local Radio Shack. Because some Macs have monaural (mono) circuitry and some have stereo circuitry, we provide separate instructions for each type.

> **WARNING!** The Mac can generate volume levels that can damage your audio equipment, not to mention your hearing. Attach the cables with the Mac's power off, and do not apply power until you read the section, "Setting Volume Levels," after the wiring instructions.

Mono Macs

To attach a monophonic Mac to a stereo, use the following:

- A cable with a 1/8-inch mini plug on one end, and a phono plug on the other (Radio Shack catalog number 42-2444).
- A "Y" adaptor containing a phono jack on one end, and two phono plugs on the other (Radio Shack catalog number 42-2435).

Connect the cables as shown in figure 8.1.

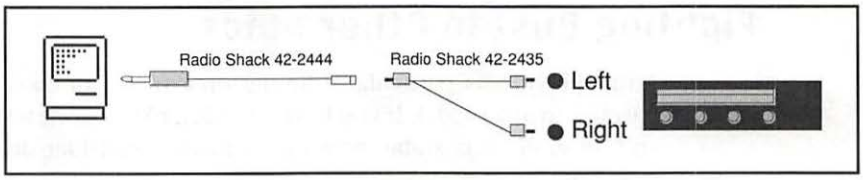


Figure 8.1: Connecting a mono Mac to a stereo.

Do not connect the Mac to a low-level input, such as one intended for a magnetic phono cartridge. Doing so can damage your stereo. Similarly, if you plan to record the Mac's audio output, connect your cables to your tape deck's Line Input jacks, *not* its microphone jack.

Stereo Macs

To attach a stereo Mac to a sound system, use a cable with a 1/8-inch *stereo* mini plug on one end, and two phono plugs on the other. (Radio Shack catalog number 42-2475 is a three-foot cable; catalog number 42-2481 is a six-foot cable.)

Connect the cable as shown in figure 8.2.

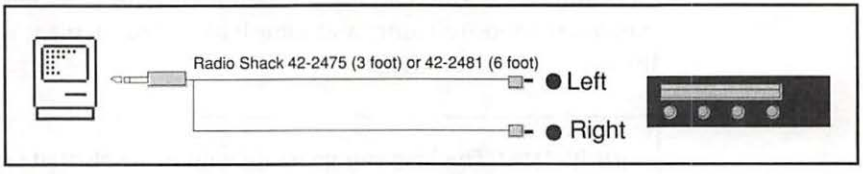


Figure 8.2: Connecting a stereo Mac to a stereo.

Do not connect the Mac to a low-level input, such as one intended for a magnetic phono cartridge. Doing so can damage your stereo. Similarly, if you plan to record the Mac's audio output, connect your cables to your tape deck's Line Input jacks, *not* its microphone jack.

Setting Volume Levels

Read these instructions carefully; you can damage your audio equipment (not to mention your ears) by setting volume levels too high.

Turn your stereo's volume all the way down. Next, use Sound on the Control Panel to set the volume level to 1, 2, or 3. Turn your stereo volume up *slightly* and click on the Sound Control Panel's volume control to produce a beep. Adjust the volume on your stereo for a comfortable listening level.

If you have attached headphones to the Mac, as described in "Attaching Headphones" later in this section, begin with a volume control setting of 1, and then ease the volume up to a comfortable listening level.

Powered Speakers

As an alternative to connecting the Mac to a stereo, you may want to consider a pair of external amplified speakers, such as Monster Design's MacSpeakers. Sold by the pair, MacSpeakers even include mounting brackets that attach to the side of the Mac or a monitor. They're also magnetically shielded to avoid distorting the screen image or damaging disks.

A less-expensive alternative is Radio Shack's Minimus-0.4 (catalog number 40-1267), which is designed for portable stereos. Sold by the pair for less than $30, they even run on batteries. Radio Shack offers several sets of powered speakers that work well with Macs.

If you use external amplified speakers that are not specifically designed for the Mac, be careful where you place them. Speakers contain magnets that can damage disks.

Attaching Headphones

You also can attach headphones directly to the Mac's audio output jack. For a stereo Mac, you can use the stereo headphones that accompany portable stereos. To use such headphones with a mono Mac, you need a mono-to-stereo mini plug adaptor (Radio Shack catalog number 274-368).

To use headphones that have standard 1/4-inch audio plugs with a stereo Mac, you need a 1/4-inch stereo-to-1/8-inch stereo adaptor (Radio Shack catalog number 274-371 or 274-367). To use such headphones with a mono Mac, you need a 1/4-inch stereo-to-1/8-inch mono adaptor (Radio Shack catalog number 274-361).

If you have a Mac II or Quadra 900 or 950 set up on the floor rather than on your desk, you also may need an extension cable for your headphones.

> **WARNING!** The Mac can generate volume levels in headphones that can damage your hearing. If you attach headphones to the Mac, do not put them on until you have switched on the Mac and adjusted the Mac's speaker volume to a low level. See "Adjusting Volume Levels" earlier in this section for guidelines on setting volume levels.



PowerBook Tips

PowerBooks have special setup and operating requirements. Their smaller keyboards and the trackball present unique operating challenges, especially when you're working on a bumpy airline flight. Ergonomically speaking, PowerBooks are as well designed as any portable computer, and they're better than most. But any portable computer presents challenges, and a PowerBook is no exception. Its smaller keyboard lacks convenient function keys and scrolling keys. Its trackball is also harder for many people to operate than a mouse. The trackball on the PowerBook Duo models is especially tiny—only 11mm in diameter, versus 33mm on big PowerBooks.

One of the biggest problems with using a portable computer doesn't have anything to do with the computer itself, but with the environment in which you're using it. As mentioned earlier in this chapter, creating a healthy work environment requires careful attention to lighting, desk and chair heights, and posture. When you're on the road, often you don't have control over these variables. Airline tray tables were designed to hold that stuff they call food, not to act as computer workstations.

Still, there are steps you can take to make PowerBook computing as comfortable as possible. This section presents some tips and insights gleaned from our experience with the PowerBook line. We also look at ways to set up a PowerBook to attain the best balance of speed, display legibility, and battery life.

Coming to Terms with the Trackball

Some people prefer trackballs to mice; we're not among them. The PowerBook trackball operates smoothly and the two big buttons are a nice touch, but all in all, we will take a mouse and a real desktop any day. For one thing, the PowerBook trackball is small, making precise pointer positioning more difficult. Dragging is also harder because the buttons are separate from the gizmo you use to move the pointer—unlike in a mouse. Combine these two factors with a bumpy plane flight, and you have a navigational challenge that would scare an Arctic explorer. Following are some tips for coming to terms with the trackball.

Don't Use It

The best way to avoid trackball troubles is to avoid using it. Every all-in-one PowerBook model has an Apple Desktop Bus (ADB) port into which you can plug a conventional mouse. (Avoid connecting or disconnecting a mouse—or

any other add-on—when the Mac's power is on.) The PowerBook Duo models also can accept a mouse when docked to a Duo MiniDock or Duo Floppy Adapter.

The standard Apple mouse that accompanies desktop Macs also will work with a PowerBook, provided that the PowerBook is plugged into its AC adaptor. The standard Apple mouse draws too much power for a PowerBook running on battery power; the battery drains quickly. If you want to use a mouse when running on battery power, you need to buy Apple's PowerBook mouse. Note that some dealers aren't familiar with this mouse—be sure to ask for the low-power ADB mouse that's designed for PowerBooks (it's Apple part number M0142).

Use the Keyboard Instead

You often can avoid using the trackball by relying on the keyboard for scrolling, issuing commands, and even selecting icons. This is a good excuse to memorize your programs' Command-key shortcuts—and to seek out programs that offer a wide selection of them.

It's also a good reason to buy a keyboard-enhancement utility, such as CE Software's QuicKeys, to create your own keyboard shortcuts. As you see in Chapter 11, you can create keyboard shortcuts that open Desk Accessories and Control Panels, as well as frequently used files.

The PowerBook's system software contains a large selection of keyboard-navigation options. You can use the keyboard to select icons, choose devices in the Chooser, and start programs. For details on the Finder's keyboard-navigation option, see the section "System 7 Keyboard Shortcuts" in Chapter 9.

Use the Finder's "Always Snap to Grid" Option

As you learn in the next chapter, the Views Control Panel contains an option called Always Snap to Grid that instructs the Finder to neatly align icons for you. This option is especially handy for PowerBooks because dragging and precisely aligning icons is complicated by that pesky trackball.

Use the By Icon View

If you have trouble using the trackball to select items in Finder directory windows, consider using the Finder's By Icon view rather than the text views (by name, by date, and so on). Big icons are easier to select than small icons.

If you do use a text view, you may want to use the Views Control Panel to increase the type size to make each item larger and, therefore, easier to select. Try 10-point Geneva.

Adjust Tracking Using the Mouse Control Panel

If you're having trouble using the trackball to position the pointer precisely, open the Mouse Control Panel and choose a slower tracking setting.

Display Tips

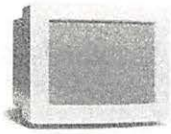
The *liquid-crystal display* (*LCD*) screens used in PowerBooks are among the better notebook computer displays. But they have their quirks and idiosyncrasies. This section describes some problems that have surfaced with certain PowerBook displays and also contains some tips for all PowerBook displays.

Into the Void: PowerBook 170 and 180 Display Woes

The most controversial PowerBook display issue concerns the active-matrix display used in the PowerBook 170 and 180. Active-matrix displays are tricky beasts, and manufacturing a perfect one—one in which every single pixel works properly—isn't easy. When a brand-new display comes off the assembly line, it's fairly common for it to have some pixels that don't light. Rather than turning black when they're supposed to, they remain white all the time—as if they were burned-out light bulbs.

Apple decided that it would allow up to five such *voids* on a PowerBook 170 or 180 screen, provided that no two voids were within an inch of each other. The problem is, Apple never announced that policy. Many PowerBook 170 owners were understandably annoyed when they took their new, expensive machines back to their dealers and learned that what they thought were screen defects were considered acceptable by Apple.

We have a PowerBook 170 that has one void smack in the middle of its screen. Sometimes it's bothersome, but generally, we have grown used to it. Other PowerBook 170 buyers haven't been as forgiving, though; some have even threatened legal action against Apple. At this writing, the issue hasn't been resolved. If you're considering buying a PowerBook 170 or 180, we recommend that you examine a few models and try to find one without voids—or at least without voids that will bother you.



TIP: If your PowerBook has voids, you can make them less noticeable by using the General Control Panel to change the desktop's background pattern so that it has more white area (see figure 8.3). A lighter desktop pattern also increases the perceived brightness of the screen.

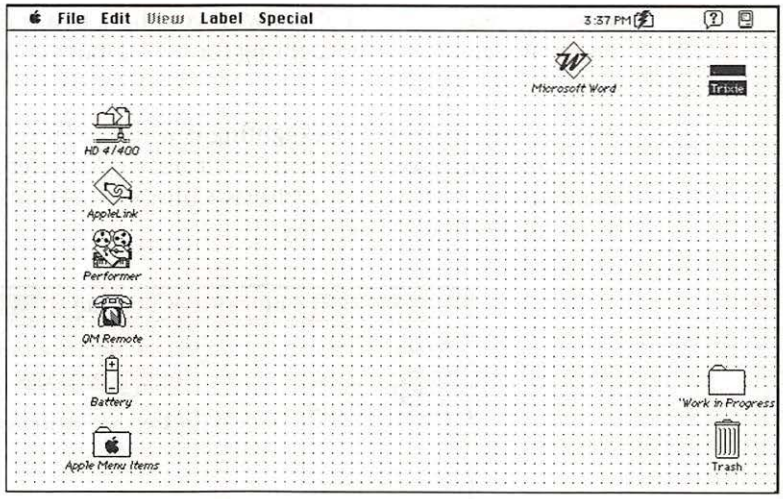


Figure 8.3: Voids aren't as noticeable with a lighter background pattern.

Cleaning the Screen

Clean a PowerBook's screen using soft, lint-free paper or cloth, moistened with some mild glass cleaner. Don't spray the glass cleaner directly on the screen.

Don't Overwork the Screen

If you're running a PowerBook using the AC adaptor, avoid leaving the computer on for more than 24 hours at a time. Doing so can cause temporary problems with the screen, such as shadows appearing when you move windows. You can fix the problem by putting the computer to sleep for at least several hours.

Extending Battery Life

When you're working away from a power outlet, you need all the battery life you can get. Here are some tips for squeezing the most juice out of a PowerBook's battery.

Working without Backlighting

One reason PowerBook screens are so legible is because they're backlit. But backlighting is a major drain on battery power. If you're on an extended sojourn away from a power outlet, consider turning backlighting off and

working under a bright light or with your back to a window. The screen isn't nearly as legible with backlighting turned off, but you will extend battery life significantly.

An easy way to control backlighting is with the PowerBook Display Control Panel that debuted with System 7.1. (It also works under System 7.0.) As shown in figure 8.4, the PowerBook Display Control Panel turns off backlighting after a specified period of inactivity.

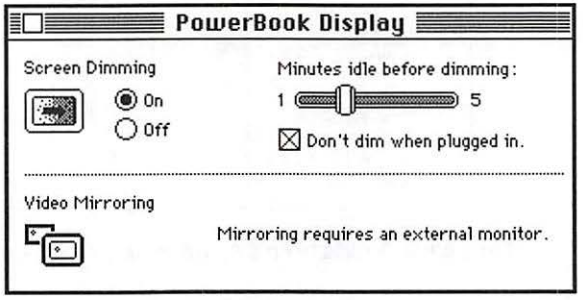


Figure 8.4: The PowerBook Display Control Panel.

Using the PowerBook Control Panel

PowerBooks provide several power-management features that enable you to balance performance against battery life. The gateway to these features is the PowerBook Control Panel (see figure 8.5). (If you're using System 7.0 on an older PowerBook, you may have an older Control Panel named Portable instead. The Portable Control Panel is covered in the next section.)

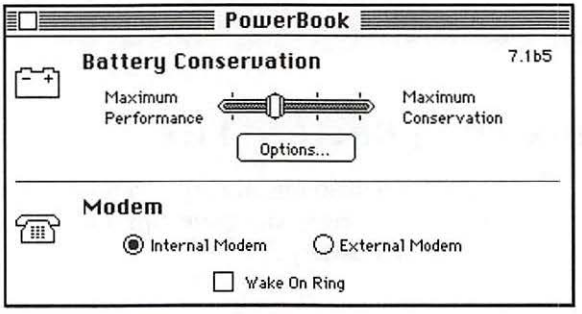


Figure 8.5: The PowerBook Control Panel.

The Battery Conservation slider controls the sleep times for the hard disk and for the PowerBook itself. Figure 8.6 shows the approximate operating times each setting provides.

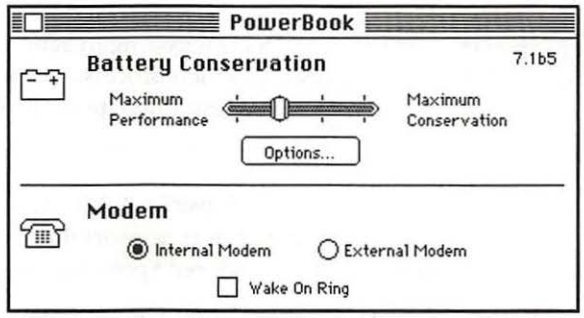


Figure 8.6: Approximate hard disk and system sleep times for the PowerBook Control Panel.

Advanced Power-Saving Options

For even more control over performance and battery usage, click the PowerBook Control Panel's Options button to display the Options dialog box (see figure 8.7).

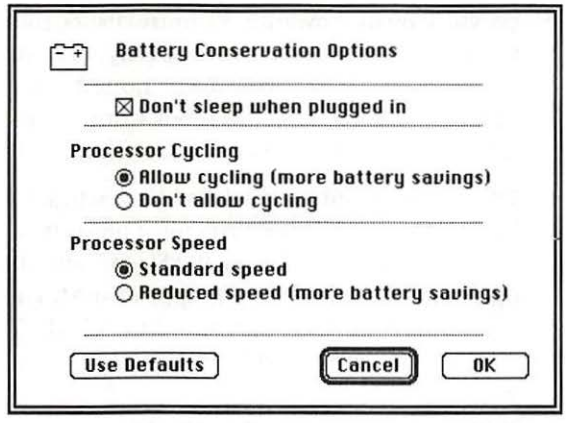
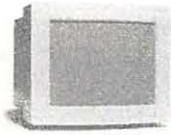


Figure 8.7: The PowerBook Control Panel's Options dialog box.

Where saving power is concerned, the two key parts of the dialog box are the Processor Cycling and Processor Speed areas.

Processor Cycling. The PowerBook's processor can turn itself off when you aren't using the computer. The moment you move the trackball or touch a key, the processor turns itself back on. This happens so quickly that you don't even notice it. When processor cycling is off—that is, when you select the Don't Allow Cycling button—the processor remains on all the time.



TIP: You can see processor cycling in action by opening the Alarm Clock Desk Accessory. When processor cycling is on, you will notice that the Alarm Clock doesn't update its display every second.

Processor Speed. The PowerBook 160, 170, and 180 can save battery power by slowing their processors down to 16MHz. To activate this option, select the Reduced Speed button.

Which option saves more battery power—allowing the processor to turn itself off now and then, or slow itself down all the time? You may think that it's the second option, but actually, it's the first. When you want maximum battery life, be sure to select the Allow Cycling option.

The Portable Control Panel

The Portable Control Panel is the predecessor to the PowerBook Control Panel we just discussed. The Portable Control Panel enables you to control the same basic settings as its replacement, but in different ways. Rather than the somewhat vague Maximum Performance and Maximum Conservation settings provided by the PowerBook Control Panel, the Portable Control Panel provides two sliders that enable you to specify, in minutes, the amount of time before hard disk or system sleep. To be honest, we prefer these sliders to the single slider provided by the PowerBook Control Panel. We think that the two sliders give you more precise control over sleep settings.

The Portable Control Panel enables you to activate or disable processor cycling, but in an awkward way—you must press the Option key while clicking on the text "Minutes Until Automatic Sleep," and then select the Rest or Don't Rest option in the dialog box that appears next. The Portable Control Panel doesn't let you slow the processor speed to 16MHz. To do this, use the Battery Desk Accessory's Power Saver button.

Other Ways to Go to Sleep

Following are several available utilities that provide other ways to put a PowerBook or its hard drive to sleep.

SpinD. Another Bill Steinberg creation, SpinD is a free FKEY that simply puts the hard drive to sleep. If you know you are going to use the drive within a few minutes, you can press Command+Shift+0 (zero) to put the drive to sleep. The drive will wake up automatically the next time it's needed. (For details on installing FKEYs, see Chapter 11.)

SuperClock. This popular free system extension by Steve Christensen adds a digital clock to the Mac's menu bar. When used with a PowerBook, SuperClock also displays an icon that indicates whether you're running from battery power or from the power adaptor (see figure 8.8). When you're running from battery power, the icon also shows how much juice is left. If you press the Control key while clicking on this icon, the PowerBook immediately goes to sleep. Note that you must press the Control (Ctrl) key, not the Command key. SuperClock also provides timer and alarm options that can be useful when you're on the road.

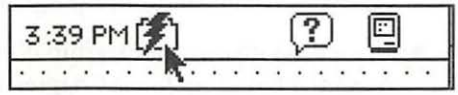


Figure 8.8: Press Ctrl while clicking on SuperClock's power icon to put the PowerBook to sleep.

Connectix PowerBook Utilities. This commercial product from Connectix Corporation gives you control over numerous aspects of a PowerBook's operation, including sleep time.

When to Keep the Hard Disk Awake

With the hard disk being one of a PowerBook's major power consumers, you may think that it's best to put it to sleep whenever you aren't using it. Not necessarily. It takes four times the amount of power to wake up a sleeping hard disk than it does to keep it spinning. As a result, if you constantly alternate between putting the drive to sleep and waking it up, you will use more battery power than if you simply left the hard disk awake all the time. Because it takes a few seconds for the disk to spin up to operating speed each time it's awakened, you also will waste time.

When Can't You Put a Duo to Sleep?

When you have attached a PowerBook Duo to the Duo MiniDock, there are two circumstances in which you can't put the PowerBook Duo to sleep: when you have an external monitor attached, or when you have an external SCSI drive attached and switched on.

If you want to be able to put a docked PowerBook Duo to sleep, you first must shut down and disconnect the monitor or SCSI device.

Other Power-Conserving Measures

Following are a few other ways to save power:

- Avoid using System 7 virtual memory when running under battery power. Using virtual memory forces the PowerBook to access its hard disk more frequently.
- If your PowerBook has a built-in modem, don't leave communications programs open when you aren't using them. When a communications program is running—even if you aren't actually on-line—the modem is drawing power. When you have finished a communications session, quit your communications program.
- Use a RAM disk as your startup disk. For details on setting up a RAM disk on a PowerBook, see Chapter 10.

How Long to Recharge?

How long does it take to recharge a PowerBook's battery? That depends on the PowerBook. The following times assume that you have shut down your PowerBook.

- A PowerBook 100's lead-acid battery recharges to 80 percent of its capacity in about 2 hours, and to 100 percent of its capacity in about 6 hours.
- A PowerBook 140, 145, 160, 170, or 180 NiCad battery recharges to 80 percent capacity in about 2.5 hours, and to 100 percent in about 5 hours.
- A PowerBook Duo's NiHy battery recharges fully in only about 1.5 hours.

If you're using the PowerBook when its AC adaptor is plugged in, the battery charges at a slower rate. It can take up to 10 hours to recharge a battery installed in a PowerBook whose power is turned on.

Changing Batteries

You can buy additional PowerBook batteries from an Apple dealer. If you also buy the external battery charger, you can recharge up to two batteries simultaneously and always have one fully charged battery available.

If you need to change the battery in an all-in-one PowerBook, shut down the computer or plug in its AC adaptor before removing the battery. If you simply yank the battery, you will lose any unsaved work. If you need to change the battery in a PowerBook Duo, you can simply put the system to sleep; you don't need to shut down first.

Miscellaneous PowerBook Tips

We wrap up this chapter with a collection of miscellaneous PowerBook-related tips. Unless otherwise noted, these tips apply to all members of the PowerBook family, including the PowerBook Duos.

Safeguarding Your PowerBook

Worried that a nosy colleague will wake up your PowerBook while you're at lunch? You may try a free system extension by Bill Steinberg called SafeSleep. When SafeSleep is installed and you wake up the PowerBook, you must type a password before the Desktop appears. You have three tries to type the correct password; if you fail, the PowerBook goes back to sleep. SafeSleep isn't a heavy-duty security program—you can bypass it several ways—but it's probably adequate to lock out casual snoopers. (Connectix PowerBook Utilities provides more secure password features.)

If you're concerned that someone will walk away with your PowerBook, you may consider buying a security cable, such as Kensington's Apple Security System, which includes a galvanized steel cable and padlock. The PowerBook 145, 160, 180, and Duo models contain a slot into which the cable locks.

Fattening Up the Pointer

We mentioned in Chapter 4 that the Mac's I-beam pointer can "submarine"—temporarily disappear—when moved rapidly across a PowerBook's screen. If you have trouble locating the pointer, try a free system extension called Cursor Fixer. Written by Dennis Brothers, Cursor Fixer fattens up the I-beam pointer, making it easier to spot (see figure 8.9).

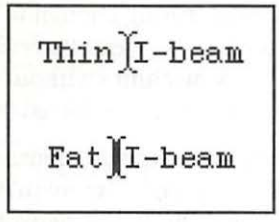


Figure 8.9: The I-beam pointer without Cursor Fixer (top) and with it (bottom).

Transporting a Sleeping PowerBook

The PowerBook manual recommends that you shut down the PowerBook before transporting it rather than simply putting it to sleep. The reason Apple

recommends that you not transport a sleeping PowerBook is because a sudden jolt could cause one of the keyboard's keys to make contact, which would wake up the PowerBook and leave its spinning hard disk prone to head crashes and other damage. Obviously, the jolt would have to be pretty strong in order to depress a key and wake up the computer. As long as you don't slam a sleeping PowerBook down on a table, you can transport it safely. We have carried a sleeping PowerBook 170 around many times and never disturbed its slumber. (Keep in mind, though, that the computer uses battery power when sleeping.)

Transporting a Docked PowerBook Duo

Is it safe to transport a PowerBook Duo when a MiniDock or other portable dock is attached? Apple recommends against it, saying that the rigors of transportation can cause undue stress on the Duo's docking mechanism. But at the same time, sources at Apple tell us that the Duo's mechanism is designed to withstand that abuse. In other words, Apple says don't do it, but it knows some people will do it anyway, so it has designed the system to withstand it. If you're carrying the system in a sturdy case that offers good protection, you can probably leave the system docked without any problems. The key point is that you shouldn't flex the docked system in a way that puts stress on the docking mechanism and expansion connectors.

PowerBooks and Air Travel

If you will be taking to the air with a PowerBook, be prepared to show the airport security personnel that the PowerBook works (in other words, that you haven't replaced its insides with a bomb). Be sure your battery is charged.

Should you put the PowerBook through an X-ray machine? We don't recommend it—the motors in older X-ray machine conveyor belts can generate magnetic fields strong enough to erase data from the PowerBook's hard disk. We have talked to several PowerBook owners who have run their computers through X-ray machines without problems, but we like to play it safe and ask that the computer be inspected by hand.

Incidentally, if you travel extensively with your PowerBook, you may consider Farallon Computing's Timbuktu Power Pack. It includes various telephone line adaptor cables, PhoneNet network connectors, and two copies of Farallon's Timbuktu software, enabling you to operate a remote Macintosh over a modem connection. PhoneNet and Timbuktu are described in Chapter 13.

Turn Down the Volume

If you're using a PowerBook to take notes in a meeting, you will probably want to turn the speaker volume down all the way to avoid annoying colleagues with

occasional error beep sounds ("Here's Roy with the quarterly sales report." Quack!). The original PowerBooks have a design quirk though. If you start up or restart with the speaker volume all the way down, you get a full-volume startup chord. If you have to restart or start up your PowerBook during a meeting and you don't want to disrupt the proceedings with a startup chord, you will need to insert a mini plug into the PowerBook's audio output jack to disable the speaker entirely.

Apple fixed this problem with the PowerBook 160, 180, and Duo line. If you choose the Simple Beep sound and turn the volume down all the way, the PowerBook will start up silently.

Why Does the Speaker Pop?

Speaking of sound, you may notice that your PowerBook's speaker makes a popping sound roughly 15 seconds after an error beep or other sound plays. Your PowerBook isn't broken; the pop is the result of the PowerBook's sound chip shutting itself off to save power.

MIDI Woes in the PowerBook Family

With its light weight and battery operation, a PowerBook is a perfect musician's computer—almost. Unfortunately, the PowerBook family's power-management features can cause data-transmission errors between the PowerBook and musical instruments connected via MIDI. (MIDI stands for *musical instrument digital interface*; see Chapter 16.)

These errors generally take place when the PowerBook is receiving a large amount of system-exclusive MIDI data, such as a sound sample. The problem occurs because the PowerBook's power-management software interrupts the computer's central processor periodically. When these interruptions occur, MIDI errors can occur, too.

The PowerBook family works well for most MIDI applications, including sequencing. But if you need to transfer large amounts of system-exclusive data, be aware that you may encounter problems.

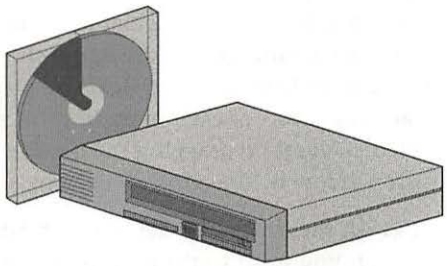
CHAPTER

9

BASIC OPERATING TECHNIQUES AND TIPS

WHAT'S INSIDE

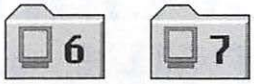
- How to improve your proficiency with the Mac
- How mouse and keyboard shortcuts enable you to do more work in less time
- Shortcuts for copying files and other Finder tasks
- Folders—organizing your hard disk for efficiency and performance
- How to use System 7 aliases to streamline your filing system
- Strategies for backing up work



Now that your Mac is set up, you're ready to invest the hundreds of tedious hours necessary to master the machine.

Just kidding. The Mac doesn't require hundreds of hours to master; you can be doing real work within your first hour or two at the machine. And the time you do spend becoming more familiar with the Mac is anything but tedious.

To get you started, this chapter is a collection of basic Mac operating tips and techniques. Unless otherwise noted by the following icons placed in the margin, this chapter applies to all versions of the Mac's system software.





Polishing Your Navigation Skills

The least expensive way to improve your Mac's performance is to master the Mac's navigation techniques—the mouse movements and keystroke combinations that control the Mac and its programs.

Selection Strategies

The act of *selecting* is one of the most common activities you perform when using the Mac. You cannot run a program, delete a word, move a graphic, or copy a file without first selecting. Because selecting is the cornerstone of Mac navigation, it helps to master the Mac's various selection options.

Chapter 3 described the three basic techniques for selecting text: *dragging* (to select a range of characters), *double-clicking* and then dragging (to select text in one-word increments), and *Shift-clicking* (to extend a selection). Now let's look at some other selection strategies.

Shift-clicking in drawing and publishing programs. Shift-clicking is a common selection technique in drawing programs, such as Claris' MacDraw series and in desktop publishing programs. Figure 9.1 shows an Aldus PageMaker window in which three elements have been selected using the Shift-click technique. As the figure shows, most graphics-oriented programs indicate selected items by placing black boxes called *handles* at the corners of each item. In most programs, you can resize a selected element by dragging the handle—just as you can resize a Macintosh window by dragging its size box.

When you're working with files in the Finder, you can Shift-click to select additional files. If you want to throw away three files, for example, click the first file, and then Shift-click each of the

remaining two. You also can use this technique to open multiple documents simultaneously. To open three Microsoft Word documents, for example, select all three by clicking the first and Shift-clicking the second and third, and then choose Open from the Finder's File menu. The Finder starts Microsoft Word, which opens the documents.

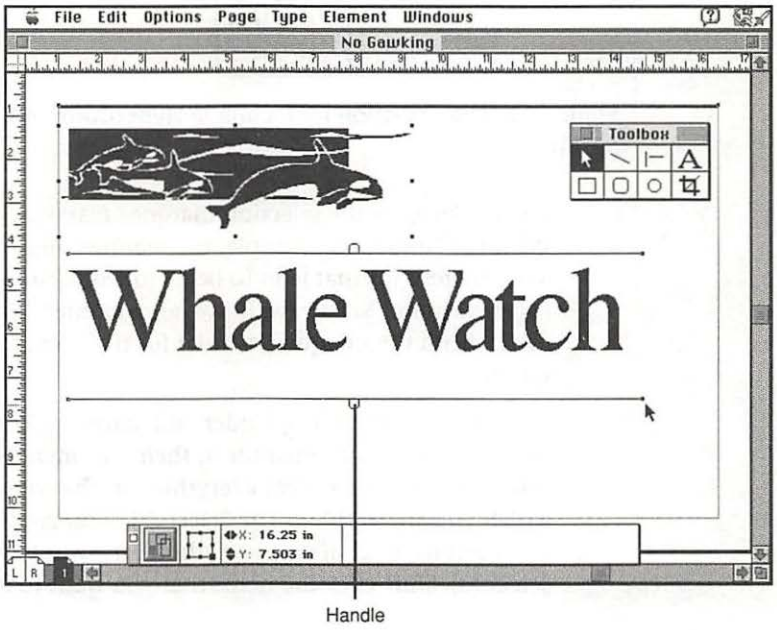


Figure 9.1: Three selected elements in Aldus PageMaker.

Selection marquees. Here's another graphics-oriented selection technique. Many drawing and publishing programs enable you to select multiple items (or rectangular portions of an image) by enclosing them within a *selection marquee,* a dotted rectangle whose dotted lines move like the lights on a theater marquee. The Finder enables you to select multiple icons using the same technique.

In drawing, painting, and publishing programs that provide tool palettes, you may need to activate a specific tool in order to draw a selection marquee. Icons can vary among programs. In HyperCard and most paint programs, for example, the selection tool icon looks like a small selection marquee. In MacDraw and Aldus PageMaker, the arrow-shaped pointer tool must be active before you can draw a selection marquee. Figure 9.2 shows both icons.

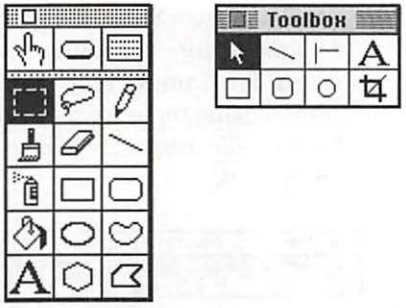


Figure 9.2: The selection tool icons in HyperCard (left) and PageMaker (right).

The workings of the selection marquee may vary between programs. With the Finder, for example, the marquee need touch only part of an icon in order for that icon to be included in the selection. With Aldus PageMaker and MacDraw, however, you must completely enclose an item within the marquee in order for that item to be included in the selection.

Select All commands. The Finder and many application programs provide Select All commands in their Edit menus. Choosing Select All is the easiest way to select everything in the window or document in which you are working. The Select All command is also handy when you want to select *almost* everything in a window: after choosing Select All, Shift-click the items that you want to deselect.

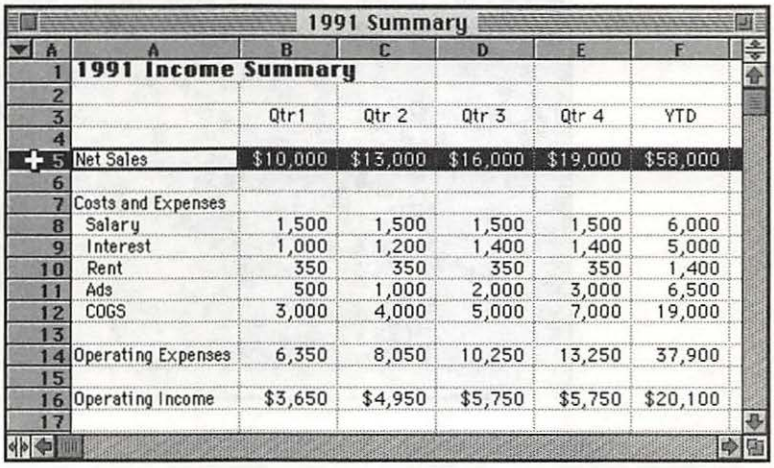
Combining Selection Techniques

As in the preceding section, you can combine many of the selection techniques we have just examined. You can use a selection marquee to select Finder icons that are adjacent to each other, for example, and then Shift-click to include icons that aren't adjacent to the ones you selected using the marquee.

Spreadsheet Selection Techniques

The selection techniques just described are generally available in all Macintosh programs. Spreadsheet programs, such as Microsoft Excel, Claris Resolve, and Lotus 1-2-3, provide some specialized selection techniques of their own—techniques that apply to the row-and-column world of the electronic spreadsheet. These techniques generally also apply to the spreadsheet modules of integrated packages, such as Microsoft Works and ClarisWorks. Check your spreadsheet program's manual to see if it supports the following techniques.

Selecting an entire row or column. You can select an entire row or column by clicking the mouse in the row or column heading (see figure 9.3). To select multiple rows or columns, drag across their headings.

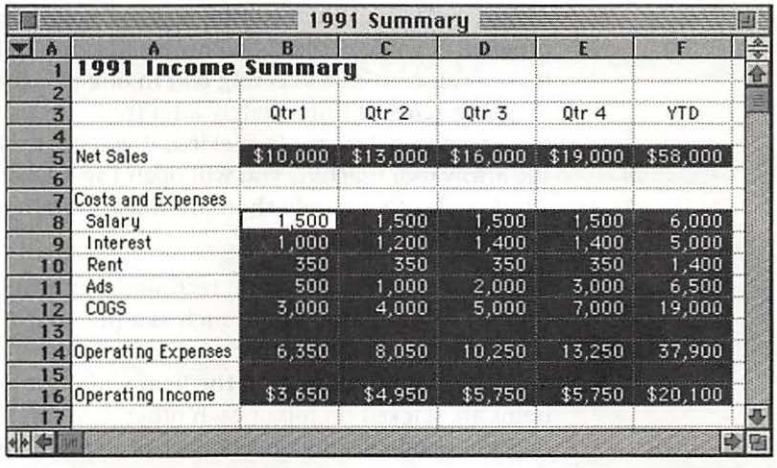


1991 Summary

	A	B	C	D	E	F
1	**1991 Income Summary**					
2						
3		Qtr1	Qtr 2	Qtr 3	Qtr 4	YTD
4						
5	Net Sales	$10,000	$13,000	$16,000	$19,000	$58,000
6						
7	Costs and Expenses					
8	Salary	1,500	1,500	1,500	1,500	6,000
9	Interest	1,000	1,200	1,400	1,400	5,000
10	Rent	350	350	350	350	1,400
11	Ads	500	1,000	2,000	3,000	6,500
12	COGS	3,000	4,000	5,000	7,000	19,000
13						
14	Operating Expenses	6,350	8,050	10,250	13,250	37,900
15						
16	Operating Income	$3,650	$4,950	$5,750	$5,750	$20,100
17						

Figure 9.3: Selecting an entire spreadsheet row by clicking in its heading.

Selecting discontinuous cells. You can select cells that aren't physically adjacent to each other by using the Command key. First, select the first cell or range of cells. Next, press the Command key while clicking within another cell or dragging across a range of cells. The resulting selection resembles figure 9.4.



1991 Summary

	A	B	C	D	E	F
1	**1991 Income Summary**					
2						
3		Qtr1	Qtr 2	Qtr 3	Qtr 4	YTD
4						
5	Net Sales	$10,000	$13,000	$16,000	$19,000	$58,000
6						
7	Costs and Expenses					
8	Salary	1,500	1,500	1,500	1,500	6,000
9	Interest	1,000	1,200	1,400	1,400	5,000
10	Rent	350	350	350	350	1,400
11	Ads	500	1,000	2,000	3,000	6,500
12	COGS	3,000	4,000	5,000	7,000	19,000
13						
14	Operating Expenses	6,350	8,050	10,250	13,250	37,900
15						
16	Operating Income	$3,650	$4,950	$5,750	$5,750	$20,100
17						

Figure 9.4: A selection containing discontinuous cells.

Selecting the entire worksheet. To select the entire worksheet, click the box in the upper left corner of the worksheet (see figure 9.5).

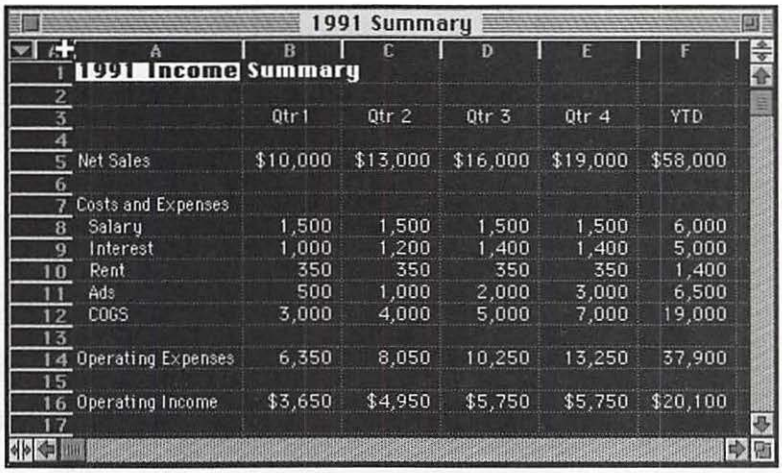


Figure 9.5: Selecting the entire worksheet.

Other Slick Selection Techniques

Spreadsheet programs don't have a monopoly on slick selection techniques. Here are some specialized selection techniques for today's most popular application programs. Even if you don't use these programs, you will probably find that similar techniques apply to the programs you do use.

Aldus PageMaker. When editing text in PageMaker (and several other programs), you can select an entire paragraph by triple-clicking within it. You can continue selecting text in one-paragraph increments by dragging across it immediately after triple-clicking. Be sure the text tool is active before triple-clicking; if you triple-click a text block while the arrow tool is active, you will open PageMaker's story editor window. That's a handy shortcut in itself, but it may not always be what you want.

Another PageMaker selection technique enables you to select items that are behind other items, such as a rule that appears behind a text block. To select an item that's behind another item, press the Command key while clicking on the item you want to select. If several items are stacked on top of each other, you can select each one in turn by Command-clicking on the stack of items. If you press Shift while Command-clicking, each one is added to the selection.

Microsoft Word. Word provides numerous selection options; its mouse-oriented ones are listed in Table 9.1.

Table 9.1: Microsoft Word selection options.

To select this...	Do this...
A sentence	Press Command and click within the sentence
One line of text	Click in the selection bar to the left of the line
A paragraph	Double-click in the selection bar to the left of the paragraph or triple-click anywhere within the paragraph
The entire document	Press Command and click within the selection bar or triple-click within the selection bar
A carriage return (paragraph mark) character	Double-click to the right of the last line of the paragraph
A column in a table	Press Option and then click within the column
An entire table	Press Option and then double-click within the table
A cell in a table	Click within the cell selection bar on the cell's left edge

Word also provides several techniques for selecting text from the keyboard. One unique technique is the *extend-to* technique, which enables you to extend a selection from the insertion point's current position to any character you type. To use this technique, position the insertion point to the left of the first character to be included in the selection, then press Command+Option+H or the minus sign on the keyboard's numeric keypad. The text *Extend to* appears in the page number area at the bottom left corner of the screen. Press a character, and Word searches ahead of the insertion point for that character, and then extends the selection to include it. To select everything from the insertion point to the end of a sentence, for example, press keypad-minus or Command+Option+H and then type a period (.).

Word also enables you to select text from the keyboard by pressing Shift and using the arrow keys as well as the scrolling keys on an extended keyboard.

WordPerfect. WordPerfect also provides numerous selection shortcuts which are summarized in Table 9.2.

Table 9.2: WordPerfect selection shortcuts.

To do this...	Do this...
Select a sentence	Press Command+Shift+U or the extended keyboard's F6 function key
Select a paragraph	Press Command+Shift+Y or Command+F6 or triple-click within the paragraph
Extend a selection to the end or beginning of a line	Command+Shift+right arrow or Command+Shift+left arrow
Extend a selection to the right or left one word at a time	Option+Shift+right arrow or Option+Shift+left arrow

Like Microsoft Word, WordPerfect also enables you to select text from the keyboard by pressing Shift and using the arrow keys as well as the scrolling keys on an extended keyboard.

QuarkXpress. This popular desktop publishing program offers numerous keyboard and mouse selection shortcuts as listed in Table 9.3.

Table 9.3: Selection shortcuts in QuarkXpress.

To do this...	Do this...
Select a line	Triple-click within it
Select a paragraph	Quadruple-click within it
All text in a chain	Quintuple-click within it
Select to top of paragraph	Press Command+Shift+up arrow
Select to top of next paragraph	Press Command+Shift+down arrow
Select to beginning of line	Press Command+Option+Shift+left arrow
Select to end of line	Press Command+Option+Shift+ right arrow
Select to beginning of story	Press Option+Shift+up arrow
Select to end of story	Press Option+Shift+down arrow

FileMaker Pro and other data managers. Claris' FileMaker Pro database manager provides form-design features that work similarly to a desktop publishing program to enable you to create forms. In FileMaker's layout mode, you can select a group of objects (such as fields or field titles) by Shift-clicking each or by using a selection marquee. These techniques also work in most other data managers.

Deselecting and Canceling a Selection

When you're selecting multiple items using a marquee or the Shift-click technique, you may occasionally select an item you didn't want to select. Rather than begin the selection process from scratch, you can simply deselect the item by Shift-clicking it.

Finally, there are times when you have finished working with a selection and want to deselect everything. In a drawing or publishing program, you can deselect everything by clicking the pointer elsewhere within the document window, in an area where there is nothing to select.

In a word processing program (and in the text-editing areas of any program or dialog box), the easiest way to cancel a selection is to simply click the mouse button to create a blinking insertion point.

Automatic Deletion

If you selected some text in order to replace it with new text, simply begin typing. You don't need to press Delete or Backspace first; your first keystroke deletes the selected text.

The Power of the Double-Click

Let's turn our attention from selecting to issuing instructions. The most common way to tell the Mac what to do is to choose a command from a menu. But the Finder and most programs also respond to another form of command: the double-click.

Where navigation is concerned, the double-click is a shortcut that usually eliminates having to choose a menu command. In the Finder, for example, you can start a program or open a document by double-clicking its icon—it's faster than selecting the icon and then choosing Open from the File menu. The Finder offers several double-click shortcuts. You can open a directory window by

double-clicking a disk or folder icon, and you can open the Trash by double-clicking its icon. Most people master these shortcuts quickly; they're more convenient than the two-step, select-and-choose-Open routine.

But once away from the Finder, some people forget about the power of the double-click. It's still there. Most programs that have tool palettes offer double-click shortcuts. Double-click a tool, and the program performs a task related to the tool, but usually a notch above its normal purpose. In HyperCard, for example, double-clicking on the eraser tool erases the entire card or background. (This same shortcut applies to MacPaint and other painting programs.) Figure 9.6 shows the other double-click shortcuts that HyperCard's Tools menu provides.

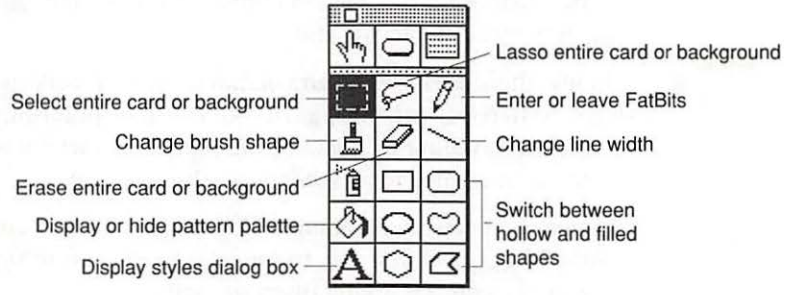


Figure 9.6: Double-click shortcuts in HyperCard's Tools menu.

In Claris' MacDraw series, double-clicking on a palette tool causes that tool to remain active after you finish using it (to draw a line or shape, for example). When you activate a tool with a single click, MacDraw deactivates the tool and reactivates the pointer tool after you have used the tool. Another double-click shortcut in MacDraw involves the pattern palette at the top of the document window. Double-clicking a pattern causes MacDraw II to display the Patterns dialog box, as if you had chosen Patterns from the Layout menu. And double-clicking on the Corner/Center control (located above the layer arrows near the bottom of the tool palette) displays the Preferences dialog box.

You also will find double-click shortcuts in Adobe Illustrator. Double-clicking on the hand tool, for example, enables you to see the full drawing area, as if you had chosen the Fit in Window command. If you double-click the hand tool while holding down the Option key, Illustrator switches to its actual-size view.

As in the preceding examples, you're most likely to encounter double-click shortcuts in graphics-oriented programs that contain tool palettes. But double-click shortcuts also exist elsewhere, even in word processing programs, such as Microsoft Word. Within Word's document window are numerous hot spots you can double-click to perform various tasks.

The double-click also has a place in Word's dialog boxes and in the dialog boxes of Word's cousin, Microsoft Excel. In both programs, you can choose a radio button option *and* confirm the dialog box by simply double-clicking on the radio button. In Word's Index dialog box, you can double-click the Nested or Run-in radio buttons to choose the type of index you want and begin the indexing process, for example. In Microsoft Excel's Alignment dialog box, you can double-click an alignment option to choose that option and okay the dialog box. In Excel's New dialog box, you can choose the type of new document you want (worksheet, chart, or macro sheet) and create the document simply by double-clicking on the document type. This technique of double-clicking a radio button to both choose the option and okay the dialog box is available in many Mac programs (including the Norton Utilities).

In Excel and in Lotus 1-2-3, you can resize a column to accommodate its widest entry by double-clicking the right cell heading boundary.

The Power of the Option Key

Another key to mastering Mac navigation techniques is, literally, a key—the Option key, whose most common purpose is to enable you to access special characters, such as accents and symbols. In the Finder and in many application programs, pressing the Option key while choosing a command or clicking the mouse performs a special variation of the command or mouse click. (In some cases, you must press both Option and Command.)

In HyperCard and many painting programs, pressing Option while dragging a selection causes the program to duplicate the selection, leaving the original where it was. Press Command+Option while dragging a selection, and the program makes copy after copy, leaving a trail of duplicates in the pointer's wake.

Many programs also use the Option key to modify the workings of a menu command, palette tool, key sequence, or mouse movement. In MacDraw, for example, pressing Option while clicking on the drawing surface enables you to select an object on a different drawing layer. In Aldus PageMaker, pressing Option while clicking within the document window turns the pointer into a hand that enables you to scroll in any direction. Many other graphics-oriented programs also provide this or a similar scrolling shortcut.

The Finder provides numerous Option and Command+Option shortcuts. You'll find them later in this chapter, in the section "Finder Shortcuts."

A Command Key Reminder

You probably already know about this navigation shortcut, but it's significant enough to repeat. All Mac programs provide Command-key shortcuts—key sequences that enable you to choose menu commands from the keyboard by pressing the Command key along with another key. While shortcuts often can vary between programs, nearly every program provides numerous shortcuts. Table 9.4 lists many keyboard shortcuts.

Table 9.4: Common Command-key shortcuts.

Key Sequence	Command Equivalent
Command+A	Select All
Command+C	Copy
Command+D	Duplicate
Command+F	Find
Command+G	Go to page
Command+I	Get Info
Command+N	New
Command+O	Open
Command+P	Print
Command+Q	Quit
Command+S	Save
Command+V	Paste
Command+W	Close
Command+X	Cut
Command+Z	Undo

Remember that these sequences may not apply to every program. Some programs, for example, use Command+P to summon the plain-text style, not the Print command. Fortunately, it's easy to find out what your favorite programs' Command-key shortcuts are: just pull down the menus and look!

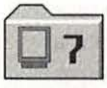
Shortcuts for Specific Programs

In addition to the generic navigation techniques we discuss, more and more programs are providing their own keyboard navigation shortcuts. Microsoft's

programs started this trend shortly after the Mac's release, and other software developers have followed suit. Today, many applications enable you to use the keyboard to choose dialog box options and "click" buttons.

Microsoft's current offerings continue the trend. In Microsoft Word, for example, you can "click" a button in a dialog box by pressing Command and the button's first letter. When the Character dialog box is open, for example, you can check or uncheck the Bold box by pressing Command+B. In the Define Styles dialog box, you can choose the Define button by pressing Command+D. When faced with a Save changes before closing? dialog box, you can answer Yes, No, or Cancel by pressing the Y, N, or C keys. Microsoft Excel provides similar keyboard shortcuts, as do Lotus 1-2-3, QuarkXpress, and MacDraw Pro, to name just a few.

Some keyboard shortcuts can seem convoluted at first—Word's Command+Shift+Option+S sequence, which opens the Footnote window, is one example. But even a finger-twister like this can become second nature if you use it often enough. Our advice: check your programs' manuals for shortcuts that apply to your work, and then memorize them or make a cheat sheet for the ones you want to use. (For details on creating your own keyboard shortcuts, see Chapter 11.)



System 7 Keyboard Shortcuts

System 7 provides plenty of keyboard and mouse shortcuts that give you more flexibility in selecting icons, opening folders, naming documents, and much more.

Trend: More Keyboard Navigation Options

In earlier versions of the Mac's system software, you had to grope for the mouse to perform even the simplest selection or navigation task. Even System 6 lacks the wide array of keyboard shortcuts that System 7 provides.

Why did it take so long for Apple's interface designers to see the light? We suspect that the Microsoft Windows operating environment for DOS PCs was one factor. Windows has always provided excellent keyboard-navigation features (indeed, you can run Windows without a mouse if you have to, although it's no picnic). Or maybe Apple's engineers got tired of reaching for the mouse themselves.

Whatever the reason, the mouse remains the Mac's preferred input device, but we're glad to see the keyboard finally getting its due.

Shortcuts for Directory Dialog Boxes

System 7 provides several standard shortcuts for navigating within directory dialog boxes. Mastering these shortcuts saves time when opening or saving files. These shortcuts are built into the Mac's system software so that you can use them with any program.

Locating a file or folder. You can locate a file or folder in an Open dialog box by using the up- or down-arrow keys or by quickly typing the item's name. If you pause too long between keystrokes, the Mac assumes that the first keystroke after the pause represents a new name, not a continuation of the old one. If you type *l-e-t-t-e-r* quickly, the Mac selects a file or folder beginning with *letter*. If you type *l-e-t* (pause) *t-e-r*, however, the Mac looks for a file or folder beginning with *ter*.

Using Return or Enter to confirm the dialog box. After you locate the file or folder you want, open it by pressing Return or Enter—you don't need to reach for the mouse to click the Open button. If you select a file, pressing Return opens it. If you select a folder, the Mac opens the folder and displays its contents in the dialog box.

Opening and closing folders. To close a folder—that is, to move up one level in the storage hierarchy—press Command+up arrow. To open a folder, select it and press Return (as described previously), or select it and press Command+down arrow.

Moving up one level in the hierarchy. To use the mouse to move up one level in the storage hierarchy quickly, simply click the disk name that appears in the directory dialog box. Each click moves you one level closer to the Desktop level.

Using Tab to switch between the file list and the text-entry box. In the Save or Save As dialog box, press Tab to switch the keyboard focus between the file list and the text-entry box. When the keyboard focus is on the file list, you can select folders by typing the first few characters of their name; when the keyboard focus is on the text-entry box, you can type a name for the file. By pressing Tab to switch the keyboard focus, you can open a particular folder and then type a document name—without reaching for the mouse. When the keyboard focus is on the file list, a bold border appears around it; when the focus is on the text-entry box, a bold border appears around it (see figure 9.7).

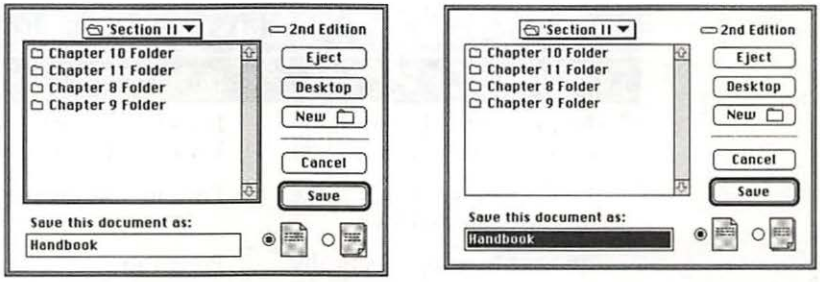
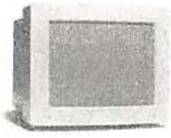


Figure 9.7: Keyboard focus is on the file list; typing selects folders (left). Keyboard focus is on the text-entry box; typing names the file (right).



TIP: If you are a System 6 user and have more than one disk on your Desktop, you can switch between them by pressing the Tab key rather than clicking the Drive button.

Creating a new folder. You can create a new folder within the currently open folder by pressing Command+N.

Accessing the Desktop quickly. Want to quickly jump to the Desktop level? Don't reach for the mouse to click the Desktop button—press Command+D instead.

Canceling the dialog box. If you decide not to open or save a document after all, you can cancel the directory dialog box by pressing Command+period (.) or the Esc key rather than clicking the Cancel button.

Selecting Icons from the Keyboard

When you're working with the Finder, you can select an icon on the Desktop or in the active directory window by quickly typing the first few characters of its name—just as you can select items within an Open or Save dialog box.

If the item you want isn't in the active window, you can still locate and select it from the keyboard—just use the Find command as described in the section "Finding Files," later in this chapter.

You also can select icons by using the keyboard's arrow keys as well as the Tab key and Shift-Tab key sequence. Table 9.5 describes these shortcuts.

Table 9.5: Keyboard shortcuts for selecting icons.

To select...	Do this...
The icon to the left or right of the currently selected icon	Press left-arrow key or right-arrow key (icon views only)
The icon above or below the currently selected icon	Press up- or down-arrow key
The next icon alphabetically	Press Tab
The previous icon alphabetically	Press Shift+Tab

After you select the icon you want and you want to open it or print it, don't reach for the mouse—just press Command+O or Command+P.

Keyboard Shortcuts for Outline Views

When you're working with folders in the Finder's outline views—by name, by date, by size, and so on—you can expand and collapse folder outlines from the keyboard using the shortcuts described in Table 9.6.

Table 9.6: Outline view keyboard shortcuts.

To do this...	Press
Expand the selected folder's outline	Command+right arrow
Collapse the selected folder's outline	Command+left arrow
Expand the entire outline of the selected folder	Command+Option+right arrow
Collapse the entire outline of the selected folder	Command+Option+left arrow

Figure 9.8 illustrates one of these shortcuts in action.

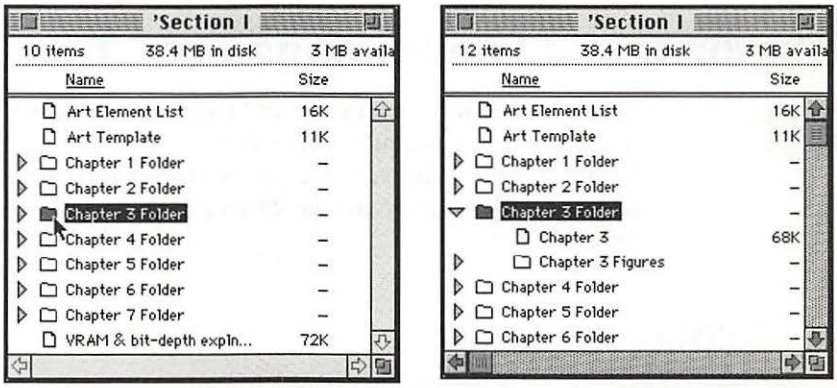


Figure 9.8: The selected folder (left). The directory window after pressing Command+right arrow (right).

Quick Reference for Finder Shortcuts

If you like the Finder shortcuts we have described here but you're worried you will not be able to remember which Command+Option+whatever sequence does what, take heart. Apple built a quick reference feature into System 7's Finder. Just choose Finder Shortcuts from the Help menu (the balloon icon on the right side of the menu bar). You can find a five-part summary of Finder shortcuts. If you want, you can leave the summary open on-screen while you work.

Controlling the Chooser from the Keyboard

The System 7 Chooser supports the same item-selection shortcuts available in the Finder and in Open and Save dialog boxes. You can select an icon (such as printer driver) by typing the first few characters of its name or by using the arrow keys. When the right side of the Chooser's window changes to reflect the item you chose, you can press Tab and then use the keyboard to select any special options. Suppose that you have two PostScript printers attached to your network and you want to choose a specific printer without groping for the mouse. First, select the LaserWriter driver, and then press Tab and use the arrow keys to select the desired printer.





Disk and File Management Tips

One of the best ways to improve the Mac's performance is to organize your hard disk's contents efficiently. This section provides tips for managing files and keeping your hard disk running at peak performance. All of these tips also apply to other high-capacity storage devices, such as SyQuest drives and Iomega Bernoulli drives.

Filing Guidelines

In a filing cabinet, folders hold related pieces of paper, enabling you to organize and quickly locate items. The Mac's electronic folders provide the same benefits for a hard disk. Rather than having to paw through hundreds of files to locate the one you need, you can go directly to a particular folder with a few keystrokes or mouse clicks. By grouping files into categories and then creating folders for each category, you can develop an efficient electronic filing system.

Equally important, extensive use of folders improves the Mac's performance. When you open a disk or folder icon, the Finder must reach out and touch every file on that disk or in that folder in order to display its name, icon, size, and other information. The more files you store within a folder, the longer this process takes. Similarly, if you leave the directory window of an overstuffed disk or folder open, you will have to wait for the Finder to sort through it every time you start up your Mac.

Filing Tips

It's obvious that folders improve the Finder's performance. But how should you organize the files on your hard disk? We cannot recommend specific filing schemes because people perform different tasks and have their own style of organization (or disorganization). But we can provide some guidelines and suggestions that you can modify to suit your needs.

- Group your documents into logical categories. Task-oriented folder names may include Correspondence, Proposals, Budgets, Memos, Client Lists, Scanned Images, and Newsletters. Or you may prefer to group documents according to when you created them: January Work, February Work, March Work, and so on. Or you may combine both approaches: Within a folder named Memos, you may create 12 additional folders: January Memos, February Memos, March Memos, and so on. Or you may mimic an alphabetized paper filing system: Within the Memos folder, create 26 folders, one for each letter of the alphabet. Then file documents according to the first character of the recipient's last name.

- Group application programs into logical categories. You may put all your graphics-oriented programs in a folder named *Graphics*, for example, all your word processing programs in a folder named *Word Processing*, and all your publishing programs in a folder named *Publishing*. If a particular program uses more than one file—perhaps it includes a help file and a few sample documents—give that program a folder of its own within the category folder.
- Separate application programs from the documents you create with them. Don't save your word processing documents in the same folder that contains the word processing program itself. Instead, create a different folder and store documents there. This approach makes it easier to locate and back up your documents.
- Create folders for storing miscellaneous documents and applications. Sometimes you create documents or use applications that don't fit into a specific category, or that you just don't feel like filing at the moment. Rather than leaving them at the top of the disk hierarchy, where they slow the Finder each time you open the disk's directory window, place them in folders named Miscellaneous Documents and Miscellaneous Applications. That isn't the most organized approach, but at least it gets them into folders, where they will not slow performance.



- Create System 7 aliases for frequently used files or folders, and then move the aliases on the Desktop. With this approach, you do not need to open the disk's directory window to access the files you use most frequently. We will look at the power of the amazing alias later in this chapter.

Finally, it's worth noting that you can nest folders approximately 12 levels deep, but navigating through more than four or five levels is a bit cumbersome.



What's in a Name?



Unlike most computers, the Mac enables you to assign lengthy, descriptive names of up to 31 characters to both folders and files. Rather than grappling with cryptic names, such as QTRBUDG.WKS and MEMO729.DOC, you can use names like *Quarterly Budget* and *July 29 Memo to Luke.*

Your choice of document names can have an impact on the efficiency of your disk filing system. Table 9.7 contains some tips for naming documents.

Incidentally, if you're fond of lengthy file names, be sure to include some differentiating characters early in their names. Otherwise, when you choose a program's Open command, you may not be able to tell which file is which.

Table 9.7: Document naming guidelines.

If you want to...	Do this...	Comments
Select the item by typing the first few characters of its name	Be sure that the file or folder contains one or more unique characters near the beginning of its name. Rather than naming a range of book chapters Chapter 1, Chapter 2, Chapter 3, for example, name them 1 Chapter, 2 Chapter, 3 Chapter, or Ch1, Ch2, Ch3.	The drawback of this approach is that it often leads to cryptic file names, and that's what the Mac's file system was designed to avoid.
Name files or folders so that they appear at the top of the list in the Open dialog box or directory window	Start their names with a punctuation character, such as a comma (,), or simply begin the name with a space.	When sorting file names before displaying them in the Open dialog box, the Mac places punctuation characters and spaces ahead of alphanumeric characters. Note that you cannot use a colon (:) as part of a file name.



The Drag-and-Drop Opening Technique

Drag-and-drop is a navigation feature that's surfacing in more and more programs. It refers to a simple technique: dragging one icon until it's on top of another icon (causing the second icon to become highlighted), and then releasing the mouse button. This technique has actually been around in one form or another ever since the Mac first appeared. When you throw a file in the Trash, for example, you're using the drag-and-drop technique.

System 7 introduced some new variations on the drag-and-drop theme. In System 7, you can open a document by dragging the document icon to an application program's icon. Many times, this isn't all that useful—in fact, it takes longer than simply double-clicking an icon. But there are times when it can be extremely handy. Suppose that you have a text-only document that you want to open with Microsoft Word. If you double-click the document's icon, you will probably get a message saying that the document couldn't be opened because the program that created it couldn't be found. Or maybe the Mac will try to start the TeachText program that's included with the Mac's system software.

To avoid either of these undesirable outcomes, simply drag the text-only file's icon to the Microsoft Word icon. When the Word icon highlights, release the mouse button. The Finder starts (or switches to) Word, which opens the document.



Streamlining Filing with Aliases

Of all of System 7's features, none streamlines filing tasks more than the *alias*. As you may recall from an earlier chapter, an alias is a small file that acts like a remote control for another file, folder, or disk. When you tell the Finder to open an alias, the Finder opens the item to which the alias points. At first glance, that doesn't seem so impressive. But as we will see shortly, aliases make possible a whole range of conveniences.

How to Make an Alias

It's easy to create an alias. First, switch to the Finder and select the item—disk, file, folder, or program—for which you want to make an alias. Next, choose Make Alias from the File menu. After a moment, the alias appears adjacent to the original item, as shown in figure 9.9.



Figure 9.9: An alias is born.

As the preceding illustration shows, an alias has the same name of the item it points to, with the word *alias* thrown in. You can rename the alias just as you would rename any other item. The alias's name always appears in *italic* type to let you know that the item is an alias.

Alias Tips

This section contains some tips for using aliases. See Chapter 13 for tips on the many ways you can use aliases with networks and System 7's file sharing features. (Remember that when we say *item* in the following tips, we're referring to a document, a program, or a folder.)

Fast Access to Items Buried in Folders

To fast access to an item that's buried within folders, make an alias of the item and then move the alias to the Desktop or to the Apple Menu Items folder (within the System Folder).

Fast Access to the Apple Menu Items Folder

If you move items (or aliases) into and out of the Apple Menu Items folder frequently, don't waste time by opening the System Folder and then the Apple Menu Items folder. Simply make an alias of the Apple Menu Items folder, and put the alias on your Desktop. You can move items into the Apple Menu Items folder by dragging them to this alias.

Easy Access to Items on Other Disks

If you use floppy disks or removable cartridges extensively, you have probably experienced the frustration of trying to remember which disk holds a particular program, file, or folder. Aliases eliminate this head scratching. Simply make an alias of an item, and then copy the alias to your hard disk. From then on, when you want to access the item, double-click its alias; the Finder will ask you to insert the disk containing the original.

Quick Access to Control Panels

If you frequently use a particular Control Panel, don't waste time by opening the Control Panels folder every time you need the Control Panel. Make an alias of the Control Panel and then move it to the Apple Menu Items folder or to the Desktop.

Aliases and the Startup Items Folder

The System Folder contains a folder named Startup Items; any items in this folder are opened automatically when the Mac starts up. You can use this folder to configure your system so that often used programs, documents, and Desk Accessories are opened and waiting for you when you start your Mac. But rather than putting original items in the Startup Items Folder, make aliases of them and store the aliases in the Startup Items Folder.

A Chain of Aliases

Suppose that you want to be able to access one from more than one place—the Desktop and the Apple menu, for example. One technique involves making an

alias of the item, and then making an alias of that alias. You can then keep each alias in a separate location.

But there's a problem with this scheme: if you delete the first alias, the second alias will not work because it points not to the original item, but to an alias. If you want to access an item from more than one place, it's better to make multiple aliases of the original item.

Alias Insights

Following are a few things to note about aliases.

- You can drag items to an alias. If you make an alias of a folder, for example, you can move an item into that folder by dragging the item to the folder's alias. Similarly, if you make an alias of a disk, you can copy an item to that disk by dragging the item to the disk's alias.
- When you select an alias and choose Get Info from the Finder's File menu, you may notice a button labeled Find Original in the Get Info window. If you click this button, the Finder locates and selects the original item. This can be useful if you need to adjust the memory requirements of a program that's buried in a folder. Select the program's alias, choose Get Info (or press Command+I), click Find Original, and then choose Get Info again.
- Aliases are smart—if you rename an item or move it to a different folder, the alias can still locate the item.
- The Finder always adds the word *alias* in a new alias's name. If you want to change that text to something else, see the customizing tip "Changing a New Alias Name" in Chapter 11.

Trashing Aliases

Aliases are smart, but they aren't geniuses. If you throw away an item for which you have created an alias, the alias remains on your hard disk. Unless you diligently remember to throw away an alias every time you throw away the item it points to, you will wind up with a bunch of obsolete aliases littering your hard disk and taking up space.

One answer to this problem is a free Control Panel called *TrashAlias*, written by Maurice Volaski and available from user groups and online services. When TrashAlias is installed, aliases are deleted automatically when you delete the files or folders to which they point.

Other Ways to Create Aliases

Several free or shareware utilities are available that streamline the process of creating and moving aliases. Following are two examples:

FinderHack, by Donald Brown (free). This system extension adds a menu to the Finder that adds several handy features. The Make Alias As command enables you to create an alias in a specific location: after you choose the command, a standard Save dialog box appears that enables you to control where the alias is located. If you use aliases to conveniently access items on other disks, this command is a real time-saver because it eliminates having to copy an alias from one disk to another. FinderHack's Make Alias in Apple Menu is another time-saver; it puts the alias in the Apple Menu Items folder for you.

Alias Director, by Laurence Harris (shareware; $7). This small program also enables you to specify the location for a new alias and provides features for deleting unwanted aliases.





Polishing Your Window Views

We have mentioned that the Finder's View menu enables you to view directory windows in several different ways—by name, by date, by icon, and more. Which view should you use? As the following observations show, it depends.

- By Icon and By Small Icon are slowest. Because the Finder must retrieve an icon's appearance and then draw the icon itself, the Finder takes considerably longer to display a directory window in either icon view. If you have a folder or disk containing a large number of files with different icons, you will get better performance by using a different view.
- By Date is useful for backing up. If you want to selectively back up files that you have modified recently, use the By Date view. Files nearest the top of the list are ones that have been created or modified more recently. Because newly created or modified files appear nearest the top of the directory window, By Date is also useful for those times when you have recently created a file but forgotten its name.
- By Kind is useful for a hard disk's top level. It places applications first, followed by documents, followed by folders. By Kind is also useful for viewing a System Folder's contents. Because this view separates files according to their type, your startup documents, system files, Chooser documents, Control Panels, and downloadable fonts are grouped together.

- By Size is useful when you need to free up disk space by deleting old or unused items. The largest files appear at the top of the list.
- By Name is useful when you're viewing the contents of a folder containing documents. In this view, files are sorted alphabetically. If you're creating a filing system that mimics an alphabetized paper filing system, By Name is the view to use.



- By Label is convenient when you want to create your own text labels and color schemes to describe the types of documents you create. (Use the Labels Control Panel to customize label names and colors.) But don't rely too heavily on the color coding available in the Label view. If you switch your monitor into grayscale mode, you will have trouble telling which colors are which. If you switch it into black-and-white mode, you will not be able to tell at all, although you will still have the text labels.

Remember that you can mix and match views as needed. You may want to use By Kind for the top level of a disk and for its System Folder, By Date for a folder whose contents you back up often, and By Name for the alphabetized folders within that Folder. The Finder remembers the last view you used for a disk and every folder on it.

A Shortcut for Switching Between Views

You can switch between views using the Finder's View menu, but you can use another way: simply click the view heading in the active directory window (see figure 9.10). If you have a large screen, this can be faster than moving the mouse pointer all the way up to the menu bar.

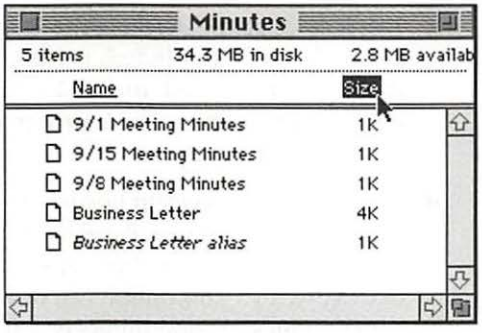


Figure 9.10: Click the desired view name to switch to that view.

Customizing Views

You can use the Views Control Panel to customize the Finder's views to show as much or as little information as you like (see figure 9.11).

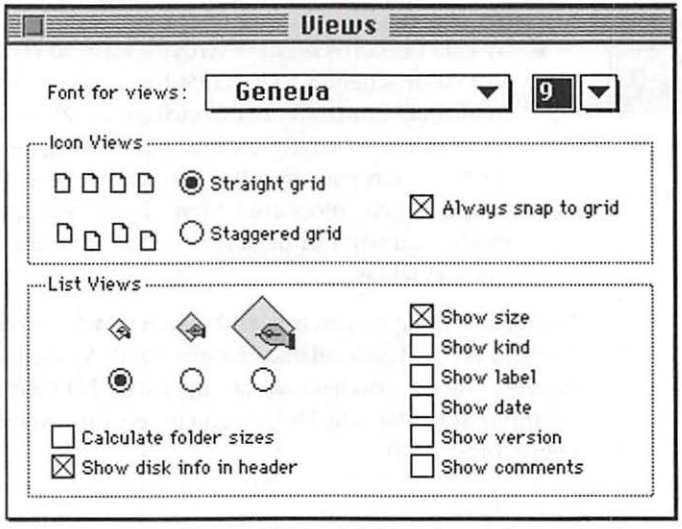


Figure 9.11: The Views Control Panel.

Following are some tips and observations on customizing views.

- If you like neatly aligned rows of icons, check the Always Snap to Grid box. This puts the Finder in what *The Odd Couple* fans will recognize as "Felix Unger mode"—it always cleans up after you.
- Think twice about checking the Calculate Folder Sizes box. When this box is checked, the Finder's performance slows considerably. When this box is unchecked, the Finder simply displays a dash (—) in a folder's Size column. If you want to determine the size of the folder's contents, select the folder and choose Get Info.
- Check the Show Version box if you want to display application, extension, and Control Panel version numbers. (Documents generally don't have version numbers, although you see how you can add them in Chapter 11.) This option can be handy if you want to check a bunch of files' version numbers without having to repeatedly use the Get Info command. (As a technical aside, the Finder retrieves version information from a file's VERS resource, which is described in Chapter 11.)

- The View menu changes depending on which Show options you checked. If you uncheck the Show Size and Show Kind options, for example, the By Size and By Kind commands vanish from the View menu. That makes sense when you think about it, although we still prefer the option of having the Finder sort windows by these items—even if the information itself doesn't appear.
- When you click a directory window's zoom box, the width of the window grows to accommodate as many columns of information as will fit on your screen. By unchecking all the Show boxes, you can use the zoom box to create a nice, thin window that shows only item names. This can speed up the process of resizing and managing the many directory windows that can litter your screen. If you need size or modification-date information, you can use the Get Info command.

In the end, the easiest way to master the Views Control Panel is to play with it—check its various options and watch your directory windows to see how they change. Incidentally, the Finder stores your Views settings in the Finder Preferences file, located within the System Folder's Preferences Folder. If you want to back up your view settings, be sure to back up this file.



If you're using System 6, you can customize many aspects of the Finder's views using a program called Layout Plus, included with the Norton Utilities. (An earlier version of the program, called Layout, is available free through online services and user's groups.) Details on Layout and Layout Plus appear in Chapter 11.



Finding Files

No filing system is perfect, and chances are that you occasionally will misplace a key document or folder. At times like those, the Finder's Find command can help. When you choose Find or use the Command+F keyboard shortcut, a dialog box appears. Type part of the file or folder name for which you are looking, and then click Find or press Return.

If the Finder locates an item whose name contains the text you typed, it selects the item for you and, if necessary, opens the folder or disk window containing the item. You can open the item by choosing Open (or pressing Command+O), or you can continue searching by choosing Find Again or pressing Command+G. If you choose Find Again, the Finder closes the window containing the last item it found.

Can You Be More Specific?

Yes, you can. The Find dialog box contains a button called More Choices. When you click More Choices, the Find dialog box expands to include pop-up menus that enable you to search using a variety of different criteria (see figure 9.12).

The search options and their criteria are described in Table 9.8.

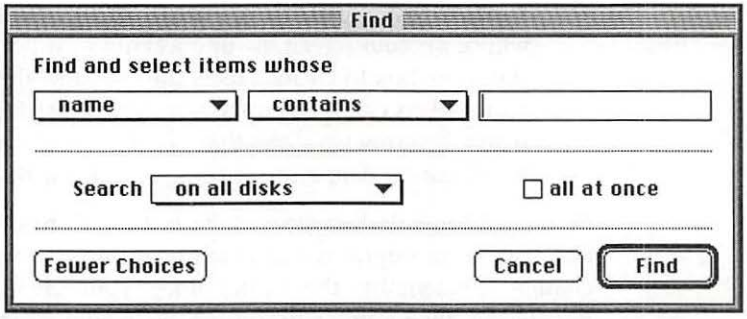


Figure 9.12: The Find dialog box after clicking More Choices.

Table 9.8: Advanced Find command options.

This search item...	Provides these options...	And you specify...
Name	Contains, starts with, ends with, is, is not, doesn't contain	Part or all of the item's name
Size	Is less than, is greater than	A size value (in K)
Kind	Contains, doesn't contain	Alias, application, document, folder, or stationery
Label	Is, is not	A label name or None
Date Created	Is, is before, is after, is not	The current date or use arrows to change to the desired date
Date Modified	Is, is before, is after, is not	The current date or use arrows to change to the desired date
Version	Is, is before, is after, is not	A version number

This search item...	Provides these options...	And you specify...
Comments	Contain, do not contain	Text that appears in the Get Info comment
Lock	Is	Locked or unlocked

Finding Everything At Once

To specify that the Finder locate and select all the items that meet the criteria you specify, click the All at Once check box. Normally, this option is unchecked, and the Finder stops each time it locates and selects an item.

Combining Search Criteria

You can combine search criteria by conducting a second search as soon as the Finder locates the items that meet the first search. Suppose that you want to find all documents modified before December 1, 1992. First, search for all documents (the Find pop-ups read "kind contains documents") with the All at Once option checked. After the Finder selects all the documents, change the pop-ups to read "date modified is before 12/1/92."

Combining Find with Keyboard Shortcuts

By combining Find with keyboard shortcuts, you can open any item on your hard disk with just a few keystrokes—no riffling through folders and dragging windows around. Just press Command+F, type part of the name of the item you want to open, and then press Command+O (or, to print the item, Command+P).



Finding Files with System 6

System 6's Finder lacks the Find command, but System 6 does include a Desk Accessory called Find File. Find File isn't nearly as useful as the System 7 Find command, but it still enables you to locate a misplaced item.

To use Find File, open the Desk Accessory, type all or part of a file's name, and then press Return or click the Go button (the icon depicting a person in a frantic search). If Find File locates files whose names match what you typed, it displays their names. Click a name, and Find File displays information about that file and shows where it's located (see figure 9.13).

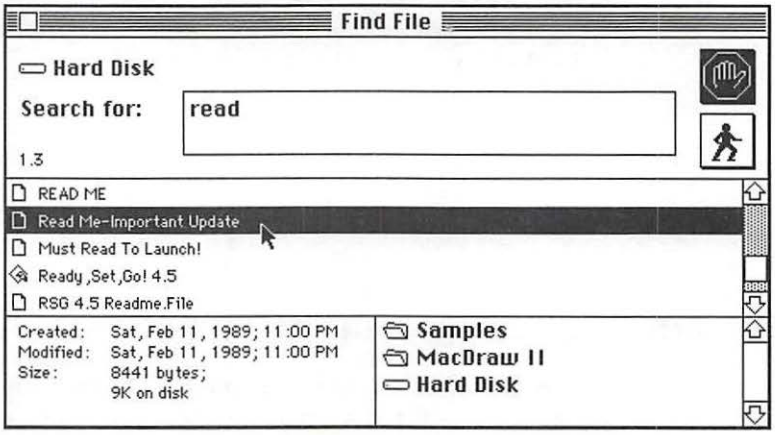


Figure 9.13: Find File in action.

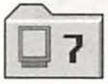
Find File is easy to use, but there are several fine points of which you need to be aware.

- Regardless of whether you're using MultiFinder, Find File conducts its search in the background, so you can switch back to an application or open a different Desk Accessory while it searches. (Don't click Find File's close box to return to an application program; doing so halts the search.) When Find File has searched an entire disk, it beeps and the stop sign icon is highlighted.
- Find File conducts logical AND searches; if you separate two character strings with a space, Find File searches for only those files containing both strings. If you type *New Proposal,* for example, Find File will locate files named *New Franchise Proposal, Proposal for New Wing, Newton Proposal,* and *New Proposal.* It will not locate files named *Eric's Proposal* or *New Suggestions,* since neither of those names contain both character strings.
- You can use the Search Here command in Find File's menu to specify that the Desk Accessory search a specific disk or folder. You may use Search Here to specify that Find File look for a document stored on a network file server. Another way to aim Find File at a different disk is to click the disk icon in the upper-left corner of Find File's window.
- You can use the Move to Desktop command to move a file or folder to the Desktop for quick access. (As mentioned earlier in this chapter, this command is an easy way to disable an Init.) To restore the file or folder to its previous location, select it and choose Put Away from the Finder's File menu.

As you see in Chapter 11, several extensions and Desk Accessories are available that provide more sophisticated file-locating features than Find File.



Finder Shortcuts



The Finder provides a variety of shortcuts that enable you to manage disks, files, and directory windows more efficiently. Table 9.9 contains System 7 Finder shortcuts; Table 9.10 is for System 6.

You also can create your own shortcuts by using keyboard utilities, such as CE Software's QuicKeys, or by using a resource-editing utility, such as ResEdit. Details and some suggested shortcuts appear in Chapter 11.

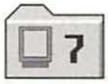


Table 9.9: System 7 Finder shortcuts.

To accomplish this...	Do this...
Eject a disk and remove its icon from the Desktop	Drag the icon to the Trash or select the disk and choose Put Away (Command+Y).
Select an icon from the keyboard	Type the first few characters of its name.
Bypass the warning dialog box that appears when you choose Empty Trash	Press Option when choosing Empty Trash.
Hide the current application when switching to another application	Press Option while choosing the desired program from the application menu.
Rename an icon	Select it, press Return, and then start typing.
Quickly determine whether a file is locked or unlocked	Select the file and press Return. If no border appears around the name, the file is locked.
Clean up everything	Press Option and choose Clean Up All.
Clean up selected items only	Press Shift and choose Clean Up Selection.
Organize icons by name	Choose By Name from View menu, then choose By Icon or By Small Icon. Next, press Option and choose Clean Up by Name.
Close all disk/folder windows	Press Option while clicking a close box or choosing Close.
Copy a file from one folder to another rather than moving it	Press Option while dragging the file to the destination folder.

continues

Table 9.9: Continued

To accomplish this...	Do this...
Copy an item to the Desktop rather than moving it	Press Option and drag the item to the Desktop.
Open an item and close its window	Press Option and double-click the item.
Open the folder or disk window that holds the current directory window	Press Command while clicking on the window's title, then choose desired folder or disk name.
Abort a program that seems to have crashed	Press Command+Option+Esc and click Force Quit.
Open a document with a program that may not have created the document	Drag the document's icon to the program's icon or alias.
Skip installing all system extensions during one startup	Hold down Shift during startup
Select the item nearest the upper-right corner of the Desktop	Press Command+Shift-up Arrow
Zoom a directory window to fill the screen	Press Option while clicking the window's zoom box.

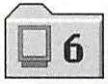
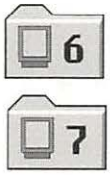


Table 9.10: System 6 Finder and MultiFinder shortcuts.

To accomplish this...	Do this...
Bypass the warning dialog box when you discard a program or system file	Press Option while dragging the file to the trash.
Close all open directory windows	Press Option while clicking any window's close box or choosing Close command *or* press Option immediately after quitting an application (Finder only).
Move an inactive window without activating it	Press Command while dragging the inactive window's title bar (works in applications, too).
Copy a file from one folder to another rather than moving it	Press Option while dragging the file to the destination folder.
Start MultiFinder when the Finder is running	Press Command and Option while double-clicking the MultiFinder icon in the System Folder.

To accomplish this...	Do this...
Quickly determine whether a file is locked or unlocked	Select the file, then move the pointer over the file's name. If the I-beam pointer appears, the file is *not* locked.
Quickly switch between applications when running under MultiFinder	Click the icon at the far right of the menu bar.
Align all icons in a window	Press Option while choosing Clean Up from the Special menu.
"Program" a directory window to close automatically when you return to the Finder	Press Option while opening the directory window (Finder only).
Rebuild a disk's DeskTop file (see Chapter 15)	Press Command and Option while inserting the disk. For hard disks, disable MultiFinder, then press Command and Option immediately after quitting an application program.



Can I Quote You?

An easy way to make your laser-printed documents look professionally typeset is to use the typographer's quotes and dashes that the Mac provides. These characters, shown in Table 9.11, are available no matter what kind of printer you use.

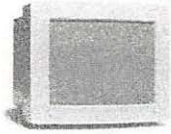
Table 9.11: Typesetter's characters and how to type them.

Character	Key Sequence
Open single quote (')	Option+]
Closed single quote (')	Shift+Option+]
Open double quote (")	Option+[
Closed double quote (")	Shift+Option+]
Em dash (—)	Shift+Option+minus (-)
En dash (–)	Option+minus (-)

The *em dash* is generally used where you would normally type two hyphens, as in "George is late—again." The *en dash* is often used in place of the word "to,"

as in "I'm on the San Francisco–Pittsburgh flight." Single *opening* and *closing quotes* are generally used to set off a quote that appears within a quote, as in "He said, 'Can I help you?'"

Most word processing programs and desktop publishing programs provide a *smart quotes* feature that creates the proper opening and closing quotes for you automatically as you type (or, with most publishing programs, when you open a word processing file). You can add a smart quotes feature to any program by using a free system extension called *SmartKeys*, written by Maurice Volaski and available through user groups and online services. SmartKeys not only converts quotes as you type, it also optionally converts double hyphens into em dashes, uses ligatures when available, and prevents you from typing more than one consecutive space. If you cannot find SmartKeys, look for Quote Init, a $15 shareware extension that performs the same basic functions, but not as elegantly.



TIP: If you're using a word processing program to type a message that you plan to transmit on a communications service, such as America Online, disable the smart quotes feature before typing the message. (SmartKeys makes this easy by enabling you to specify a list of programs in which its conversion features should be disabled.) Communications services generally cannot interpret the Mac's typesetter's quotes, and substitute other characters in their place.





The Importance of Backing Up

The Mac is generally very reliable, but hardware and software can fail, and when they do, they can take your work with them. So, no matter how you use your Mac, one of the most important things you can do is to make backup copies of your disks at regular intervals.

Backing Up Floppy Disks

If your Mac has one floppy drive and a hard disk, you can back up floppies in two ways:

- If the hard disk has enough free space on it, you can use the hard disk as an intermediary. First, copy the original floppy disk's contents to the hard disk by dragging the floppy's icon to the hard disk. When you do, the Mac creates a new folder on the hard disk and stores the floppy's contents within it. Next, eject the original floppy, insert the

backup floppy, and copy the contents of the new folder to the backup. Finally, you will probably want to throw away the new folder on the hard disk to free up space.

- If you cannot or don't want to use the hard disk as an intermediary, you can still back up a floppy on a one-floppy drive system, but you will need to do some disk swapping. First, insert the backup disk, and then select its icon and choose Eject from the Finder's File menu. The Finder dims the disk's icon to show that the disk ejected but that the Finder still knows about it. Next, lock the original disk, insert it, and drag its icon to the backup disk's dimmed icon. When asked if you want to replace the backup disk's contents, click OK. During the backup process, you will be asked to swap disks as needed.

Floppy disks are easier to back up if your Mac has two floppy drives. If it does, first lock the original disk (slide the plastic tab in the corner of the disk so that you see through the small square hole), and then drag its icon to a second floppy disk. When the Mac asks if you want to replace the contents of the second disk with those of the first, choose OK.

Backing Up a Hard Disk

The easiest way to back up a hard disk is by using a *backup utility program*. If you use System 6, you can use the *HD Backup* program that accompanies the System 6 package. If you use System 7—or you want a more fully featured backup utility for System 6—consider a commercial program, such as Dantz Development's *DiskFit* or *Retrospect*. The Norton Utilities 2.0 also comes with a powerful backup program.

These sophisticated backup programs enable you to be more selective about which files you want to back up; you can, for example, choose to back up only applications or only documents. After you specify what you want to back up, the program tells you how many floppy disks you need and prompts you to swap disks during the backup process.

Specialized Backup Hardware

The problem with backing up a hard disk—and the biggest reason why most people don't do it often enough—is that hand-feeding floppy after floppy is boring and tedious. For backing up large-capacity hard disks, you may consider another storage device, such as a *tape drive,* which uses special tape cartridges to store the contents of a hard disk, or a *removable media drive,* such as an Iomega Bernoulli drive or one of the many drives based on SyQuest mechanisms. These cousins to hard disks store between 40 and 90 megabytes on removable

cartridges; they're much faster than tape drives, and you can use them for general-purpose storage along with your hard disk. You learn about these drives in Chapter 17.

Developing a Backup Strategy

How often should you back up? That depends on how much you use your Mac. Use this rule of thumb—back up when you reach the point where you wouldn't want to re-create lost work if the worst happened.

Some people alternate between two sets of backups, such as backing up to Set #1 on Monday, to Set #2 on Tuesday, and then reuse Set #1 on Wednesday. With this approach, if one backup set fails, you have another as a safety net.

Because fire, water, and thieves don't discriminate between backups and originals, it's a good idea to store your backup disks separately from the originals—at home if your Mac is in the office, in the office if your Mac is at home, or in a safe-deposit box if you want extra security.

An Informal Backup Approach

If you store all your documents separately from your applications, an informal backup approach may work for you. Rather than running a backup program, simply drag an entire folder full of documents to a floppy disk or, better still, to a high-capacity drive, such as a second hard drive, a network file server, or a SyQuest or Bernoulli drive.

This approach means more work for the Mac because it copies every file within the folder, regardless of whether it was modified since your last backup. It takes hardly any effort on your part, however, and you don't need to buy a backup program. Simply start the informal backup before you go to lunch or take a break.

Whether this approach will work for you depends on the types of documents you store and their size as well as the backup medium you use. If you're backing up QuickTime movies or large scanned images, obviously you cannot drag your documents folder to a floppy disk. If you have access to a second high-capacity storage device, however, it's worth considering.

Extra Insurance

Finally, for additional insurance against lost work, consider buying a disk utility package, such as the Norton Utilities. These products contain specialized software that enable you to resurrect damaged or accidentally deleted disk files and recover disks that you accidentally erased. They cannot replace a diligently followed backup routine, but they can help you recover a disk or file that's damaged in between backup sessions. We will take a closer look at file-recovery utilities in Chapter 17.

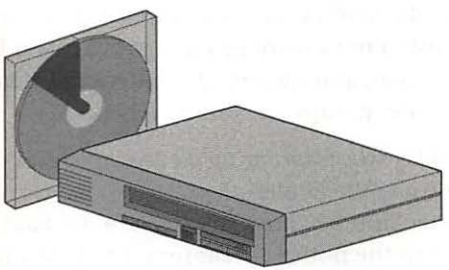
CHAPTER

10

FINE-TUNING THE SYSTEM

WHAT'S INSIDE

- Streamlining the System Folder to save disk space and memory
- Managing extensions and Control Panels
- When to use virtual memory—and when to avoid it
- Configuring a Mac for best performance
- Color versus monochrome: the performance angle
- Boosting performance with disk caches and RAM disks
- How to fine-tune program memory requirements to get the most from your Mac's memory
- Switching between the Finder and MultiFinder when running System 6

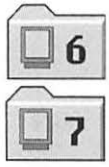


Knowing how to use a Macintosh is one thing; knowing how to fine-tune one for best performance is another. In this chapter, we open the hood and start tinkering with the Mac's system software and with the System Folder itself.

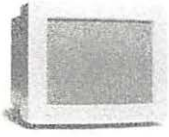
As with other chapters, use the margin icons to locate the tips that apply to System 6, to System 7, or to both system versions.

Managing Extensions

Now and then, you may need to disable an extension or Control Panel temporarily. Perhaps it uses memory that you need for a particularly voracious program, or perhaps you suspect a conflict between it and another extension or Control Panel. Following are three techniques for managing extensions.



Drag 'em by hand. One way to disable an extension or Control Panel temporarily is to first drag it to the desktop (the gray-shaded area on which the Trash icon and disk icons rest), and then restart the Macintosh. To move the extension or Control Panel back to the appropriate place within the System Folder, select it and choose Put Away from the Finder's File menu.



TIP: Rather than rooting through the System Folder in search of a particular extension or Control Panel, use the System 7's Find command or System 6's Find File Desk Accessory to locate it (see the section on finding files in the previous chapter).



Use Extension Manager. A easier way to manage extensions under System 7 is to use a Control Panel called Extension Manager. Written by Apple programmer Ricardo Batista, Extension Manager displays a scrolling list box where you can select the extensions and Control Panels you want active or disabled (see figure 10.1).

When you close Extension Manager, it copies disabled extensions and Control Panels to different folders within your System Folder, where they are loaded by the Mac's system software when you restart. To reactivate an extension or Control Panel, simply reopen Extension Manager, select the files, and then restart. Extension Manager is available free from user groups and online services.

Hold down the Shift key when starting up the Mac. You can disable all extensions by choosing the Finder's Restart command and then holding down either Shift key until the `Welcome to Macintosh` message appears with the notice `Extensions Off` below it. When you

start the Mac this way, all extensions are disabled, and virtual memory and file sharing are turned off. If you're having problems with extensions or you need every bit of RAM possible, use this technique.

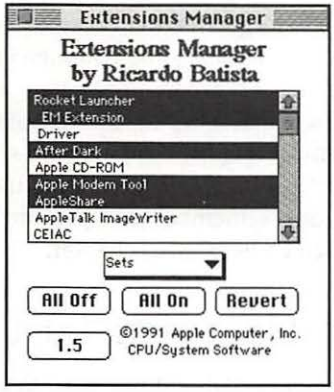


Figure 10.1: Choosing extensions with Extension Manager.



System Folder Setup

This section contains tips for streamlining your System Folder. The techniques described here can help you conserve memory and disk space—two scarce commodities on many Macs.



Saving Disk Space By Removing Extensions and Control Panels

Chapter 5 describes the extensions and Control Panels that accompany System 7 and 7.1. Examples include CloseView, for magnifying the screen image; Easy Access, for simulating mouse movements using the numeric keypad; and Sharing Setup, File Sharing Monitor, and Users & Groups for managing System 7's file-sharing features.

Each of these files performs a useful task, but none are essential to the Mac's basic operation. You can save memory by dragging one or more of them out of the Extensions or Control Panels folder and onto the desktop or into another folder, and then restarting.

If you never plan to use them, you can throw them in the Trash and save some disk space, too. (Be sure you have copies elsewhere before throwing them away.)

In this day of multimegabyte Macs and hard disks, saving a few hundred bytes of disk space here and there may not seem very exciting. Still, there are times

when every little bit—or kilobit—helps, especially if you work with disk- and memory-intensive data, such as QuickTime movies and still color images, or if you're trying to shoehorn as much as possible into a PowerBook's built-in hard drive.

It's easy to forget that many extensions and Control Panels also nibble away at your RAM. In fact, some commercial extensions use far more RAM than the ones we have been discussing here. Farallon Computing's Timbuktu software (described in Chapter 13) uses at least 125K to 150K of RAM, for example, while CE Software's QuicKeys keyboard-enhancement utility (covered in the next chapter) uses over 100K. If you use these or other similarly RAM-hungry extensions, remember that you can recover their RAM by disabling them as described earlier in this chapter.

Other Ways to Streamline the System Folder

When you're paring down your System Folder, don't confine your efforts to extensions and Control Panels. Many other System Folder files may be candidates for the Trash. In particular, you should get rid of any printer drivers that aren't applicable to your system. If you don't have an ImageWriter and you never format documents intended for one, for example, there's no reason to waste 46K of disk space on its driver. Table 10.1 lists the disk space used by the printer drivers that accompany System 7.

Table 10.1: Disk space used by System 7.1 printer driver

Driver	Disk Space Used
ImageWriter	46K
AppleTalk ImageWriter	51K
LQ ImageWriter	65K
LQ AppleTalk ImageWriter	73K
Personal LaserWriter LS	102K
StyleWriter	108K
LaserWriter	219K
Personal LaserWriter SC	72K
Total	736K

Other candidates for the silicon landfill include Control Panels that aren't applicable to your hardware. If you have a Mac Classic, SE, or Plus, for example, you don't need the Control Panels that pertain to a Mac II-class machine, such as Color and Monitors.

And remember that you can save disk space by removing unneeded fonts from the System file (or from System 7.1's Fonts folder, located within the System Folder). You can clean out your electronic type foundry in two ways: by removing entire typefaces you don't use, or, for bitmap fonts, by removing only those font sizes you don't use. If you use Courier for writing manuscripts, for example, you wouldn't want to remove the 12-point size, but you could purge the larger sizes. The larger the font size, the more disk space it uses.

If you use bitmap fonts with an ImageWriter or other QuickDraw-based printer, however, don't remove any sizes that the printer's driver requires to produce high-quality output. Don't remove a 24-point font size, for example, if you plan to print that font in 12-point using an ImageWriter's best-quality mode. If you use a PostScript printer, you can still get excellent results when printing with the larger sizes, even though the derived sizes will look jagged on-screen.



Living without MultiFinder: Streamlining System 6

The previous section discussed System 7, but much of it applies to System 6, too. You can pare down System 6's appetite for disk space by removing unneeded printer drivers, extensions (INITs), and Control Panels.

Another effective way to save RAM and disk space is to remove the system files associated with MultiFinder. Removing MultiFinder-related files from a system disk prevents you from using MultiFinder with that disk, but if your Mac has only 1MB or 2MB of memory, or if you use huge application programs on a 4MB or 5MB machine, you may not get much use out of MultiFinder anyway.

If you want the option to use MultiFinder but you can live without its background printing option, remove only the PrintMonitor and Backgrounder files, leaving the MultiFinder file intact.

If you have a hard disk, saving RAM is probably more important than saving disk space. In that case, don't throw away any MultiFinder-related files. Instead, use the Finder's Set Startup command to specify that your Mac run under the Finder, not MultiFinder. Restart the Mac after using the command to put the changes into effect. By not running under MultiFinder, you will often gain enough memory to run an application program that isn't able to run under MultiFinder.

You will find more tips for saving memory and for working with MultiFinder later in this chapter.

Use At Ease When Memory is Tight

In Chapter 5, we introduced At Ease, which creates a simplified interface intended primarily for home and educational use. At Ease provides another benefit, however. When you use it rather than the System 7 Finder, you have an additional 200K available for programs.



How to Use System 7 Virtual Memory

As you may recall from earlier chapters, System 7 provides a virtual memory feature that enables the Mac to treat a hard disk as an extension of memory, *swapping* programs from RAM to a storage file located on the hard disk, and vice versa. Virtual memory tricks the Mac into thinking that it has more RAM than it really does have.

System 7 virtual memory works on all Macs except the Plus, SE, Classic, and PowerBook 100; to use virtual memory with the original Mac II, you must add the optional paged memory-management unit (PMMU) chip, a Motorola 68851.

To activate virtual memory, open the Memory Control Panel and click the On button in the Virtual Memory section. (If you don't see the virtual memory section, your Mac doesn't support virtual memory.) Next, click the up or down arrow as needed to specify the amount of total memory you want. If you have more than one hard disk, you can use the Select Hard Disk pop-up menu to choose which hard disk you want to use for the virtual memory storage file. You get the best results if you choose the fastest hard disk you have. Finally, choose the Special menu's Restart command to put your changes into effect.

The Memory Control Panel doesn't let you select a removable-media drive (such as a SyQuest or Bernoulli drive) for virtual memory storage. The reason is simple. If you were to eject a cartridge containing the virtual memory storage file, a system error would probably occur. If you're willing to take that risk—perhaps your removable-media drive is your sole storage device—see the tip "Using Virtual Memory with Removable Media" in Chapter 11.

Virtual Memory Drawbacks

Virtual memory can get you through a temporary memory crunch, but it doesn't eliminate the need for memory expansion. You will probably want to add as much real RAM as needed to accommodate the most memory-hungry

application program you plan to use. Otherwise, you will have to endure painfully slow performance as the Mac constantly swaps data between RAM and the hard disk. Virtual memory is most useful for extending the number of programs you can run at once—provided that each program fits within your Mac's real RAM.

Another drawback of virtual memory is that it devours hard disk space, requiring roughly twice as much as you've set aside for memory. (If you use virtual memory to turn a 4MB Mac into an 8MB Mac, for example, you will use 8MB of hard disk space.) At this writing at least, memory prices are at their lowest levels in years, and you may be better off buying a real memory upgrade.

Also note that using virtual memory on a battery-powered Mac will drain your battery quickly because the Mac will have to access the mechanical hard disk more often. If you activate virtual memory on a PowerBook, you will see a message to this effect.

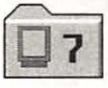
By the way, if you have a 68000-based Mac and you're thinking of buying a 68030 accelerator board, note that System 7's virtual memory software will not work with the accelerator. System 7's virtual memory relies on software routines that aren't present in the ROM chips of 68000-based Macs. But don't give up on virtual memory: you can still use it with a 68030-accelerated Mac by buying Connectix Corporation's Virtual utility; indeed, Virtual is included with many 68030 accelerators.



Virtual Memory with System 6

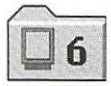
Versions of Connectix Corporation's Virtual are also available that add virtual memory features to System 6. The same basic virtual memory points apply to System 6: virtual memory is useful for those times when you want to run numerous programs simultaneously, provided that you have enough real RAM to accommodate the largest program you use. If you don't, your Mac will spend a great deal of time swapping data between the hard drive and RAM—and you will spend a great deal of time waiting for it.





Virtual Memory and QuickTime

If you're using programs that rely on Apple's QuickTime extension to play back digitized video clips and sound, avoid using virtual memory. It can cause choppy, erratic movie playback.



Taking Screen Snapshots



In the last chapter, we mentioned that one way to remember the various navigation options a program provides is to make a cheat sheet. The System file contains an FKEY that saves the screen image as an image file when you press Command+Shift+3. In System 6, this image is a MacPaint-format file; in System 7, it's a PICT file.

This FKEY was designed primarily to make the Mac's screen easy to reproduce in manuals and books. (It's hard to imagine it now, but reproducing a computer's screen used to mean photographing it.) You can use the snapshot FKEY to take electronic snapshots of your programs' palettes and dialog boxes, and then combine and annotate them using a graphics program.

Following are a few tidbits to keep in mind about the snapshot FKEY.

- Because of the way the Mac responds to the mouse button, the Command+Shift+3 sequence does not enable you to take a snapshot of a menu that's pulled down or of any event that involves the mouse button being down (such as an opened pop-up menu). If you need to take snapshots of open menus or other mouse-down events, use a commercial screen-capture utility, such as Mainstay's Capture.



- Images are named Picture 1, Picture 2, Picture 3, and so on. If you have more than one video card or monitor attached to your Mac, the picture contains the entire desktop.

- You can open and print your screen snapshots using the TeachText program that accompanies System 7. If you want to annotate the image or crop out unimportant sections of it, you can use a graphics program, such as MacDraw, a publishing program, such as Aldus PageMaker, or a word processing program, such as Microsoft Word.



- Under System 6, the Mac names snapshot documents Screen 0, Screen 1, Screen 2, Screen 3, and so on, through Screen 9. If all ten names exist when you press Command+Shift+3, the Mac beeps. To create additional snapshots, throw away or rename one or more existing snapshots. Keep in mind that System 6's snapshot FKEY creates MacPaint, not PICT, files.

- If you have the standard Apple Video Card installed on any member of the Mac II family, snapshots appear sideways (in landscape orientation) on the page. If you want the final image to contain just a portion of the screen, cut or copy that portion, paste it into a new document, and then use your paint program's Rotate command to reorient it.

- The Command+Shift+3 FKEY doesn't work if you have a color Mac configured to display colors or gray shades. Use the Monitors Control Panel to put the Mac in black-and-white mode. Utilities are available that let you take snapshots of a color or grayscale display; see Chapter 11 for details.



Performance Tips

This section is a collection of tips and insights for getting maximum performance out of your Mac by optimizing the settings of its video circuitry and by using RAM to decrease the need for disk accesses.





Matching the Video Mode to the Task

Many people who have color Macs leave their machines in color mode all the time, whether they're working with a color graphics program or with a page of black-and-white text in a word processing program. It's true that icons and windows look great in color (especially with System 7), but manipulating the extra memory required to create color screens takes time—time that could be better spent on other tasks.

A better operating approach is to match the current video mode to the task at hand. If you're using a word processing program and don't need color, for example, switch into black-and-white mode. (By *black and white,* we're referring to the one-bit-per-pixel mode.)

What kind of performance gain can you expect? We ran some informal tests on a Quadra 700, and found that it took 77 seconds to scroll through this chapter's text in 256-color mode, and a whopping 238 seconds in millions-of-colors mode. In black and white mode, the same task took only 25 seconds. Are color icons and windows really worth such a dramatic decrease in performance?

You will notice performance differences like these in any program that performs extensive screen drawing. In another test we performed, Aldus PageMaker required 6 seconds to redraw a two-page spread with the Mac in 256-color mode. In black-and-white mode, however, the time dropped to 3 seconds.

You will get the best performance out of your Mac if you use the Mac's color or gray scale modes only when your current task requires it. Using the Monitors Control Panel to switch between modes doesn't take *that* long, and the time you spend doing it will be paid back with interest by the Mac's faster performance.

Faster Ways to Switch Video Modes

Although it doesn't take that long to summon the Monitors Control Panel, there are even faster ways to switch video modes. One is with a free FKEY called *Switch-A-Roo*, by Bill Steinberg. Switch-A-Roo is available from user groups and online services.

You install Switch-A-Roo into your System file using Apple's ResEdit. (Or, leave it out of the System file and access it with a system extender utility, such as Suitcase II. Both ResEdit and Suitcase II are described in Chapter 11.) In either case, after you install Switch-A-Roo, you use it to specify your two favorite video modes (see figure 10.2). After that, you can switch between the two modes by simply pressing Command+Shift+9 rather than using the Monitors Control Panel.

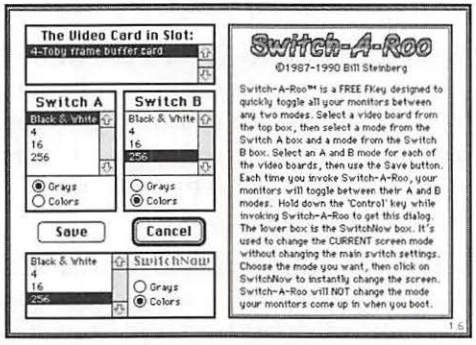
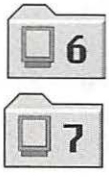


Figure 10.2: Setting up Bill Steinberg's Switch-A-Roo.

After you set up Switch-A-Roo the first time, it creates a file in your System Folder called Roo File, which stores the results of your setup. To specify different operating modes, invoke Switch-A-Roo by pressing Ctrl+Command+Shift+9. Or, simply throw the file Roo File in the Trash.

You also can quickly switch between two video modes by using the ScreenEase extension that accompanies CE Software's QuicKeys utility, described in Chapter 11.



Keeping Your Hard Disk in Tune

As you use a hard disk, its contents become *fragmented*—files are scattered across the disk rather than being stored in contiguous blocks. Just as it takes you longer to read an article that's scattered throughout a magazine rather than printed on contiguous pages, it takes a hard disk longer to load a fragmented file into

memory. We will explore the concepts behind fragmentation in Chapter 15. For now, it's enough to say that fragmentation slows a hard disk, and that there are ways to cure it.

One way to defragment a disk is to run a defragmentation utility, which reorganizes the disk's contents so that all files are contiguous. Several Macintosh disk utility packages include defragmentation utilities; the Speed Disk program that accompanies the Norton Utilities for the Macintosh (see figure 10.3). Defragmentation utilities are also called *disk optimizers*.

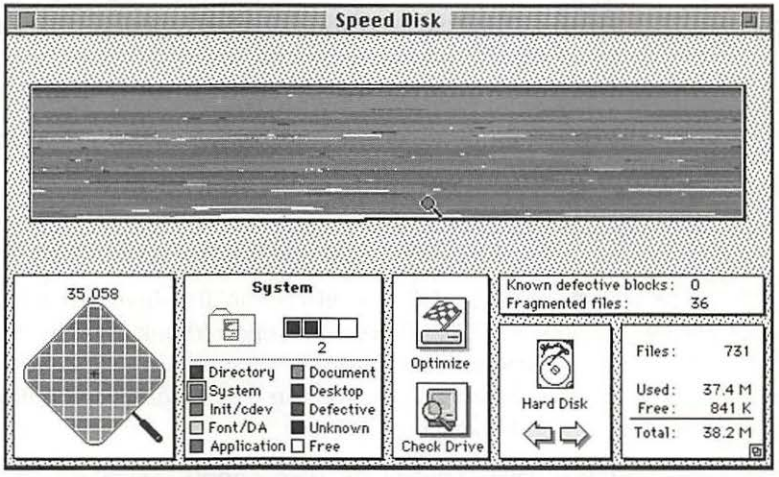


Figure 10.3: Optimizing a disk with Speed Disk.

Before running a disk optimizer, back up the entire hard disk. If a power outage or system crash occurs during the defragmentation process, you can lose files.

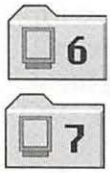
Defragmenting by Hand

Another way to defragment a hard disk is to first back it up, erase it, and then copy your applications and documents back to the hard disk. When you restore the hard disk's contents, begin by copying the System Folder. Then, copy the applications you use most often, and then your most frequently accessed documents.

What's the Best Way to Defragment?

Should you use a defragmentation utility or perform the task "by hand?" The manual approach requires more time, but it also gives you a chance to do some

spring cleaning, purging your disk of those dusty programs and files you no longer use. The automatic approach requires less effort, so you will probably use it more often.



Using Disk Caches and RAM Disks

Disks—even hard disks—are slow when compared to memory. Within memory, data moves at the speed of light. With disks, data-transfer speeds are restricted by the mechanical nature of the rotating disk and the drive's read/write heads. For this reason, you will always get better performance when you keep as much of an application program or document in memory as possible. Put another way, you will get better performance when you minimize disk accesses.

You can minimize disk accesses in the following two ways:

- With the *disk cache* option available in System 7's Memory Control Panel and System 6's General Control Panel, you can adjust the size of the disk cache to provide the best performance for your programs.
- Use a *RAM disk,* an electronic disk drive that actually exists in the Mac's RAM. If you have a PowerBook, IIvx, IIvi, Performa 600, or Quadra, you can use the Memory Control Panel to create a RAM disk; with other Macs, you can use any of several utility programs to create and manage a RAM disk.

If you have a PowerBook, there's another good reason to fine-tune your disk cache and, if appropriate, use a RAM disk: by reducing disk accesses, you get more operating time between battery charges.

Disk Cache, RAM Disk—What's the Difference?

On the surface, a disk cache and a RAM disk provide the same benefit—they cut down on disk accesses by storing program code and data in memory. Beneath the surface, however, these two performance-boosting options work very differently.

A disk cache saves the most recently accessed program code and data in memory, in the likely event that it will be required again later. If it is required again, the Mac retrieves it from the RAM cache, eliminating the need for a disk access. As the cache fills, older code and data are replaced by more recently accessed code and data. (Conceptually, this process works similarly to the font cache in a PostScript printer that we talked about in the previous chapter.) The Mac's disk cache is always on, but you can control how much RAM is reserved for caching.

On the other hand, a RAM disk is not dynamic; that is, unlike a disk cache, its contents don't change to match the way you use the Mac. *You* determine what the RAM disk will contain. If you store an application program on a RAM disk, it will start and run at top speed.

Note that RAM set aside for caching or for a RAM disk is not available for running programs—if you create a disk cache or RAM disk that is too large, you may not have enough free memory to run your programs.

Which should you use and when? That depends on how much memory you have, and also on how you use your Mac.

Cache Advantages

A disk cache generally provides better performance improvements than a RAM disk under the following circumstances.

- When you switch between two programs frequently using System 7 or System 6 MultiFinder. In this case, parts of each program are stored in the cache, reducing disk accesses when you switch between them.
- When you regularly repeat certain tasks during a work session.
- When you use a large, complex program extensively. In such cases, you probably hear your hard disk being accessed frequently as the Mac swaps portions of the program into and out of memory. (If the hard disk has an activity light, it flashes frequently.) Large programs will run faster when portions of them are in the disk cache.
- When you're sorting a large database or editing a large word processing document. In this case, parts of the database or document will be stored in the cache. (Many data base managers provide their own internal caching; with such programs, using the Mac's disk cache won't improve sorting and data-retrieval performance, but it is likely to improve other aspects of the program's operation, such as displaying large dialog boxes or switching between form-layout and data-retrieval modes.)

The degree of improved performance you can expect from a disk cache depends on the speed of your Mac and, particularly, its hard disk. The slower your hard drive, the more improvement you can expect from a disk cache.

So how large a disk cache should you use? As a general rule, the larger the cache, the better the performance increase, until the cache size equals roughly 25 percent of your total amount of RAM. On a 2MB machine, for example, you shouldn't create a cache larger than 512K. In the end, there are no carved-in-stone rules regarding disk cache size. You need to balance the benefits of the disk cache against its disadvantages.

Cache Disadvantages

The Mac's disk cache has the following drawbacks.

- It uses memory that could otherwise be used to run programs. On a 2MB machine, not using a large disk cache can make the difference between being able to run a program and not being able to run it.
- Its performance improvement is minimal if your computing routine is haphazard rather than repetitive. If you jump between different programs to perform different tasks, much of the code and data that are squirrelled away in the cache may not be needed again.



RAM Disks

A RAM disk isn't actually a disk at all; it's an area of memory that the Mac *thinks* is a disk. You can store system files and/or applications on a RAM disk, and run them at top speed.



Creating a RAM Disk on a Quadra, IIvx, or PowerBook

If you have a Quadra, IIvx, IIvi, Performa 600, or PowerBook, you can create a RAM disk using the Memory Control Panel. Click the On button in the RAM Disk area and then use the slider to specify the size of the RAM disk. Finally, restart the Mac. When the Finder reappears, you will see the RAM disk and its unique icon (see figure 10.4).

After the Finder reappears, you can copy application programs or system files to the RAM disk. The RAM disk retains its contents even if you restart the Mac or press the reset switch. The RAM disk will be lost, however, if you choose Shut Down. (This doesn't apply to a PowerBook 100, which retains a RAM disk even if you shut down.) Before actually shutting down, however, the Finder displays a warning message and gives you a chance to change your mind (see figure 10.5).

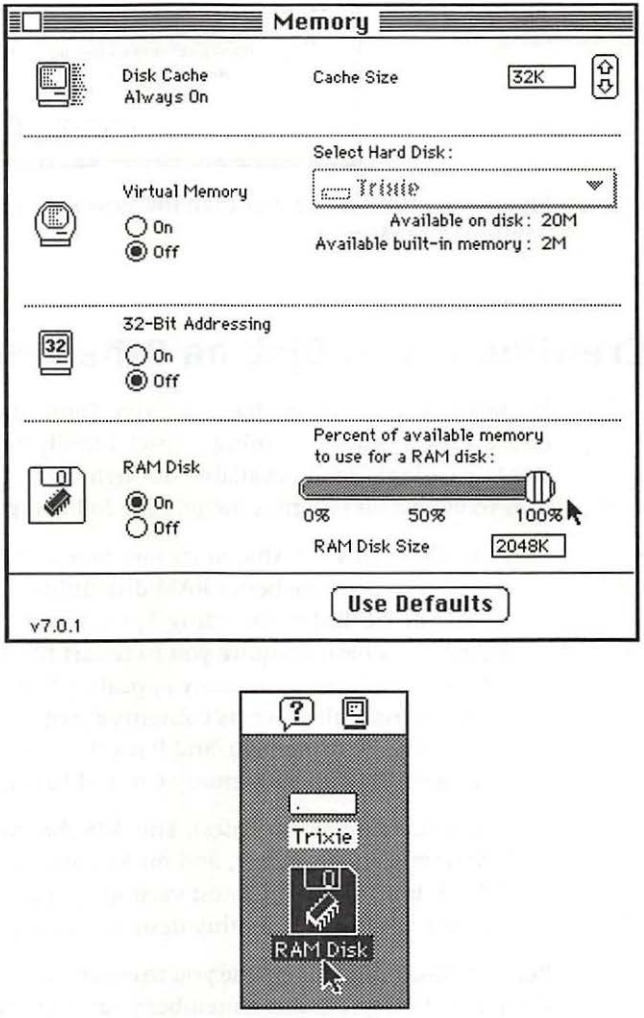


Figure 10.4: Creating a RAM disk using the Memory Control Panel (PowerBooks, IIvx, IIvi, Performa 600, and Quadras only). Specifying the size of the RAM disk (top). The RAM disk icon (bottom).

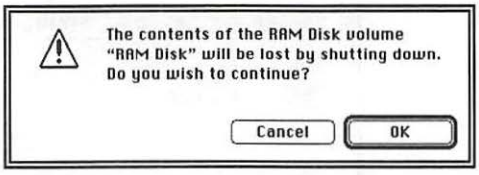
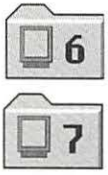


Figure 10.5: On Macs other than the PowerBook 100, shutting down destroys a RAM disk.



Creating a RAM Disk on Other Mac Models

On Macs other than Quadras, IIvx, IIvi, Performa 600, and PowerBooks, you create a RAM disk by running a special utility program. Several inexpensive RAM disk programs are available through user's groups and on-line information services. Our favorites include the following:

AppDisk. This $15 shareware program works only under System 7, but it's one of the better RAM disk utilities we have seen. Unlike most RAM disk utilities (including Apple's own Memory Control Panel), AppDisk doesn't require you to restart the Mac to create or resize a RAM disk. It offers so many appealing features (including the ability to automatically save its contents at regular intervals) that Quadra, IIvx, IIvi, Performa 600, and PowerBook owners may prefer to use it rather than Apple's Memory Control Panel.

RamDisk+ (by Roger Bates). This $35 shareware program works under System 6 and System 7, and on Macintosh models as elderly as the 512K Enhanced. The latest version operates as a Control Panel. Generally, it's not as smoothly designed as AppDisk, but it does the job.

Both of these programs enable you to choose the files you want to store on the RAM disk. Both programs remember your settings, so after you specify them, you can create a RAM disk by simply starting the program. Both can be configured to create a fresh, fully loaded RAM disk for you each time you start up your Mac.

RAM Disk Advantages

The primary advantage of a RAM disk over a disk cache is that its performance-boosting benefits surface immediately. By comparison, a disk cache's performance improvements surface over time, as you use the Mac.

What kind of performance gains do RAM disks provide? We measured the time required to start Microsoft Word from a PowerBook 170's hard disk and from

a RAM disk. It took 10 seconds from the hard disk, but only five from the RAM disk—a 100 percent improvement. And the speed difference would have been even more significant had we stored the System Folder on the RAM disk, too.

Trend: RAM Disks Rediscovered

When the 512K Mac debuted late in 1984, RAM disks enjoyed a burst of popularity. Back then, the Mac's system software was lean enough that you could store it in a RAM disk. In fact, if you stripped down the System Folder, you could even fit the system *and* a small application program on the RAM disk, dramatically boosting the Mac's performance. To Mac pioneers who were frustrated by the sluggish performance of the Mac's floppies and early hard drives, RAM disks were a godsend.

As the Mac's system software and application programs grew more complex, RAM disks became less popular. When the Mac Plus was in its heyday, RAM chips were so expensive that most people weren't willing to donate any memory to a RAM disk. What's more, the Plus had a SCSI port that allowed for much faster hard disks.

Today, RAM disks are enjoying a comeback. They're ideal for PowerBooks because they extend battery charges by reducing disk accesses. RAM disks also are useful for performance-intensive tasks, such as digitizing video clips using QuickTime. Thanks to falling memory prices and performance-critical applications, RAM disks are back.

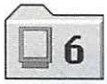
RAM Disk Disadvantages

Although RAM disks boost performance, they have the following serious drawbacks.

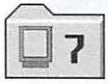
- They lack the "intelligence" of a disk cache. A RAM disk contains only what you put in it. If you need a program that isn't on the RAM disk, you must run it from a disk or copy it to the RAM disk.
- They're ephemeral. When the power goes or a system crash occurs, a RAM disk's contents are usually lost. Thus, you should think twice about storing documents on a RAM disk; if you do, remember to copy them to a hard or floppy disk at regular intervals.

A RAM disk's transitory nature also has some subtle ramifications. Many application programs store working preferences in separate disk files, which are usually kept in the System Folder's Preferences folder. If you run such a program

from a RAM disk containing a System Folder, you will need to copy the preferences file to a floppy or hard disk to avoid losing your latest preference settings.



RAM Disks and QuickTime



The best way to get smooth video captures and playback is to digitize or play back from a RAM disk. You will need a vast amount of RAM in order to accommodate a lengthy video clip, of course, but RAM prices have fallen to the point where it may be practical to have a few dozen megabytes, especially if you need top QuickTime performance.



RAM Disks and PowerBooks

We have mentioned that RAM disks are ideal for PowerBooks because they minimize battery-draining disk accesses. If you use a memory-efficient application program and you're willing to roll the dice and store documents on a RAM disk, you can configure a PowerBook so that its hard disk is virtually always off, thus dramatically lengthening the life of a battery charge. The PowerBook 160, 180, and Duo models are even better candidates for RAM disks, since they can accommodate more RAM than a PowerBook 100, 140, 145, or 170.

We have come up with a way to configure a 4MB PowerBook 170 to run a compact program, such as the ClarisWorks integrated package, from a RAM disk that also acts as the startup disk. With this scheme, the hard drive is on only briefly when the PowerBook starts up.

First, you need to create a stripped-down System file by removing all sounds and all fonts except for one. We cheated on this step and simply used the pared-down System file located on the Norton Utilities 2.0 Emergency Disk. (Be sure to use the high-density Emergency Disk.) If you don't have this disk, make a duplicate of your PowerBook's System file and then pare down the duplicate.

After you create the minimalist System file, use the Memory Control Panel to create a 2048K RAM disk. (If you have more than 4MB of RAM in your PowerBook, feel free to create a larger RAM disk.) Then perform these steps to set up the RAM disk:

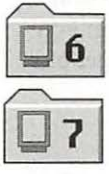
1. Copy the stripped-down System file and the Finder file to the RAM disk.
2. Copy the application program to the RAM disk. If you copied ClarisWorks, you should have roughly 183K free on the RAM disk.

3. Open the Startup Disk Control Panel and select the RAM disk as the startup disk.
4. Open the Portable Control Panel and set the hard disk's sleep time to its smallest setting.
5. Choose Restart from the Finder's Special menu. The PowerBook starts up from the RAM disk that also contains the application program. After a half-minute or so, the hard disk goes to sleep. If you save documents on the RAM disk, the hard disk won't wake up.

Needless to say, this technique has its drawbacks. You're limited to only a few fonts, and you cannot print anything, since no printer drivers are installed. And you need to remember to copy your RAM disk-based documents to the hard disk now and then to guard against losing them. But these drawbacks may not be important when you're away from a power outlet and need to maximize battery life. And if your PowerBook has more than 4MB of RAM, you can create a RAM disk large enough to hold more fonts as well as extensions, Control Panels, and printer drivers.

A Memory Balancing Act

This section has shown that a disk cache or RAM disk can boost performance by minimizing disk accesses. We also have provided some guidelines for determining how large a cache or RAM disk you should create. But these guidelines are just starting points. To determine how to best use your Mac's RAM, you need to weigh the memory requirements of your programs and extensions against the performance benefits of a disk cache or RAM disk. Experimenting is the best way to establish an ideal balance.



Multitasking and Memory

All this talk about disk caches and RAM disks leads us to another memory-related topic: multitasking. In theory, System 7 and System 6 MultiFinder enable you to run numerous programs simultaneously and switch between them with a mouse click. In practice, the number of programs you can run simultaneously depends on their size and on how much memory your Mac has. If your Mac has just 2MB of RAM, you probably see insufficient-memory messages frequently.

The obvious solution is to expand your Mac's memory. Memory is relatively inexpensive, but you still may prefer to spend your computing dollars on software or more mass storage. Or you may simply have to work through a crunch until a recently-ordered memory upgrade arrives.

There is no magic shoehorn to help you squeeze more programs into your Mac's memory, but there are techniques for getting the most out of the memory you do have. In this section, we explore these techniques by examining the following:

- How System 7 and System 6 MultiFinder use memory.
- How to configure your system and application programs to use your Mac's memory efficiently.
- How to interpret the Finder's memory-usage graph.

How Multitasking Uses Memory

To set the stage for our tour of multitasking memory issues, first examine how the Mac's memory is used by System 7 and System 6 MultiFinder. When you start a program, the program requests a specific amount of memory. If the amount requested is available, the Mac sets it aside for the program, and then starts the program.

The chunk of memory a program requests must be *contiguous*. Recall from Chapter 1 that each byte of memory has its own address. When a program requests a chunk of memory from the Mac, it's requesting a continuous range of addresses. To return to the post office analogy we used in Chapter 1, it's as if a large postal customer says, "I need 10 post office boxes, and they all have to be sequentially numbered and adjacent to each other. Don't try to give me boxes 1 through 5, then 11 through 16." (True, people don't usually request more than one post office box; we're bending reality a bit to prove a point.)

When a postmaster assigns a range of post office boxes, those boxes aren't available to any other customers. Similarly, after the Mac gives a program chunk of memory, that memory isn't available to other programs. When you quit a program, the memory it used becomes available—just as when people move, their post office boxes become available to new residents.

Where Do Memory Requirements Come From?

Initially, the amount of memory a program requests is determined by the program's developer; but you have the final say. By using the Finder's Get Info command, you can change a program's memory allocation. Select the program's icon and choose Get Info from the File menu. The program's memory information appears at the bottom of the Get Info window (see figure 10.6).

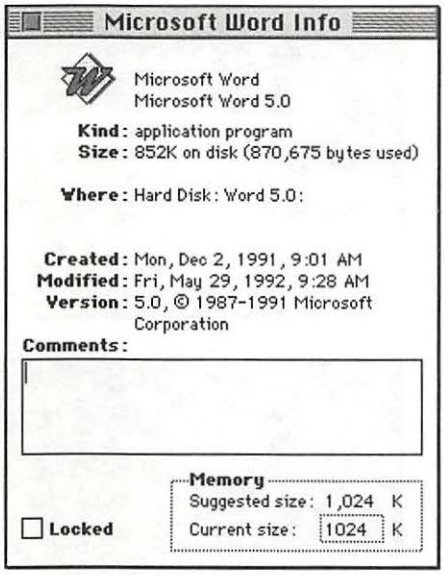


Figure 10.6: Memory information in the Get Info window.

As figure 10.6 shows, the Get Info window provides a text box labeled Current Size (in System 6, it reads Application Memory Size). Above that, another value appears next to the text Suggested Size. The Suggested Size is the minimum amount of memory the developer recommends. The Current Size is the preferred amount—the "if I had my druthers" amount. With some applications, both values are the same. Often, however, the Current Size value will be higher—sometimes much higher.

You can use the Current Size box to change the amount of memory a program requests. By carefully altering this memory value, you can use your Mac's memory more efficiently. We will discuss this point in detail shortly.

Fragmented Memory

As you start and quit programs, the Mac's free memory becomes *fragmented*—divided into chunks scattered throughout the total range of memory addresses. Why does this happen? Think about the post office. When one resident leaves town, his or her post office boxes become available to new residents. But some residents stick around, and their boxes remain in use (see figure 10.7). As some residents move in while others move away, the post office's set of free boxes becomes fragmented.

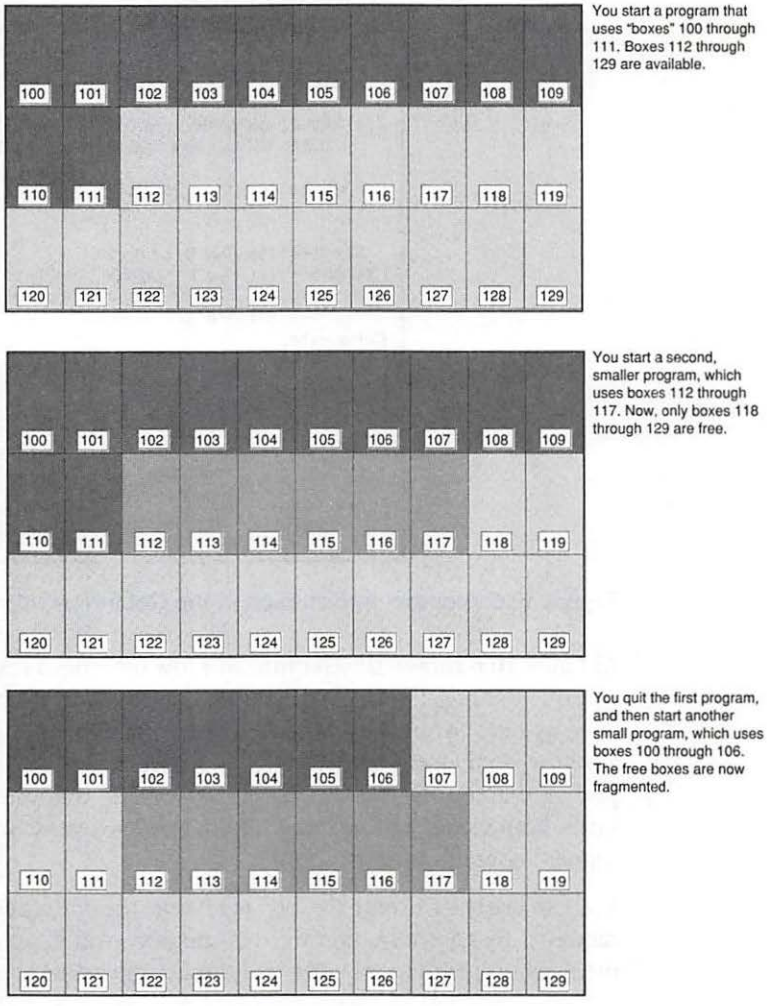


Figure 10.7: How memory becomes fragmented.

A similar situation occurs within the Mac. When you quit one program, its memory is freed. But if other programs are still running, their memory is in use. As you quit some programs and run others, the Mac's memory becomes fragmented.

When memory becomes fragmented, the largest program you can run is limited by the largest free block of memory. Assume that your Mac contains 900K of free memory, scattered throughout its total memory in several chunks, the largest of which is 700K, for example. In this case, you can run a program only if it requires 700K or less—even though a total of 900K may be free.

You can find out how much space exists in the largest free block of memory by activating the Finder and choosing About This Macintosh from the Apple menu (in System 6, choose About the Finder). The Finder reports how much total memory exists in your machine, and also lists the size of the largest unused block of memory (see figure 10.8). We will examine the graph again later in this chapter.

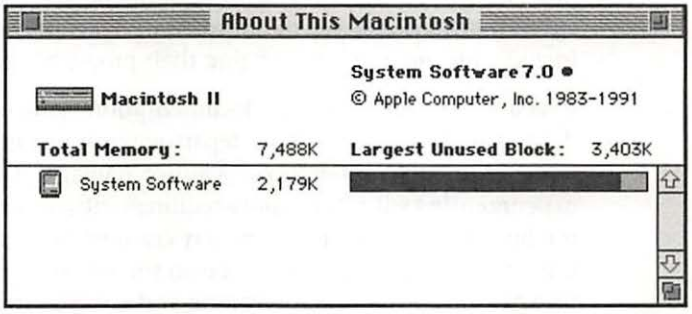


Figure 10.8: The Mac's free-memory display.

Defragmenting Memory

The solution to fragmented memory is to quit all the programs you're running. You can then restart the programs you want to use, and the Mac will assign memory in contiguous blocks. To return to the post office once more, quitting all programs is the equivalent of the postmaster unassigning *all* the post office boxes. The postmaster can then assign post office boxes in contiguous blocks, with no fragments—until someone moves, of course, starting the fragmentation process all over again.

Fine-Tuning Application Memory Requirements

So you can use the Get Info command to view and tweak a program's memory requirements. But under what circumstances may you want to change memory requirements? And how much of a change should you make?

You may want to change a program's memory requirements for two basic reasons:

- To decrease the amount of RAM used by the program in order to squeeze more programs into memory or to have some memory left over for a larger disk cache or a RAM disk.

- To increase the amount of RAM used by the program in order to improve its performance or, with programs that store documents entirely in RAM, to be able to create larger documents or open more document windows simultaneously.

As for how much of a change you should make in a program's memory appetite, that's a bit more difficult to determine. Your first step should be to consult the program's manual for memory recommendations. Unfortunately, you may strike out there: a survey of our software shelves revealed that few companies include information on changing their program's memory requirements.

If you strike out with the documentation, you may consider calling the developer's technical support department for recommendations. Or you may want to just experiment. You cannot damage an application program by experimenting with its memory requirements, although if you give a program too little memory, the program may crash while you're running it, taking any unsaved documents with it. To be on the safe side, perform your experiments on a backup copy of the application and save your work often. (Saving often is always a good idea.)

How to Reduce Memory Requirements

Here's how to reduce an application program's appetite for memory.

1. If the program is running, choose its Quit command. (You cannot change memory requirements when a program is running.)
2. In the Finder, select the program's icon and then choose Get Info from the File menu.

   The Get Info window appears, with the program's memory information at the bottom of the window.
3. If the program's Suggested Memory Size is less than the Current Size, reduce the Current Size value to match the Suggested Size.

Or

3. If the Suggested Size and Current Size values are identical, you can try reducing the Current Size to a lower value, but the program may run unpredictably, or it may not run at all.
4. After you alter the Current Size value, click the Get Info window's close box or choose Close from the File menu. If you entered a value lower than the Suggested Size value, the Finder asks if you're sure you want to change the Current Size to less than the suggested minimum. Click OK or press Return.

Finally, try running the program. If you simply reduced the Current Size to match the Suggested Size, the program should run without incident, although you may notice slower performance and more frequent disk accesses. And with programs that store their documents entirely in memory, you will be restricted to smaller documents.

You can often coerce an application program to accept a smaller memory cubbyhole, but you pay the price in terms of performance and/or document size. But that may be a price you're willing to pay. If you have a reasonably fast hard disk, more frequent disk accesses won't bog you down excessively, and if you have a fast Mac, performance will still be acceptable. There may be times when decreasing a few programs' memory requirements is the only way you can simultaneously run the programs you need for a particular project. In these cases, sluggish performance is a small price to pay in return for being able to work the way you want to work.

The Effects of Increased Memory Sizes

What happens when you give a program *more* memory than its Suggested Size? It depends on the program. With programs that swap documents between disk and memory (such as Microsoft Word and Aldus PageMaker), you generally notice better performance. With programs that store their entire documents in memory (such as most integrated packages and graphics programs), you will be able to create larger documents and have more documents open simultaneously.

The best way to fine-tune your programs' memory requirements is to experiment. Adjust your programs' Current Size settings until you reach the ideal balance between performance, reliability, and RAM efficiency. You will get better use out of the memory you have, and you will develop a greater appreciation for the Mac's complex memory-management capabilities.





How to Read the Mac's Memory Graph

One useful tool for determining how much memory to give programs is the Finder's memory graph, which appears when you choose About This Macintosh from the Apple menu (About the Finder in System 6).

A typical memory graph display appears in figure 10.9. Notice that each bar has a light- and dark-shaded portion. The light-shaded portion indicates how much memory has been allocated to the program (or to the System and Finder). The dark-shaded portion indicates how much of that memory is actually in use.

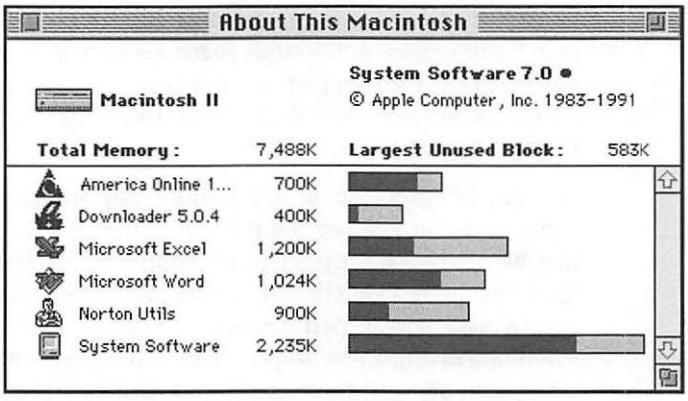


Figure 10.9: The Mac's memory graph.

You can gauge how an application program is using memory by switching back to the Finder and choosing About This Macintosh. If a given program's bar contains a great deal of white space, the program isn't using all the memory allocated to it. Consider reducing that program's Current Size value. (Remember that you must first quit the program before you can change its memory requirements.)

To get a realistic picture of a program's memory requirements, don't simply start a program and immediately switch back to the Finder to check its memory graph. Instead, open a typical document and perform some typical tasks—choose a few commands, edit some text, and so on. *Then* return to the Finder and choose the About This Macintosh command.

There's an even better way to monitor a program's memory use. First, drag the Finder's memory graph window to the bottom of the screen, and then switch back to the program and resize its document window so that you can see the graph (see figure 10.10). With this approach, you can see the graph change as you work, and thereby get the most accurate picture of how the program uses memory. This technique is especially practical if you have a large screen or more than one monitor.

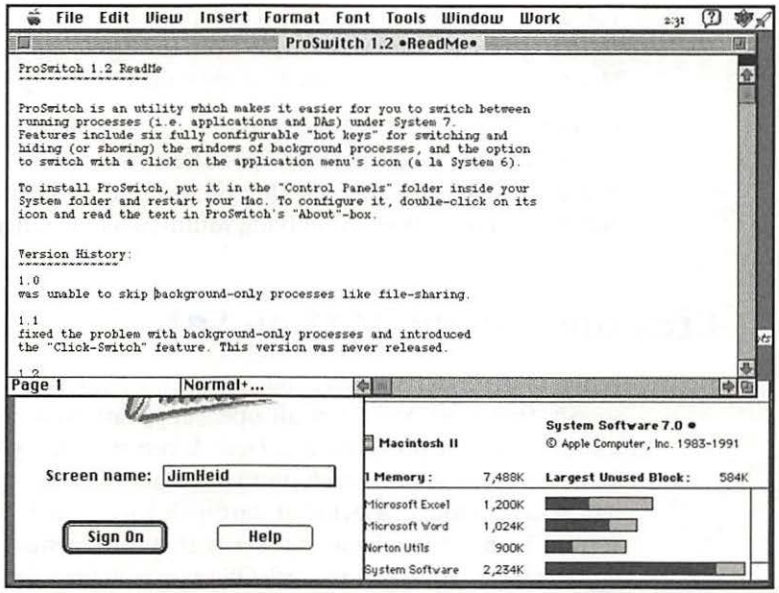


Figure 10.10: Move the memory graph to see it while you work.



Miscellaneous MultiFinder Tips

Let's wrap up our hands-on look at multitasking with a potpourri of miscellaneous tips for System 6 MultiFinder.

Desk Accessories and MultiFinder

System 6 MultiFinder uses a system file named DA Handler that provides a layer in which all open Desk Accessories run; however, the DA Handler has two drawbacks:

- It slows down the opening of Desk Accessories, because the Mac must load DA Handler itself before it can open the Desk Accessory you chose.
- If you have very little memory left, DA Handler often will not be able to open a Desk Accessory. Instead, it displays an error message recommending that you "try closing another Desk Accessory or quitting an application."

You can eliminate both drawbacks by holding down the Option key while choosing a Desk Accessory's name from the Apple menu. This trick causes the Mac to open the Desk Accessory within the current application's layer.

If you have a resource-editing utility, such as Apple's ResEdit, you can modify MultiFinder so that it normally opens Desk Accessories in the current application layer, and opens DA Handler only when the Option key is pressed. For details, see the section "Modifying MultiFinder" in Chapter 11.

Creating an Application Set

When MultiFinder is active, you can use the Finder's Set Startup command to specify that your Mac start all open applications automatically when you restart. Open the programs and Desk Accessories that you want to be opened automatically each time you start your Mac. With the applications still open, return to the Finder. Select your startup disk icon (click it once) and choose Set Startup from the Special menu. Verify that the Opened Applications and DAs option is selected, and then click OK or press Return. From now on, when you start up your Mac, MultiFinder will open the applications and Desk Accessories you specified.

Alternatives to MultiFinder

Let's end our look at MultiFinder by examining some ways to avoid using it. The fact is, you cannot always afford to donate the extra memory required to accommodate MultiFinder, especially if you run memory-hungry programs, such as the Adobe Photoshop color image-processing program.

Fortunately, you can enjoy some of the benefits MultiFinder provides without running it:

Use Desk Accessories. These handy miniprograms are always available. Desk Accessories are available for most common computing tasks, including word processing, painting and drawing, disk and file management, and simple filing.

Use integrated software. If your work involves performing relatively light-duty tasks with a variety of programs, consider an integrated program, such as Microsoft Works, Claris' ClarisWorks, and Symantec's GreatWorks, which provide word processing, data management, spreadsheet analysis, drawing, and telecommunications features. These programs don't have all the features of stand-alone pro-grams, such as Microsoft Word, Lotus 1-2-3, or Claris FileMaker Pro, but you may not need the depth of features those programs provide.

Use a print spooler. One of MultiFinder's benefits is that it provides background printing to PostScript printers. You can get the same benefit with print-spooling software which also supports background printing to ImageWriters.

None of these alternatives provides the same flexibility as a 4MB or 5MB Mac running MultiFinder or System 7, but combined, they come reasonably close. Put another way, you cannot have your cake and eat it too, but you can at least nibble at the icing.

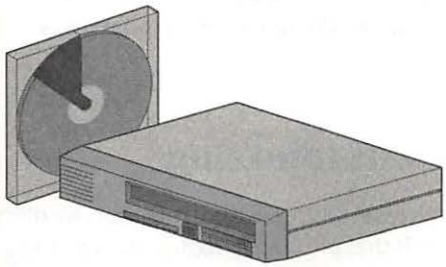
CHAPTER

11

CUSTOMIZING TIPS

WHAT'S INSIDE

- The two categories of customizing: fun and functional
- The memory and performance costs of customizing
- How to change the way the Mac interface looks and sounds
- A look at utilities that streamline System 7 navigation
- Adding keyboard and mouse shortcuts to your favorite programs
- Tips for customizing the Finder
- Technical background on resources and resource editing
- How to use Apple's ResEdit utility to customize programs, fonts, and documents



After you begin to master the Mac, you start thinking of ways you can improve it to suit your working style: "If that command had a keyboard shortcut, I could choose it faster. I use a certain file all the time—I wish I didn't have to root through folders every time I need it. If there was a Desk Accessory that enabled me to copy and delete files, I wouldn't need to switch back to the Finder all the time."

You can have these things and many more. The Mac is a malleable machine you can sculpt to fit the way you work. To help, this chapter includes a collection of tips and techniques for customizing the way the Mac and its programs work, and for changing the way the Mac interface looks and sounds.

In this chapter, we also take a closer look at the way the Macintosh uses system resources, such as menus and fonts, and we show you how to use Apple's resource-editing utility, *ResEdit*, to modify programs, fonts, the Finder, icons, and printer drivers.



Unless otherwise noted by margin icons, all the tips in this chapter apply to System 7 and later versions.



Two Categories of Customizing

You can break down the types of customizing jobs into two broad categories:

Fun. The Macintosh is a customizer's playground. Utilities are available that change the appearance of Macintosh windows; that enable you to replace the Mac's Desktop with any picture; that play sounds when you insert or eject disks, empty the Trash, and move windows around. If you have the memory and disk space to spare, you can have the Macintosh equivalent of mag wheels, flames on the fenders, and foam dice hanging from the rear-view mirror.

Functional. Many of the customizing projects you can perform *will* make your work easier by enabling you to choose commands and palette tools from the keyboard rather than reaching for the mouse; by enabling you to modify printer drivers to support nonstandard page sizes; by giving you fast access to often-used files and folders; or by enabling you to change the names the Finder gives to newly created aliases.

The Hidden Cost of Customizing

Whether fun or functional, most of the customizing tools we discuss are system extensions or Control Panels that ultimately reduce the amount of memory left over for programs. Installing the software we discuss here can gobble up half a

megabyte or more of RAM. If you find your digital foam dice and mag wheels don't leave enough RAM left over for programs, use an extension manager, such as Extension Manager (covered in the previous chapter) to disable extensions you cannot do without.

Another drawback of extension mania is that it lengthens the Mac's startup time dramatically. You can drum your fingers sore waiting as icon after icon marches across the bottom of the Mac's screen. Extensions that play sounds, create color Desktops, and animate the interface also can slow down overall performance, particularly on slower Macs but also on mid-range machines, such as an LC II or IIsi.



Fun Customizing Tips

Let's start out with the fun stuff. In this section, we show how do the following:

- Turn a picture into a startup screen that appears rather than the `Welcome to Macintosh` message
- Replace the Mac's Desktop pattern with a picture
- Customize the appearance of windows, icons, and other aspects of the Macintosh interface
- Add sounds to the System file
- Modify the Mac to play sounds when you perform various activities

Startup Screens

The Mac's `Welcome to Macintosh` message may be inviting, but it isn't personal. You can turn any picture into a *startup screen* that appears rather than the welcome message.

Startup Screen Basics

The first thing you need is a black and white or color image. (If you have a monochrome Mac, such as a Classic or SE, you must use a black and white image.) A large selection of startup screens is available from online services and user groups—you will find everything from blue skies to racing cars to cheesecake. You also can create your own image using a scanner, video-capture device, or graphics program.

If you have a monochrome Mac, simply save an image in MacPaint format and be sure to name it *StartupScreen*. All major painting and bitmap graphics programs can save files in MacPaint format. Place the image in the System Folder and restart to see it.

For the Mac to display a color startup screen correctly, the image file must be saved in a special format. (Technically, it must be a PICT file that contains a PICT resource with an ID number of 0—that's the number zero, not the letter *O*. PICT files are described in more detail in the next chapter; we look at resource ID numbers later in this chapter.) Several popular paint programs, including Canvas, SuperPaint, and PixelPaint, can create startup screen PICT files. Choose Save As from the File menu, select the startup screen option, and name the file *StartupScreen* (note the spelling). Save the file in the top level of the System Folder—not within any folders, such as the Extensions folder. Restart to view the startup screen.

In addition to the programs just mentioned, you also can create startup screen PICT files with a shareware program called *The Giffer*, by Steve Blackstock.

Trend: Shareware Everywhere

Many of the programs we discuss in this chapter aren't commercial software packages, but *shareware*. Shareware programs aren't sold in stores and they usually don't come from large commercial software firms. Many are developed by Mac programming enthusiasts in response to requests from fellow users. Shareware has been popular in the Macintosh since the beginning; today, there's more shareware out there than ever.

The shareware concept is simple. Try the program at no charge for a week or two. If you like it, send the author the amount he or she requests, usually between $5 and $50. Some authors simply give their programs away; others have unique registration requirements. One requests a post card, another asks for $20 or a case of beer, and another would gratefully accept Grateful Dead concert tapes. Most shareware authors encourage you to distribute their programs to others, provided that you include the documentation file that accompanied the program.

The best sources for shareware programs are generally user's groups and information services, such as CompuServe and America Online. The manuals for shareware programs are generally disk files that you print using your word processing program. Some shareware authors provide a printed manual when you register the program.

Shareware often is distributed in a *compressed* form that uses less disk space. Besides enabling manuals and other files to accompany the program file itself, this reduces the time required to transfer the software over phone lines. To *decompress* the files, you need a utility, such as Raymond Lau's *StuffIt Lite*, which is, itself, a shareware program. (A commercial version of StuffIt is also useful for *archiving* old disk files

for backup purposes because compressed files use less disk space. And it's handy for squeezing backup copies of huge System files onto floppy disks.) Bill Goodman's Compactor Pro is another popular shareware compression utility.

Shareware can be an economical way to expand your software library, but there are potential drawbacks. Unlike commercial software publishers, shareware programmers don't have formal testing departments; they rely on networks of friends and fellow users to test their wares and find bugs. Thus, the first releases of shareware programs can have bugs. It's common to see an update or two appear on an information service within a few days or weeks of a program's release. Also, unless a particular program becomes popular, it may not be updated as new system versions are released. Many older shareware programs don't run reliably under today's system software.

Finally, because of their informal distribution network, shareware programs can be carriers of computer *viruses*—software created by programming vandals. Viruses are designed to invade your System file or applications, where they can damage data and cause system errors. Most users' groups and information services diligently check new contributions for viruses, but that's no guarantee a program you obtain will be virus-free. The chances of your system being infected by a computer virus are very small, but they do increase if you trade shareware frequently.

These cautions aren't intended to steer you away from shareware. A wonderful variety of programs is available through this informal and friendly distribution network. If you do find a program you like and use, reward its author. Help keep the shareware system alive.

Switching Between Startup Screens

To add some suspense to your startup routine, try a shareware system extension called *ScreenChooser*, by Marcio Luis Teixeira. ScreenChooser randomly chooses between multiple startup screens. Store all the startup screen files in a single folder (you can name each file anything you like), and then open ScreenChooser and tell it which folder contains the screens. After that, you will see a different image each time you start up.

Controlling Where the Startup Screen Appears

If you have more than one monitor, you can specify which monitor you want to use for the startup screen. You may want to do this if you have one color

monitor and one full-page monochrome monitor and you want the startup screen to appear on the color monitor.

To control where the startup screen appears, open the Monitors Control Panel and press the Option key. When you press Option, a Mac with a smiling face appears on the monitor and displays the startup screen (see figure 11.1).



Figure 11.1: When you press Option, a smiling Mac icon appears on the monitor and displays the startup screen.

If you want the startup screen to appear on a different monitor, continue pressing Option while you drag the smiling face to that monitor.

Startup QuickTime Movies

If you're fond of QuickTime, you can create a startup movie—simply name it Startup Movie and store it in the System Folder.



Replacing the Desktop Pattern

You can use the General Controls Control Panel to change the color and pattern of the Mac's Desktop. If you would like an even flashier desktop, you can use a free system extension called *DeskPicture* (by Clay Maeckel) to replace the Desktop pattern with an image (see figure 11.2).

DeskPicture requires its image to be startup screen PICT format; that is, a PICT file containing a PICT resource with an ID number of 0 (zero).

A commercial program called *Wallpaper* (from Thought I Could Software) enables you to create larger, flashier patterns than does the General Controls Panel.



Customizing the Mac's Interface

Apple's user interface designers have spent innumerable hours refining the appearance of the Mac's interface elements—its windows, scroll bars, buttons, and icons—to make them attractive without being flashy and obtrusive. Still, if you want to personalize your Mac's interface (for better or worse), you will find numerous tools for the job.

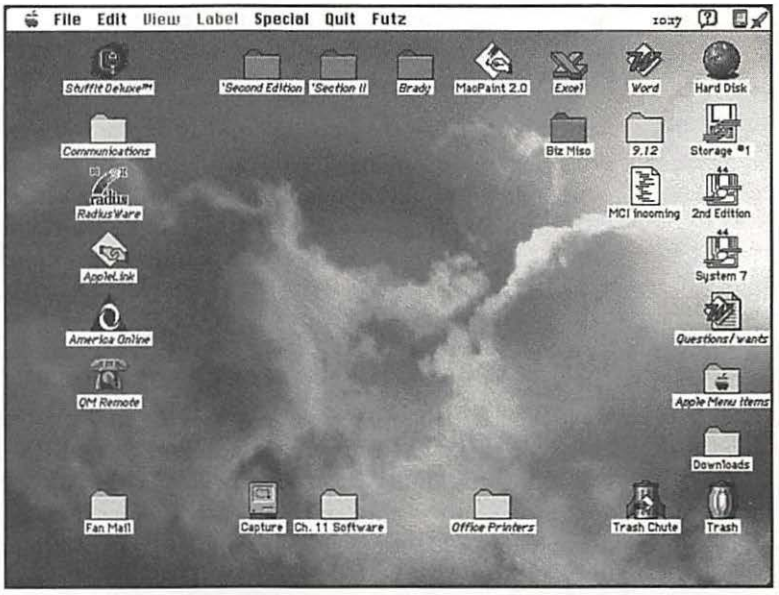


Figure 11.2: A picture Desktop.

Customizing Windows and Buttons

The easiest way to customize the overall appearance of the Macintosh interface is with Dubl-Click Software's *ClickChange*. ClickChange consists of an application program that provides a collection of various designer interface schemes. Some even simulate the interfaces of other computers, such as PCs running Microsoft Windows (see figure 11.3).

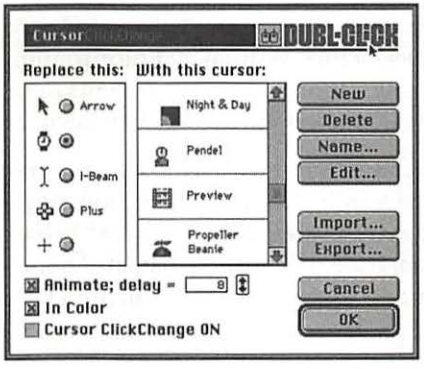


Figure 11.3: Dubl-Click Software's ClickChange.

After choosing the scheme you want, restart the Mac and the extension makes your changes. ClickChange also includes several animated mouse pointers you can choose as replacements for the wristwatch and its moving hands.

Another interface customizing tool is a shareware extension called *Greg's Buttons*, by Greg Landweber. Greg's Buttons replaces the standard black and white buttons, check boxes, and radio buttons with attractive, three-dimensional color ones that match System 7's windows and scroll bars. Greg's Buttons also colorizes the stop sign, caution, and note alert icons.

Customizing the Trash

If you have kids (or other Sesame Street fans) in the house, you may try a system extension called *The Grouch*, by Eric Shapiro. When The Grouch is installed and you choose the Empty Trash command, the Trash lid opens and Sesame Street's Oscar the Grouch pops out, waves, and sings a measure from *I Love Trash.* Reports have surfaced of kids becoming so fond of Oscar that they throw away file after file just to see and hear him. Their parents' cries inspired Eric Shapiro to create an application program version of The Grouch that simply displays the animation and plays the song without actually emptying the Trash.

Customizing with Sound

The Grouch is just one way you can modify the Mac to play sounds when various events occur. If your Mac came with a microphone, you also can create your own system error beeps. (Macs that don't contain sound-input circuitry, such as the SE, Classic, PowerBook 100, need an external sound digitizer, such as Macromedia's MacRecorder.) Online services and user group software libraries are bursting with megabytes of digitized sounds you can use.

For even more fun with sound, try the legendary shareware extension *SoundMaster*. Written by Bruce Tomlin, SoundMaster enables the Mac to play sounds during a variety of events—emptying the Trash, closing and opening windows, restarting, shutting down, and more (see figure 11.4).

Riccardo Ettore's *Sound Manager* is another shareware sound package. Sound Manager includes an application program called *Sound Mover* that enables you to manipulate sounds easily and install them in the System file, and a Control Panel called *SndControl* that, like SoundMaster, modifies the Mac to play sounds during various events (see figure 11.5).

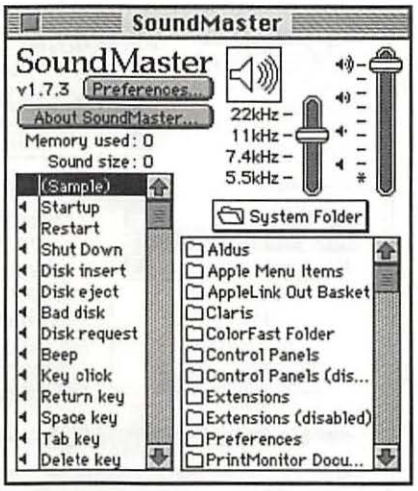


Figure 11.4: Bruce Tomlin's SoundMaster.

A popular free system extension called *SuperClock* (by Steve Christensen) can play sounds at hourly intervals. Another clock-and-sound oriented program is Rick Gansler's free *Talking Clock*, an FKEY that announces the time when you press Command+Shift+6.

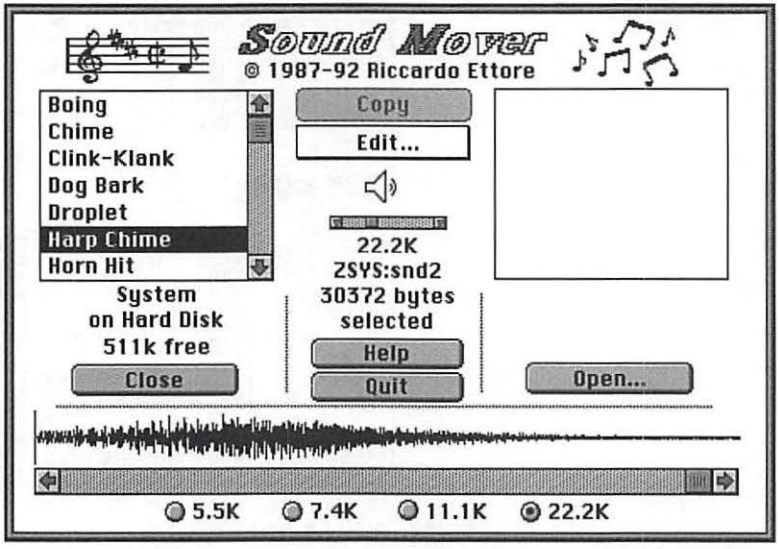
For some technical background on digitized sound concepts and more details on recording sound, see the section "Sound Details" in Chapter 16. Later in this chapter, we show you how to add sounds to the System file using ResEdit.



Functional Customizing

If you have any memory left over after installing some fun customizing software, you may consider some extensions that perform genuinely useful tasks. This section's tips describe the following:

- Easier ways to delete unwanted files
- Ways to reclaim some memory by quitting the Finder
- Faster ways to switch between programs
- Utilities that enable you to create your own keyboard shortcuts



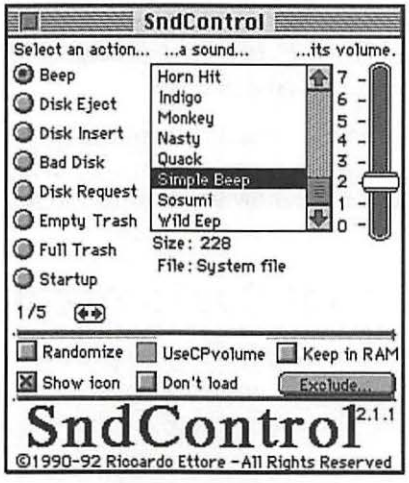


Figure 11.5: Riccardo Ettore's Sound Mover (top) and SndControl (bottom), both part of the shareware Sound Manager package.

Faster Trashing

When you choose the Finder's Empty Trash command, a dialog box appears and tells you what's in the Trash and gives you a chance to cancel the command. This extra step helps you to prevent throwing files away

accidentally, but it can be annoying—especially for those of us who never, ever throw away the wrong file.

To skip the trash warning, press the Option key while choosing Empty Trash. To skip the trash warning permanently, select the Trash icon and choose Get Info from the File menu. In the Trash Info window, uncheck the Warn Before Emptying check box. Close the window, and you will never be bothered (or rescued) by trash warnings again.

Trashing Files with Trash Chute

An even faster way to trash files is with a free program called *Trash Chute*, by Milissa Rogers. Place the Trash Chute icon on your Desktop, perhaps alongside the Trash. To delete a file, simply drag the file to the Trash Chute icon. The file is deleted immediately. Trash Chute does not delete folders automatically.

> **WARNING!** Don't drag an alias icon to the Trash Chute icon. If you do, Trash Chute deletes the file to which the alias points rather than deleting the alias itself.

Quitting the Finder

Under System 7, the Finder is always running—and always using up memory. If you need to reclaim an extra few hundred K, you can quit the Finder by installing a shareware FKEY called *AntiFinder*, by Marcio Luis Teixeira. After installing AntiFinder, start a program and then switch back to the Finder. Next, press Command+Shift+9 (or the number you used when installing AntiFinder). The Trash and disk icons disappear, and you return to the program you just started. The Finder is now gone—as are the contents of the Apple menu. To jump-start the Finder and get it running again, quit all running programs.

Another way to quit the Finder is to use Adam Stein's *System 7 Pack*, a shareware utility program that provides numerous ways to modify the System 7 Finder (see figure 11.6).

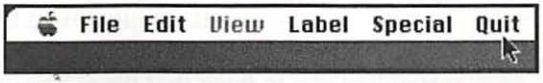


Figure 11.6: Adam Stein's System 7 Pack can add a Quit command to the Finder.

What if you want to start additional programs or open documents after quitting the Finder? You could quit all running programs to restart the Finder, but a faster alternative is to use the file-opening option available in CE Software's *QuicKeys* keyboard-enhancement utility. The file option displays a standard Open dialog box that enables you to open any file or program without needing to return to (or, in this case, start up) the Finder.

Also keep in mind that you can use Apple's At Ease software (described in the previous chapter) to remove the Finder and free up some memory.

Faster File Access

In Chapter 9, we mentioned that folders are the best way to keep track of the large number of files a hard disk can hold. But the more you use folders, the longer it often takes to access a particular file or program because you often need to root through several nested folders to get to the file you need.

One way to quickly access a file that's buried within folders is to use the System 7 Find command or the System 6 Find File Desk Accessory. Another method is to create System 7 aliases for buried files and move them to the Desktop or the Apple Menu Items folder (within the System Folder). For more information about these techniques, see Chapter 9.

Several commercial utilities are available that provide other slick ways to quickly access programs or documents. Following are a few examples:

On Cue. This system extension from Icon Simulations adds a menu of frequently accessed files or folders to the Mac's menu bar. You can specify the files you want listed in the On Cue menu, and open a particular file by simply choosing its name.

Directory Assistance. This extension, included with Symantec's Norton Utilities for the Macintosh, adds a menu bar to the inside of the Open and Save dialog boxes that provides numerous filing features. You can create a list of frequently used files and folders, delete files, create new folders, search for files and folders, and more—all without closing the Open or Save dialog box. Other products that perform similar tasks include Super Boomerang (part of Now Software's Now Utilities) and Aladdin Systems' Shortcut.

QuicKeys. This versatile utility from CE Software enables you to assign a keyboard shortcut to an often-used file. In figure 11.7, for example, the Control+P keyboard shortcut is assigned to a file named *Proposal,* enabling you to open that file at any time by pressing Control+P.

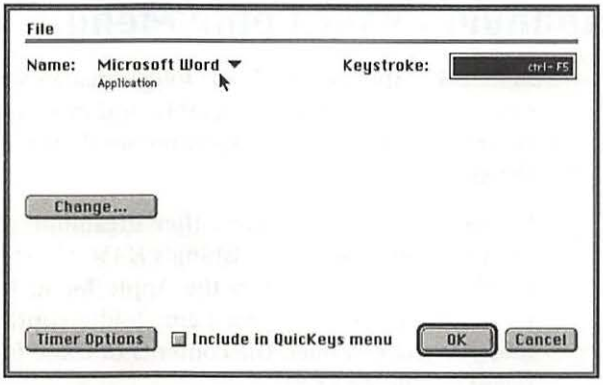


Figure 11.7: Assigning a key sequence to a file using QuicKeys.

Disktop. Also from CE Software, this Desk Accessory enables you to copy, delete, and open files; start programs; create folders; and more—without returning to the Finder. You can even add frequently used documents and applications to DiskTop's menu, where they're just a mouse click away. DiskTop also can search for files using several criteria, including name, size, and date of creation or modification.

Faster Program Switching

Being able to run several programs simultaneously under System 7 is great, but having to travel up to the Application menu to switch between them can get tiresome. You can speed up application switching the following ways:

Just Click. This free extension from Luis Bardi enables you to switch between programs by clicking on the Application menu—as you could with the old System 6 MultiFinder.

PwrSwitcher. This free extension from David B. Lamkins enables you to switch between programs by pressing the power-on key present on all Apple Desktop Bus keyboards.

QuicKeys. It's easy to set up an application-switching keyboard shortcut in QuicKeys. With the QuicKeys Control Panel open and the Universal keyset selected, open the Define menu and choose System 7 Specials from the Extensions submenu. When the System 7 Specials dialog box appears, choose Next Application from the Specials for System 7 pop-up menu. Next, click or Tab to the Keystroke box and type the key sequence you want to use. Close the dialog box and the QuicKeys Control Panel. You now can switch between programs by pressing the key sequence you specified.

Expanding Your Apple Menu

System 7's Apple Menu Items folder enables you to have one-click access to often used files, folders, programs, and even network file servers. But all this flexibility can lead to long Apple menus that take a long time to open and scroll through.

Several utilities are available that streamline the Apple menu, but the best known is Microseeds Publishing's *HAM*. Short for Hierarchical Apple Menu, HAM turns folders within the Apple Menu Items folder into hierarchical menus. If the Apple Menu Items folder contains any folders (or aliases to folders), you can open the contents of those folders directly from the Apple menu (see figure 11.8).



Figure 11.8: HAM creates hierarchical menus within the Apple menu.

HAM offers several other slick navigational shortcuts. It keeps track of files and programs you open, and places their names in the Apple menu, offering quick access to recently used items, for example.

Customized Finder Keyboard Shortcuts

In the previous chapter, we mentioned that System 7's Finder provides a larger selection of keyboard shortcuts than did earlier Finders. Still, there are no Command-key shortcuts for many commands, including Restart, Shut Down, Empty Trash, and Sharing, to name just a few. You can add keyboard shortcuts for these commands by using CE Software's *QuicKeys*, but you also can modify the Finder itself so that the keyboard shortcuts actually appear in the Finder's menu.

One of the easiest ways to add keyboard shortcuts to the Finder's menus is by using Adam Stein's *System 7 Pack* shareware utility. System 7 Pack not only enables you to create and change the Finder's Command-key sequences, it also enables you to customize other aspects of the Finder (see figure 11.9).

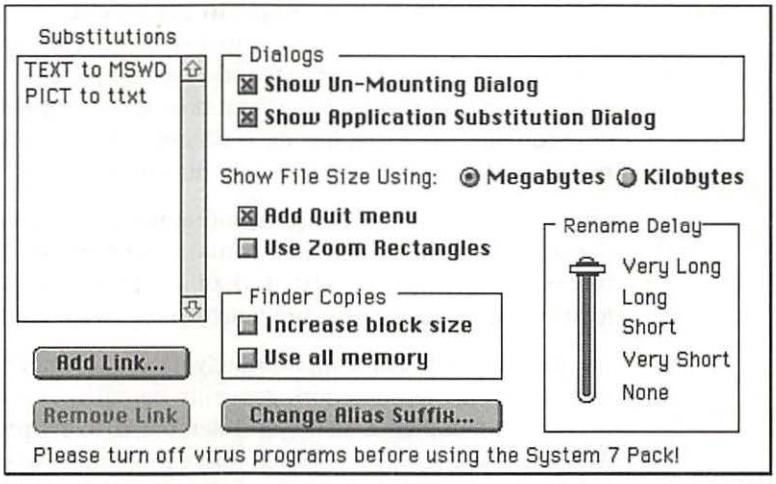


Figure 11.9: Adam Stein's System 7 Pack.

Customizing with ResEdit

A hard-core customizer's toolbox isn't complete without a copy of ResEdit, Apple's resource-editing utility. The rest of this chapter presents some ResEdit customizing projects for System 6 and System 7, and provides additional technical background on what resources are and why they're so important to the Macintosh.

Resource Details

As you may recall from Chapter 5, resources supply the Mac and its applications with program code and/or data that the Mac or an application needs to run. The resources you're most likely to encounter when working with the System Folder are system resources, such as fonts and sounds, Control Panels, and Chooser extensions, such as the LaserWriter and ImageWriter printer drivers.

In addition to these resources, applications and documents can contain resources, such as icons, menus, and dialog boxes. To understand where those resources are located, let's first look at the basic structure of Macintosh disk files.

Two Forks to a File

The Mac's file structure is unique in the personal computer world in that a single disk file can actually comprise two distinct physical components: a *data fork* and a *resource fork*. Notice we said *can* comprise. A file doesn't need both a data and a resource fork; whether it does is determined by its creator. If a file does contain both forks, the Mac's system software works behind the scenes to make these two forks appear as one file on the disk.

The data fork, as its name implies, contains data. In the case of a word processed document, the data fork may contain the text you typed using the word processing program. The data fork of an application file usually is empty, at least at first; an application program can use its data fork to store information.

The resource fork, again appropriately named, contains resources. An application program's resource fork generally contains everything the application needs to run: its menus, dialog and alert boxes, icons, program code, and more. As for a document, its resource fork can contain specialized resources that pertain to only that document. Claris' MacDraw II, for example, uses a MacDraw II document's resource fork to store the customized Font, Size, and Layout menu settings that you can create for that document, and also to store preferences and custom patterns that pertain to that document.

Resource Types

Resources are grouped into categories called *resource types*. A resource type is described by a four-character name. Table 11.1 is a partial list of common resource types and their purpose.

Table 11.1: A partial list of Macintosh resource types.

Type	Description
ALRT	Template for the appearance of an alert box
BNDL	Bundle—the Finder uses BNDL resources to associate files with their icons
CDEF	Program code that creates and handles custom controls (buttons, dials, and so on)
CNTL	Control template—defines the appearance or name of a control, such as a button
CODE	Contains a segment of an application program's software
CURS	Cursor—defines the appearance of a mouse pointer
DITL	Dialog item list—defines what appears in a dialog or alert box
DLOG	Template for the appearance of a dialog box
DRVR	Program code for Desk Accessory or driver
FKEY	Function key—a Command+Shift+number routine
FOND	Font family descriptor (see Chapter 6)
FONT	Font bit map description (see Chapter 6)
fmnu	Finder menu—contains special menu resources for System 7's Finder; you can edit these resources with ResEdit 2.1.1 or a later version
ICN#	Icon list—a series of icon definitions; generally used by the Finder to show icons in various states (active, inactive, hollow); application icons are ICN# resources
ICON	Icon—a single icon definition, like that of a printer driver you see in the Chooser
icl	Large color icon—System 7 version of cicn, made up of icl8 (8-bit) and icl4 (4-bit) icon resources
ics	Small icon—System 7 version of cicn, made up of ics4 and ics8 resources.
INIT	Initialization information; used at startup; can be present in system extensions and Control Panels
INTL	International resource—contains data that an application uses to create displays appropriate to a given country (proper date formatting, currency symbols, and so on)
MBAR	Menu bar—defines all the menus in a menu bar
MENU	Defines an individual menu's commands and keyboard shortcuts

continues

Table 11.1: Continued

Type	Description
NFNT	Font in new-font-numbering-table format (see Chapter 6)
PACK	Package—contains RAM-based system software
PAT[1]	Pattern—defines a QuickDraw pattern (the patterns drawing and painting programs show in their palettes).
PAT#	Pattern list—a collection of patterns
PDEF	Contains printing software
PICT	Picture—the pictures that often appear when you choose an About command are usually PICT resources; also appear in Alarm Clock Desk Accessory and many Control Panels
ppat	Pixel pattern—used to generate Desktop patterns
PREC	Print record—storage area for printer driver data
snd[1]	Sound resource—enables the Mac to play synthesized and digitally recorded sounds
STR[1]	String—a series of characters that may appear in a dialog box or be used by a program; in an error message, for example
STR#	String list—a collection of strings
SIZE	Contains memory-requirements information used by the Finder or System 6 MultiFinder
WDEF	Window definition—describes the appearance of a window
WIND	Window template—used by the Window Manager to create a window.

[1]*Name includes a space at the end. Most programming manuals list these resources within single quotes; for example 'snd ' and 'STR '.*



Why Resources?

Resources enable the components of an application—its program code, menus, dialog and alert boxes, icons, cursors, and so on—to be created, manipulated, and stored separately. This segregation of components adds a great deal of flexibility to the Macintosh:

- To create foreign-language versions of their software, developers need only alter the resources that contain language-specific information. A developer may replace the English-language menu, dialog box, and alert box resources, for example, with new resources in French.

- If many programs use the same resources, those resources can be stored in the System file and made available to all programs. Examples of such *shared resources* include mouse pointer shapes, fonts, sounds, RAM-based system software components, and the templates that specify the appearance of the standard Open and Save dialog boxes.
- Because resources enable application programs to be divided into smaller chunks, the Mac can manage its memory more efficiently by keeping in memory only those resources required at a given moment. An application developer can designate an expendable resource as *purgeable*. If the Mac needs more memory for a given task, it can use a portion of its system software called the Memory Manager to clear purgeable resources from memory. Large resources, such as fonts and dialog box templates, are often designated as purgeable.

Where Does ResEdit Come In?

ResEdit enables you to access a file's resource fork and alter its contents. By altering a file's resources, you can modify many functional and cosmetic aspects of that file.

You can buy ResEdit and its documentation through the Apple Programmer's and Developer's Association (APDA; its address appears in Appendix B). ResEdit is also widely distributed through users' groups and online information services. Many different ResEdit versions are floating around within this informal distribution network; be sure you're using the latest version by selecting the file and choosing the Finder's Get Info command. At this writing, the latest *released* version is 2.1.1. Some later versions are available in pre-release form, but are likely to be less reliable and have fewer resource editing features. The instructions in this chapter assume that you're using ResEdit version 2.1 or later.

You can identify a prerelease version of ResEdit by the presence of a letter in its version number. Version 1.3d1, for example, indicates *development release 1* of version 1.3. Version 1.3a1 indicates the first *alpha* release, while 1.3b1 indicates *beta* release 1. *Development* releases are the least reliable and the most likely to change cosmetically; they're rough prototypes of the final software. Alpha software is generally cosmetically complete—the wording and appearance of menu commands, palette icons, and dialog boxes is finalized or close to it—but the software can be incomplete or buggy. *Betas* are closest to final, released versions; they're cosmetically complete, and all commands and features have been implemented, and the final bug-extermination campaign is underway. (Apple uses the *d, a,* and *b* designations for all its pre-release software; many other developers have also adopted it.)

ResEdit's documentation describes the program's operation, but because many people obtain ResEdit through user groups and online services, we will summarize the program's workings here. For more details on ResEdit, you may want to read *ResEdit Complete,* by Peter Alley and Carolyn Strange (Addison-Wesley).

> **WARNING!** You can damage files by using ResEdit carelessly. It's a good idea to make a backup copy of the file you want to modify, and perform your modifications on the copy. You can use the Finder to make a copy of a file to be modified: select the file and then choose Duplicate from the File menu.

Opening a File with ResEdit

To open a file for editing, choose Open from the File menu and double-click the file's name (or select the file and click Open or press Return). If the file doesn't have a resource fork, a dialog box appears and prompts you to create one. Generally, you click Cancel. (We will explain why—and point out when you may want to click OK—later in this chapter.)

When you open a file's resource fork, a *resource picker* window appears listing the resources in that file, sorted alphabetically. A typical file's resource window is likely to contain standard resource types (MENUs, DLOGs, ALRTs, WINDs, and so on) as well as specialized resource types created by the file's developer. Generally, when using ResEdit to modify applications, you work with only standard resource types.

You can have numerous files open simultaneously, although to avoid altering the wrong file's resources accidentally, you may want to work with one file at a time when getting acquainted with ResEdit.

Following are a few things to note about ResEdit's Open dialog box:

- Unlike the Open dialog boxes in most programs, ResEdit's Open dialog box also shows *invisible* files—ones whose names and icons don't appear in Finder directory windows or on the Desktop. Two examples of invisible files are the Desktop DB and DeskTop DF files that help the Finder keep track of the files on a disk and their icons.
- As with other Open dialog boxes, you can select a file or folder by typing the first few characters of its name. To open a folder, double-click it or select it and choose Open.

- The Open dialog box contains a check box labeled Use Alias Instead of Original. Check this box if you want to open an alias file itself; if this box is unchecked and you double-click an alias name, ResEdit opens the file or folder to which the alias points.

A ResEdit Exercise: Modifying TeachText's Menus

Because ResEdit is a complex utility, we included the following exercise to guide you through the resource-modifying process.

This exercise shows you how to modify the TeachText program that accompanies the Mac's system software. We have chosen this program because every Mac includes it. In this exercise, we modify one of TeachText's MENU resources to add a Command-key shortcut to the Edit menu's Clear command. After making this modification, you can choose TeachText's Clear command by pressing Command+B. This isn't exactly an earth-shaking advancement, but it gives you a feel for working with ResEdit.

Before performing this exercise, make a duplicate copy of TeachText. Select the TeachText icon and choose Duplicate from the Finder's File menu. Use this duplicate as your surgical guinea pig.

1. Start ResEdit and choose its Open command. Locate the TeachText duplicate (its name should be *TeachText copy*) and open it.

   A resource picker window appears listing the resources in the TeachText program. Each resource has a corresponding icon associated with it.

2. Double-click the MENU resource.

   The MENUs from TeachText window appears (see figure 11.10).

   The numbers below each menu are the resource identification numbers, or *resource IDs,* of each of TeachText's menus. (As you may recall from Chapter 6's discussion of font ID numbers, the Mac's Resource Manager uses resource IDs to refer to resources.)

3. The Edit menu has an ID number of 3. To open this menu for modification, double-click the Edit menu's entry.

   A resource window for the Edit menu appears (see figure 11.11). Don't perform any modifications yet.

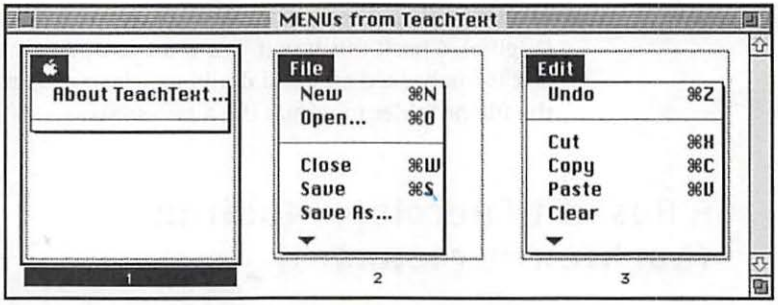


Figure 11.10: The MENUs from TeachText window.

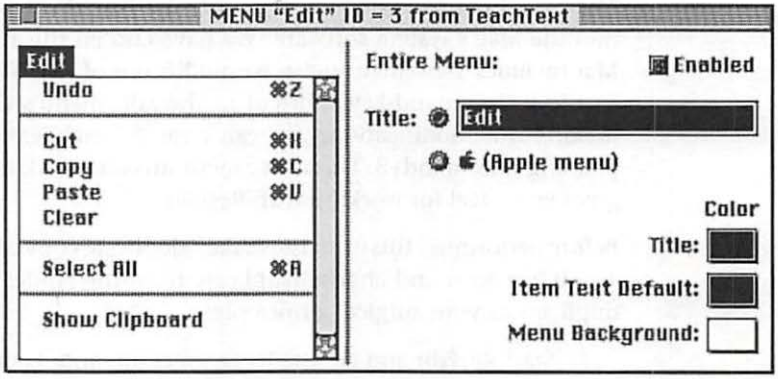


Figure 11.11: The Edit menu's resource window.

This window is a *menu editor* that enables you to modify the characteristics of menus. ResEdit has other types of editor windows for modifying other resource types; you encounter several of them later in this chapter.

4. To modify the Clear command, select it by clicking it once. The menu editor window changes to list the options available for menu commands (see figure 11.12).

   For this exercise, the most important component in the menu editor window is the text-editing box labeled *Cmd-Key*. Each menu item has a Cmd-Key box.

5. To add a Command-key shortcut to a menu item, click in the Cmd-Key text box and type a capital *B*. (A lowercase *b* will work, too, but will make the Edit menu's appearance inconsistent with that of other programs.) Notice that ResEdit shows the new Command-key adjacent to the Clear command immediately (see figure 11.13).

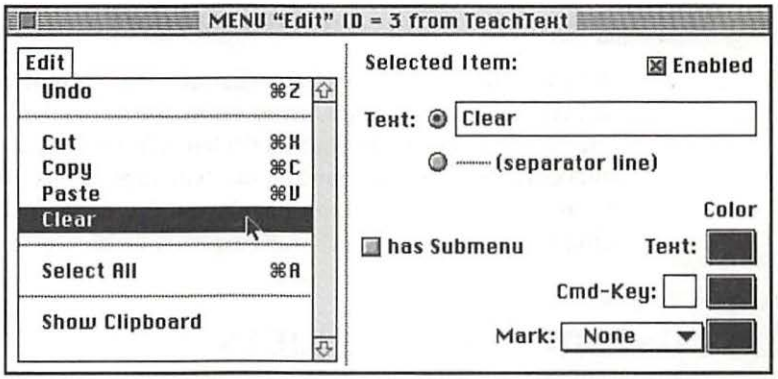


Figure 11.12: The menu editor with the Clear command selected.

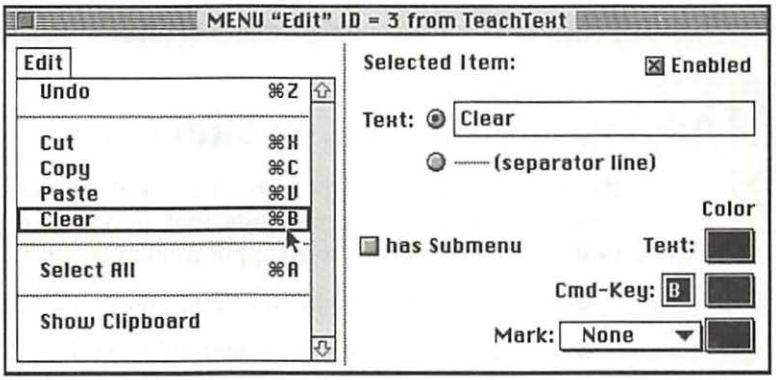
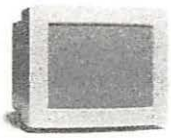


Figure 11.13: Key equivalents added to the Clear command.

Double-check your work, close the menu editor window, the MENUs from TeachText window, and finally, the TeachText window itself. When you close the TeachText window, ResEdit prompts you to save your changes. Click Yes or press Return. Finally, quit ResEdit.



TIP: You don't actually have to close each window before quitting. As with other Mac applications, you can simply choose Quit and click Yes when asked to save changes. As you get more accustomed to working with ResEdit, you will probably want to take this faster route back to the Finder.

Trying the Modified TeachText

To try your new keyboard shortcuts, start up the copy of the TeachText program and type a few characters. Now select the characters you typed and press Command+B. The text should be deleted. If it isn't, pull down the Edit menu and verify that the Command+B shortcut appears next to the Clear command. If it isn't listed, you may not have saved the TeachText program after modifying it.

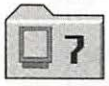


Customizing Projects

Now you're ready to tackle some customizing projects. This section presents tips for adding Command-key shortcuts to commands that lack them, adding keyboard shortcuts to dialog box buttons and to mouse movements, modifying printer drivers to accommodate custom paper sizes, and much more.



Adding Command-Key Shortcuts



If you're fond of Command-key shortcuts, you're probably frustrated when you encounter often-used commands that don't have them. You can add Command-key shortcuts to an application in two ways:

- Using ResEdit to modify the application's MENU resources
- Using a keyboard-enhancement utility, such as CE Software's QuicKeys.

Each of these customizing tools has its strengths and drawbacks.

ResEdit Pros and Cons

Following are advantages of using ResEdit to add or modify Command-key shortcuts:

- Your changes are saved directly in the application program. If you copy the program to another disk or to another Mac, your shortcuts move along with it.
- Your shortcuts appear in the program's menus, just like the shortcuts the application's developer specified. You don't need to refer to a separate menu or reference screen to refresh your memory when you forget a particular shortcut.
- You don't need to donate the extra memory required to accommodate the keyboard-enhancement utility.

Following are the disadvantages of using ResEdit to modify Command-key shortcuts:

- It's tricky. You can damage an application file if you aren't careful.
- Some application programs use special menu-handling code that prevents you from adding or changing shortcuts using ResEdit. One notable example is the Microsoft Word word processing program.
- Some application programs provide many different menus, each of which is active at a different time. Microsoft Works' menus, for example, change depending on whether you're working with a word processing, spreadsheet, database, or communications document. For applications like these, using ResEdit is either impractical or downright impossible.

Keyboard Utility Pros and Cons

Why use a keyboard utility rather than ResEdit to add keyboard shortcuts? Following are some reasons:

- You can create shortcuts that use the Control, Shift, and Option keys in addition to, or rather than, the Command key. ResEdit enables you to use only the Command key.
- You don't risk damaging an application file by altering something you shouldn't accidentally.
- You can add shortcuts to applications, such as Microsoft Word, whose menus don't use standard MENU resources.
- You can use the utility to create other shortcuts that simulate mouse movements and button clicks, enter text, and more.
- You can record multiple events and assign them to one key sequence. You may, for example, create a sequence that issues the Quit command, responds Yes to the Save changes? dialog box, and then shuts down your Mac.
- You can specify whether a given shortcut applies to only a specific application (a *local* shortcut), or to every application you use (a *universal* shortcut). If you have the Apple Extended Keyboard, you can assign macros to function keys. You can record the Command+S (Save) key sequence as a universal shortcut and assign it to the F15 (pause) key, for example. With this shortcut, you can issue the Save command in virtually any program by pressing F15.

Unfortunately, using keyboard shortcut utilities also can have the following drawbacks:

- Your shortcuts are stored in separate files maintained by the keyboard utility. If you want to move an application program to a different disk and retain the shortcuts, you must move the utility and its keyboard-shortcut file there, too. Because you're likely to create your shortcuts over time as you use various programs, you must remember to create backups of the files of that utility so that you will not lose the shortcuts if the worst happens.
- Your shortcuts don't appear in the application's menus. If you forget one or more of them, you must use the utility's menus or dialog boxes to refresh your memory.
- The utility itself uses memory. If you don't plan to use the utility for other tasks, you may not want to donate precious RAM for a few keyboard shortcuts.
- Some keyboard utilities require certain menu titles and commands—File, Edit, Copy, Paste, Quit, and Shut Down, to name several—to appear in English and, therefore, are unlikely to work with non-English versions of the Mac's system software.
- Because keyboard utilities modify the way the Mac responds to its keyboard, occasional incompatibilities can surface.

Notes About ResEdit and Menus

Following are a few odds and ends you may want to keep in mind before modifying the MENU resources of your applications.

- Avoid duplicating an existing Command-key shortcut. The Mac responds to Command-key shortcuts from right to left on the menu bar. If you assign the same Command-key shortcut to a command on both the File menu and the Edit menu, for example, the shortcut will work for the Edit menu's command, not the File menu's.
- Many applications contain several MENU resources for the same menu title. Microsoft Excel contains several MENU resources that create the File menu, for example, but each resource is used at a different time, depending on what kind of document is active. If you're modifying the menus of such programs, be sure to modify the alternate versions of each menu, too; otherwise, your Command-key shortcuts will not always be available.
- Use capital letters in ResEdit's Key Equiv box. Lowercase letters work (the Mac's Menu Manager doesn't distinguish between capitals and lowercase), but they will look odd in the menus.

- If you have an Apple Extended Keyboard, you generally can use function keys as Command-key shortcuts, but there is a catch. The menu does not indicate which function key you should press. Instead, a hollow Apple symbol appears next to the Command-key symbol. Worse, the Mac uses the same Apple symbol for every function key, so if you create Command-function key shortcuts for several commands, they will all look the same.



Macro Utilities

If you decided that a keyboard macro utility is a more appropriate customizing tool, you need to decide which utility to use. Two popular keyboard utilities are CE Software's *QuicKeys* and Affinity Microsystem's *Tempo II*. (Apple's MacroMaker is a simple macro utility included with System 6. MacroMaker has compatibility problems with many programs and isn't very widely used, so we will not cover it here.)

In this section, we spotlight the key differences among each macro utility to help you decide which is most appropriate for you.

The primary difference between keyboard utilities concerns the methods they use to record the events you want to play back.

With Tempo II, you create macros by invoking the utility's record mode, performing the tasks you want to record, and then stopping the recording process. While you're recording, the utility is keeping track of where the mouse pointer is when you click the mouse, and of which keys are pressed. When you play back the macro, the utility recreates those events. Tempo II adds its own menu to the menu bar.

With QuicKeys, you usually create macros not by recording events, but by choosing commands from QuicKeys' menus, which appear in the QuicKeys Control Panel (see figure 11.14). To create a macro (in QuicKeys parlance, a *quickey)* that chooses a menu command, for example, you choose Menu/DA, choose the desired menu command, and then assign a keystroke sequence to it. To create a macro that performs several events, you use the Sequences menu to chain numerous individual quickeys together. QuicKeys doesn't add a menu to the menu bar.

QuicKeys contains many clever built-in shortcuts that Tempo II lacks. You can define macros that insert the current time and date or true opening and closing quotes, for example (discussed in Chapter 9). Another built-in shortcut enables you to leaf through the open windows on your Desktop. Numerous System 7-specific shortcuts are available for turning balloon help off and on, activating and deactivating file sharing, and more. And as we explain shortly, QuicKeys also contains intelligent scrolling shortcuts that enable you to use the extended

keyboard's navigation keys (page up, page down, and so on) to scroll windows. In addition to these shortcuts, QuicKeys is ideal for creating keyboard shortcuts for menu commands and dialog box buttons and for creating macros that enter frequently used text for you.

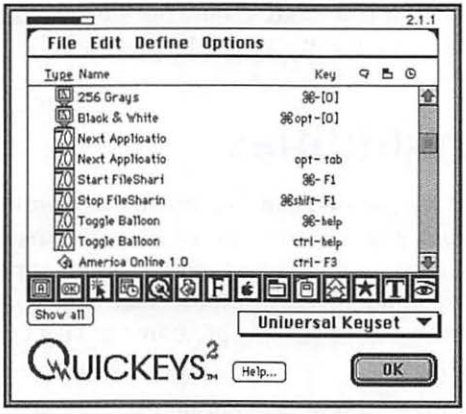
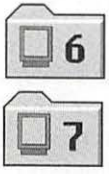


Figure 11.14: CE Software's QuicKeys.



Macro Utility Shortcuts

In the following sections, we will look at the different types of shortcuts you can create with a macro utility and provide some advice as to which utility can best accommodate each type of shortcut.

Menu Command Shortcuts

You can use either macro utility to create keyboard shortcuts for menu commands. Both QuicKeys and Tempo II remember menu command names, not command positions, so your shortcuts will work even if your program shuffles the position of menu commands as it runs.

Dialog Box Shortcuts

Tempo II is ideal for creating dialog box shortcuts. With Tempo II, you can start and stop the recording process while a dialog box is open by pressing Command+comma (,). You can begin recording after the dialog box is open, and you can stop recording before closing the dialog box. If you press Command+Option while clicking the mouse, Tempo II's menu pops up, enabling you to pause and resume recording and choose additional recording options.

With QuicKeys, you can use the Buttons command in QuicKeys' Define menu to create shortcuts for the buttons in a dialog box.

Mouse Shortcuts

A third category of keyboard shortcut involves recording a mouse movement, such as clicking on a palette tool or dragging an icon or a window. Tempo II and QuicKeys handle this task easily. To automate complex mouse movements that require recording of the mouse's path or the time it took to move from one point to another, use Tempo II or QuicKey's real-time recording mode.

Macros that Start Programs

Most people use the same programs frequently. For them, macros that start those programs can save time, especially if the programs are buried in folders. Tempo II and QuicKeys are ideal for creating application-starting macros because they don't rely on the application residing at a specific location on the desktop. Instead, they remember the name of the application you started.

Both Tempo II and QuicKeys also enable you to create *transfer macros that* allow you to move to a specific program (and open a specific file, if you want) without using the Finder. When you play back a transfer macro, the macro utility instructs the active program to quit (and ask you to save changes, if necessary), and then starts the specified program. (If you're running under System 7 or System 6 MultiFinder, both utilities simply start the second application without quitting the one you're using.)

Creating transfer macros is easier in QuicKeys because you need not actually transfer to the program specified in the macro. Instead, you choose the desired application from a dialog box that QuicKeys displays. QuicKeys also enables you to create a "generic" transfer macro, which, when played back, displays a standard Open dialog box that enables you to choose an application or file to open.

Macros that Enter Frequently Used Text

If you type the same keystrokes frequently, such as your name and address, or if you paste a shape or object into drawings frequently, you can create macros that perform the task for you. Any macro program enables you to easily record and play back keystrokes. Tempo II has a unique *autopaste* feature that enables you to define and recall graphics or text easily. Simply select the text or graphic and choose Autopaste from Tempo II's menu. Tempo II records a macro that,

when played back, retrieves what you selected from Tempo II's macro file, and then pastes it into the active document. QuicKeys Paste Ease extension works similarly.

Ten Ways to Use Macros

Because macros reflect the way a person uses his or her Mac, they tend to be specialized. Still, many common tasks can benefit from automation. This section contains a list of ten macro shortcuts you may find useful. In the following descriptions, we noted when a given shortcut requires a specific macro utility. If no macro utility is mentioned, you can use any utility to create the shortcut.

Ejecting and forgetting a disk icon. Tired of reaching for the mouse to drag disk icons to the Trash? Create macros that do it for you. You may press Control+1 to eject the disk located below the startup disk, Control+2 to eject the disk below that, and Control+3 to eject the fourth disk down. (Begin with the disk below the startup disk because you cannot drag the startup disk's icon to the Trash.)

Opening and closing Desk Accessories. With macros, you can press Control+A to summon the Alarm Clock, Control+C to call up the Control Panel, Control+R to display the Chooser, Control+F to open Find File, and Control+= (equal sign) to open the Calculator. If you use System 6 MultiFinder, record a macro that chooses the DA Handler's Quit command and assign it to Command+Q.

Changing double hyphens to em dashes. As mentioned in Chapter 9, documents look more professional when you take advantage of the Mac's special typographic symbols. Many applications use the Mac's typographic quotes automatically as you type, but they do turn two hyphens (--) into an em dash (—) automatically. The solution? A macro that uses your word processor program's search-and-replace feature to change all double hyphens to em dashes. Use it just before printing, and you will never see a double hyphen again.

Using the extended keyboard's navigation keys. Word processor programs aside, few applications support the extended keyboard's Ins/Help, Del, Home, End, Page Up, and Page Down keys. QuicKeys' Mousies menu enables you to put the Home, End, Page Up, and Page Down keys to work easily. After you assign one of these navigation shortcuts to a key, QuicKeys "clicks" the scroll bars in the active window to scroll to the top or bottom of your document or scroll up or down by the windowful. As for the extended keyboard's Help key, consider

assigning it to a macro that chooses the Finder's Get Info command. We also created a Finder macro that assigns the Close command to the Del key. This combination makes it easy to open and close a Get Info window. (It's also ideal for closing Desk Accessories.)

Switching applications under System 7 or System 6 MultiFinder. Rather than reaching for the mouse to switch between applications, create a macro that does the job. (We showed how to do this using QuicKeys earlier in this chapter.)

Starting often-used applications. Create Finder-specific macros that start your favorite applications and then assign the macros to the number keys on your keypad. Pressing 1 may start your word processing program, 2 may start your publishing program, and 3 may start your paint program. To create these macros using QuicKeys, use the Define menu's File command. Because QuicKeys' File command lists documents as well as applications, you also can use it to directly open frequently used documents.

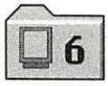
Putting the Esc key to work. In many of Microsoft's programs, pressing Esc when a dialog box is open cancels the dialog box. That's a useful shortcut to add to any application program, and QuicKeys is ideal for the task. Use its Button command and specify *Cancel* as the button to look for. Save the macro as a universal macro.

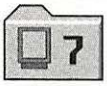


Switching Set Startup options. Many users switch between running under MultiFinder and running under the single Finder frequently. If you're in this group, you can save time by creating macros that choose the Finder's Set Startup command, specify the Finder (or MultiFinder), okay the dialog box, and then choose the Restart command. For creating this multi-step macro, Tempo II is easier to use than QuicKeys. Tempo II enables you to record the Restart and Shut Down commands; before the Mac restarts or shuts down, the utility's window appears, enabling you to save the macro. If you are using QuicKeys, use the Specials menu to specify the Restart or Shut Down commands.

Tearing off menus. HyperCard, MacPaint, and several other applications provide tool or pattern palettes in the form of *tear-off menus*—menus that you can "tear" away from the menu bar and drag anywhere on the screen, where they're always available. Generally, these applications don't remember that a menu has been torn off; each time you start the application, you must tear off the desired palette if you want to keep it available at all times. The solution? Create a macro that tears the menu off and drags it to the desired position.

Pasting to the Scrapbook. Most people frequently need to paste snippets of text or graphics into the Scrapbook. Rather than choosing Copy manually, opening the Scrapbook, choosing Paste, then closing the Scrapbook, create a macro that performs all four steps for you. Because Command+V is the standard keyboard shortcut for the Paste command, you can assign the Control+V shortcut to your paste-to-Scrapbook macro. With this macro, saving something in the Scrapbook is a matter of simply selecting it and pressing Control+V.





Custom Paper Sizes

If you have an ImageWriter, chances are you occasionally need to print on paper whose dimensions aren't listed in the Page Setup dialog box. In this section, we show how to modify the ImageWriter driver to accommodate custom paper sizes. The ImageWriter driver modification applies to all recent versions of the ImageWriter and ImageWriter LQ drivers.

Coercing the ImageWriter driver into accommodating custom paper sizes involves altering one of the driver's PREC (print record) resources. You can use ResEdit to perform this task, which is explained shortly.

You also can use some easier ways to modify the ImageWriter driver that don't require ResEdit. One way is to use free application by Bill Steinberg called *PREC Manager,* available through user's groups and online services. Another utility called *Widgets,* is included with CE Software's *DiskTop* Desk Accessory, and provides Finder-like disk- and file-management features. Microsoft Word 5.0 also enables you to create a custom page size directly by using the Preferences command.

Background on PREC Resources

How does the ImageWriter driver use PREC resources to determine available page sizes? The ImageWriter driver contains three PREC resources. PREC resource number 3 is the one that controls which paper sizes appear in the Page Setup dialog box. This resource contains the following:

- A number corresponding to the total number of page sizes defined in the resource. The Mac uses this number to determine how many radio buttons to create in the Page Setup dialog box.
- The dimensions of each paper size, expressed in units of 1/120 of an inch. 11 inches is listed as 1320 units, for example.
- The descriptive labels—International Fanfold, Computer Paper, and so on—that appear adjacent to each radio button.

The ImageWriter driver isn't the only place you may find a page-size PREC resource. Applications can contain their own PREC resources that override the PREC 3 resource in the ImageWriter driver. These higher-priority PREC resources have a higher ID number: 4. When you choose the Page Setup command, the Mac performs the following search to find the highest-priority PREC resource:

1. First, it looks for a PREC 4 resource in the active printer driver. If one isn't found there, the Mac looks in the active application's resource fork. If the application doesn't contain a PREC 4 resource, the Mac looks in the active System file's resource fork.

2. If the Mac doesn't find a PREC 4 resource in any of those places, it searches for a PREC 3 resource. The Mac searches in the same order: first the active printer driver, then the active application file, then the active System file.

3. If the Mac doesn't find a PREC 3 resource in any of those places, a system error occurs. For this reason, be sure to always have one PREC 3 resource available. (In other words, don't remove the PREC 3 resource from the System file.)

4. When it finds a PREC 4 or PREC 3 resource, the Mac uses its contents to determine which sizes have been defined and to construct a radio button for each size. The dimensions of the size you choose are passed along to the application program, which uses them to set margins and perform other tasks relating to the chosen page size. At printing time, the Mac uses the dimensions to determine when to instruct the ImageWriter to advance to the next page.

Among popular applications, Microsoft Works and Word are two that contain a PREC 4 resource. If you use either of these applications and you want to create custom paper sizes, you will need to modify their PREC 4 resource rather than (or in addition to) modifying your ImageWriter driver's PREC 3 resource.

Aldus PageMaker doesn't contain a PREC 4 resource, but it does override the PREC 3 resource when creating its Page Setup dialog box. This isn't a drawback, however, because PageMaker enables you to specify a custom paper size in its Page Setup dialog box.

Using ResEdit to Create a Custom Paper Size

To use ResEdit to create a custom paper size, make a duplicate copy of your ImageWriter driver (this is the copy you will modify). Start ResEdit and open the ImageWriter driver backup. ResEdit opens the driver's resource fork and

displays a resource picker window listing the resource fork's contents. Locate the PREC entry in the resource picker window and double-click it. A new window appears listing the PREC resources in the ImageWriter driver.

Double-click the PREC with an ID number of 3. ResEdit opens the PREC 3 resource and displays its contents in a new window (see figure 11.15).

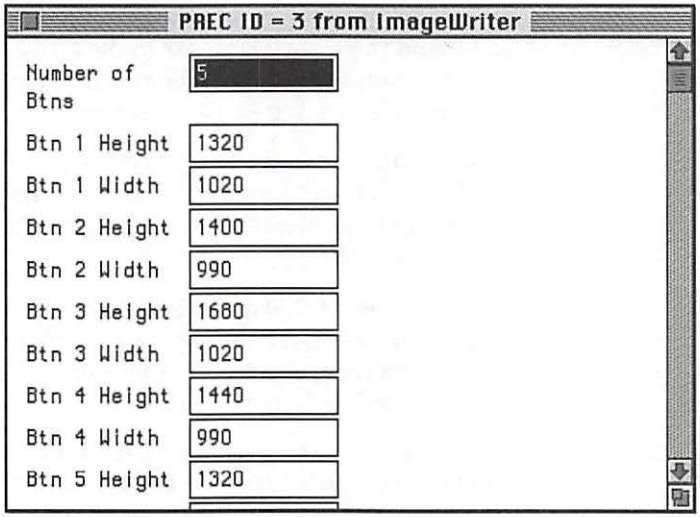


Figure 11.15: Resource-editing window for the PREC 3 resource.

The window lists the resource's contents in the order described previously: the number of page size buttons, the page size dimensions of each button, and the text of the buttons themselves.

The ImageWriter driver contains definitions for five paper size buttons, but the driver can accommodate six definitions. You can edit an existing definition, or create a sixth. To create the sixth definition, first replace the 5 that appears in the Number of Btns text box with 6. Next, scroll to the bottom of the window and replace the upside-down question mark (¿) that appears in the Btn 6 Name text box with a short name that describes your custom paper size, such as *Index Card*.

To specify the page size, locate the Height and Width text boxes for the button you're defining. (If you're creating a sixth button, use the Btn 6 Height and Btn 6 Width buttons.) Next, calculate the dimensions of the paper by multiplying their dimensions in inches by 120. For a 3 1/2- by 5-inch index card, use a height dimension of 420 and a width dimension of 600. Figure 11.16 shows what the PREC 3 resource editing window looks like if you define a sixth button for index cards.

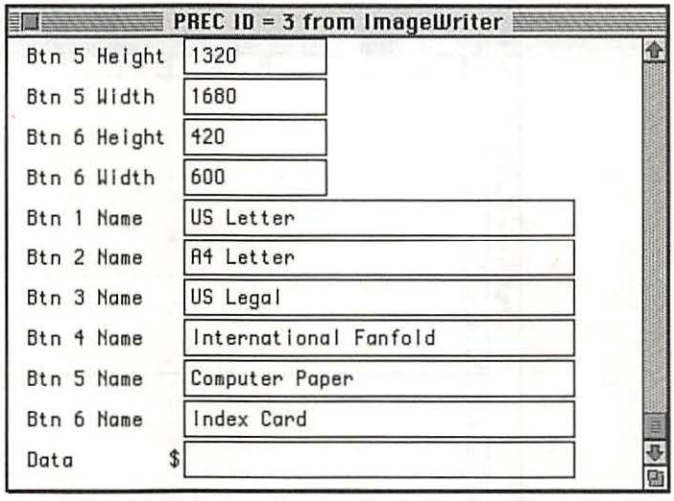


Figure 11.16: The PREC 3 window with an Index Card button definition.

After you edit the resource, double-check your work and then close the template window, the PRECs window, and the ImageWriter window. You also can choose Quit and then click Yes or press Return when prompted to save changes.

Trying the New Size

After you save the modified driver, use the Chooser Desk Accessory to select it. The best way to try the new page size is to open an application program whose document window reflects the current page size. MacDraw is ideal. Regardless of the application you use, the steps for trying the new size are the same. Choose Page Setup from the File menu, select the new size, and click OK. If you're using MacDraw for this test, you will see it update the page break lines in document window to reflect the new page size. Turn on the rulers, and you see that the page break lines reflect the new page size (see figure 11.17).

Many applications establish preset margins, so the rulers may not reflect the exact page size. With the index card as the current page size, for example, MacDraw II displays the page break lines at 3-inch intervals, not 3 1/2-inch intervals.

Also note that some applications may not work properly with custom paper sizes. Most Mac programs are tested with only standard page sizes, so be sure to test a modified ImageWriter driver with the applications you use before replacing your unmodified driver. (And keep a backup of the unmodified driver handy—just in case.)

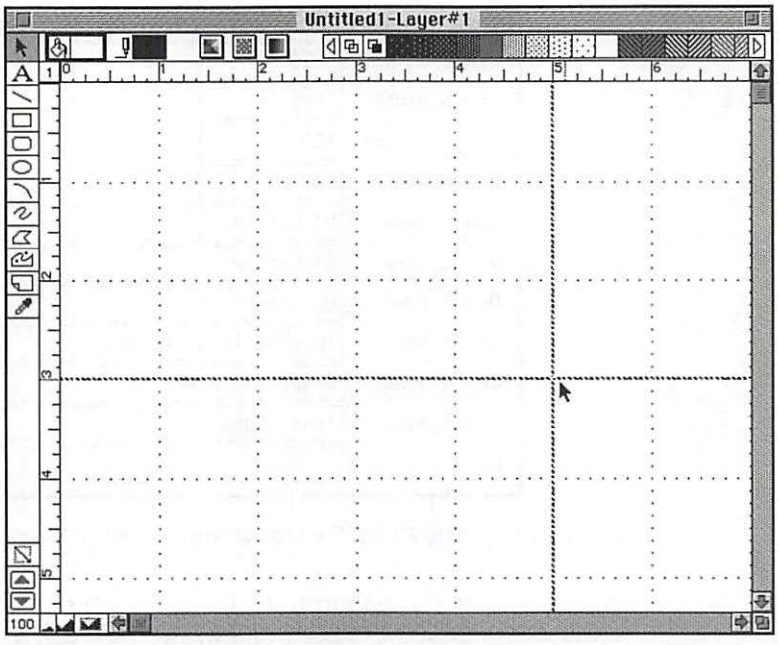


Figure 11.17: The Index Card page size at work in MacDraw II.

Adding a PREC 4 Resource to an Application

If you want to use a custom paper size in just one application, you can add a PREC 4 resource to that application, causing it to override the ImageWriter driver's PREC 3 resource.

Open an unmodified copy of the ImageWriter driver and open its PREC window. In the PRECs from ImageWriter window, select the PREC 3 resource, choose Copy from the Edit menu, and then close the ImageWriter file.

Next, open the application you want to modify. When the application's resource window appears, choose Paste from the Edit menu. Next, locate the PREC entry in the application's resource window, and open it. A window, titled PRECs (from *application name*) opens. If a PREC 4 resource already exists in that application, remove the resource you just added by selecting it and choosing Clear from the Edit menu. Otherwise, select the PREC with an ID number of 3 and choose Get Resource Info from the Resource menu. A window containing information about the resource opens. Type 4 in the text box labeled ID.

After adding the new PREC resource to the application, modify its page sizes as described in the previous section. Finally, close the application's resource

window, and answer Yes when asked to save changes. To try the PREC 4 resource, start the application and use its Page Setup command as described earlier.



Other ResEdit Projects

This section is a potpourri of functional customizing projects that use ResEdit. You will find tips for preventing files from being renamed, changing the appearance of dialog boxes, and more.

Using ResEdit's Get Info Command to Change File Characteristics

You can get information on a file or folder by choosing Get File/Folder Info from the File menu and then selecting it. As figure 11.18 shows, the Get File/Folder Info command enables you to examine and alter a file's or folder's *attributes*—a collection of settings and statistics used by the Finder and applications.

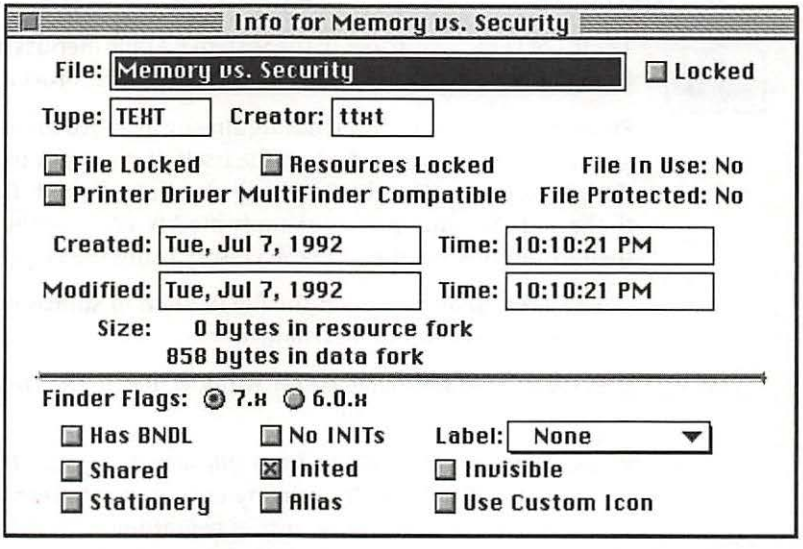


Figure 11.18: File attributes in ResEdit's Get Info window.

We will explore the list of file attributes in more detail Chapter 17. For now, let's concentrate on just one attribute: the *locked* attribute that appears next to the file's name. When this attribute is checked, you cannot change a file's name.

This can be especially useful if the file is used in a macro that expects to find a specific file name.

But wait—can't you prevent a file from being renamed by simply using the Finder's Get Info command to lock the file? Yes, but that also prevents modifications to the file. A file whose name is locked can be modified or even deleted.

To lock a file's name, choose Get File/Folder Info, and then select the desired file. When ResEdit's info window appears, select the Locked button that appears to the right of the file's name. Then close the info window, and answer Yes when asked to save changes. If you need to rename the file later, simply uncheck the locked-name attribute. Or, duplicate the file using the Finder, rename the duplicate, and throw away the original. When you duplicate a file whose locked-name attribute is checked, the Finder does not activate the locked-name attribute in the duplicate.

Incidentally, ResEdit isn't the only tool you can use to alter file attributes. Programs that enable you to alter attributes include disk utilities and several file-management Desk Accessories.

Renaming Desk Accessories in System 6



The list of Desk Accessories in the System 6 Apple menu is in alphabetical order. By renaming Desk Accessories, you can change the order in which they appear.

Renaming Desk Accessories that are already installed in the System file involves opening and editing the System file itself. If you want to rename an installed Desk Accessory, make a backup copy of your System file first, and then modify the backup. You may prefer to simply modify a copy of the Desk Accessory, and then install the renamed Desk Accessory using the Font/DA Mover.

1. Start ResEdit and open the file (System or suitcase) containing the Desk Accessory to be renamed.
2. In the file's resource picker window, locate the DRVR entry and open it by double-clicking.

   A new window, DRVRs from *(file name)*, appears. If you opened the System file, you will see many entries, most beginning with *Desk Acc.* (You also will see some entries beginning with *Driver.* These are fundamental software routines that help the Mac communicate with the printer and other add-ons. Desk Accessories and drivers share some common technical characteristics; that is why they're grouped together under the DRVR resource type.)

3. Locate the Desk Accessory you want to rename, and select it by clicking on it (just once), and then choose Get Resource Info from the Info menu.

   ResEdit displays an info window for the Desk Accessory.

4. In the Name text box, edit the Desk Accessory's name as desired. Don't change any other entries in the Get Info window.

   To move a Desk Accessory to the top of the Apple menu, type a space or punctuation character before its name. Avoid using the following characters: ; ^ ! < / (. These characters denote certain menu characteristics, such as Command-key shortcuts or a disabled menu command. The Mac may not be able to create the Apple menu properly if you use them in a Desk Accessory name.

5. Close the Get Info window and repeat steps 3 and 4 for each Desk Accessory you're renaming.

6. Choose Quit from the File menu and answer Yes when asked to save changes.

If you modified a backup copy of your System file, you will need to replace your original System file to see the renamed Desk Accessory. (Remember that you cannot replace the System file on the current startup disk.) If you modified a Desk Accessory in a suitcase file, use the Font/DA Mover to install the Desk Accessory.



Renaming Desk Accessories in System 7

If you use System 7 and you want to rename a Desk Accessory so that it appears elsewhere in the Apple menu, you don't have to go through the routine we just described. Simply rename the Desk Accessory's file using the Finder.

You still can rename a Desk Accessory's DRVR resource, but the only places you notice the new name are in the Desk Accessory's About command and in the application menu when the Desk Accessory is open.



Modifying the System 7 Finder

If you're running System 7 and you try to open the Finder using ResEdit, you see an alert message that tells you that the file is open from another application. This is ResEdit's less-than-clear way of saying that you cannot modify the Finder file when the Finder is running.

One way to work around this is to duplicate the Finder and modify the duplicate, and then replace the original Finder after starting up with a different disk. An easier method is to use one of the Finder-quitting techniques we described in the section "Quitting the Finder," earlier in this chapter. After quitting the Finder, you can open and modify it using ResEdit.

6 7 Altering Dialog Boxes

Another customizing job you may want to tackle is altering the appearance of the dialog boxes your applications display. The most useful dialog box modification you can make is to lengthen the text boxes into which you type values or text, and to lengthen the list boxes that enable you to choose documents to open. Both modifications enable you to see longer file names (see figure 11.19).

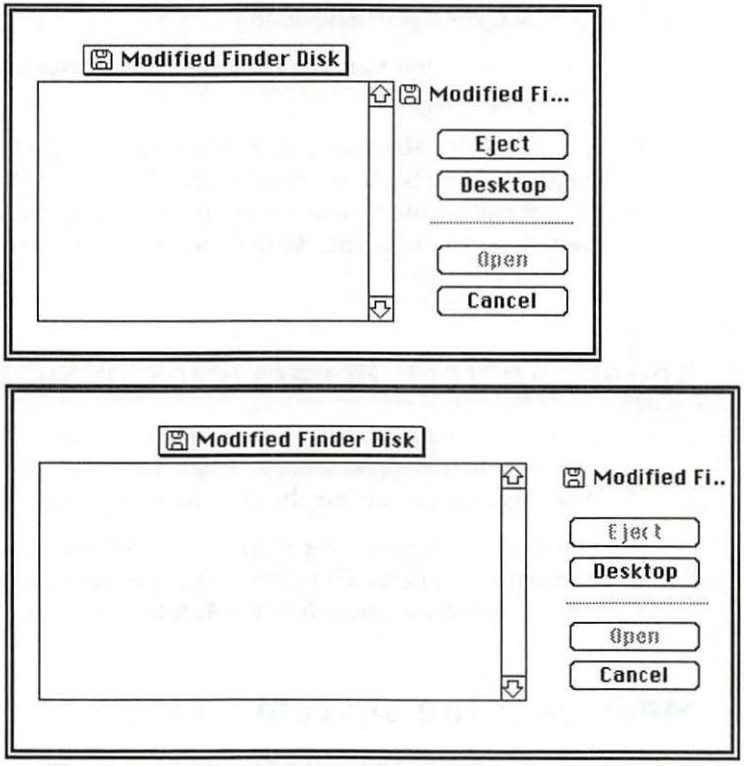


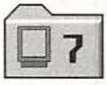
Figure 11.19: An unmodified Open dialog box (top) and its modified counterpart (bottom).

Altering a dialog box is one of the riskier ResEdit modifications you can make. Programs generally expect their dialog boxes to contain a specific number of items, and you can cause a program to crash by adding items to or removing them from a dialog box. Following are a few comments and cautions concerning dialog box remodeling:

- Many programs contain DLOG resources that override the System file's standard Open and Save resources. To see longer file names in such programs, modify their DLOG resources.
- Be careful to not delete any items from a dialog box. Application programs generally expect their dialog boxes to contain a specific number of items, and are likely to crash if they don't.
- As you experiment with dialog box editing, you're likely to encounter a special character code that begins with a caret (^) and ends with a number, as in ^0 or ^1. Don't edit these items; they're placeholders that the application replaces with text. You may see a sentence reading *Save changes to ^0?*, for example. When the program is running, it replaces the code ^0 with the name of a file.
- If you double-click on a dialog box item, a window appears that enables you to change its type (from check box to button, for example). Changing an item from one type to another is likely to cause a program to crash.
- The DITL menu that appears when a DLOG resource is open contains commands that enable you to change the order in which the dialog box's contents are drawn (Bring to Front, Send to Back), and the number of each item within the dialog box (Set Item Number). Do not use these commands when editing an application's dialog boxes.

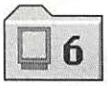


Installing Fkeys



The easiest way to work with FKEYs is to use a system utility, such as Suitcase II or Master Juggler. If you don't have these utilities and you want to install FKEYs directly in the System file, you can use ResEdit. Open the file containing the FKEY, copy the FKEY to the Clipboard, and then open the System file and paste the FKEY into it.

Numerous FKEY installation utilities are also available from user groups and online services.



Modifying the System 6 Finder

Versions 5.3 through 6.1 of the Finder file contain a *layout* resource that specifies a hodgepodge of Finder settings. From the customizer's viewpoint, the most interesting settings include the following:

- Font and size used to label icons
- Spacing of icons in directory windows
- Size of the headers and footers the Finder prints when you use the Print Directory command
- Line spacing of the Finder's text views (that is, all views except By Icon and By Small Icon)
- View used for new directory windows
- Date format used by text views and the Get Info window
- Finder warnings that appear when you throw away an application file
- Icons that are "snapped" by the Finder when you drag them to an invisible grid

The Finder's layout resource has a resource name of LAYO. If you open the LAYO resource using ResEdit, you will see a window similar to figure 11.20. Table 11.2 describes the contents of the LAYO resource in Finder 6.1.

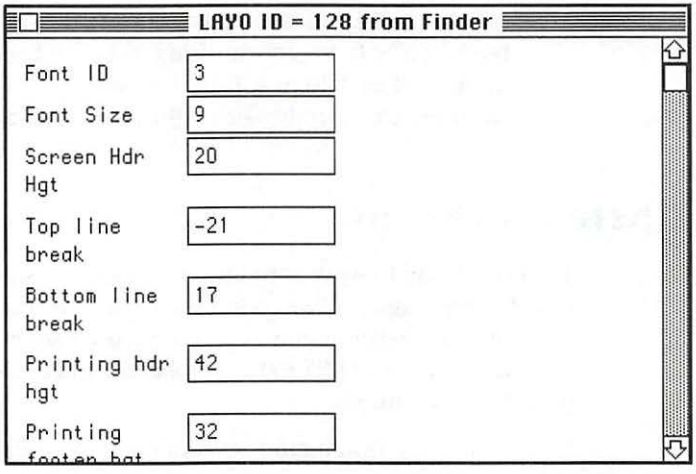


Figure 11.20: The Finder's LAYO resource.

Table 11.2: Inside the Finder's LAYO resource.

Preset Item Name	Value	Purpose
Font ID	3	Font used by Finder (Geneva)
Font Size	9	Font size used by Finder (9 point)
Screen Hdr Hgt	20[1]	Size of information bar that appears at the top of directory windows
Top line break	-21[1]	
Bottom line break	17[1]	
Printing hdr hgt	42[1]	Height of header when Printing Catalog
Printing footer hgt	32[1]	Height of footer when Printing Catalog
Window Rect (top)	62[1]	Size and position of new directory windows (measured from the upper left corner of the screen)
Window Rect (left)	14[1]	
Window Rect (bottom)	250[1]	
Window Rect (right)	418[1]	
Line spacing	16[1]	Line spacing of text views
Tab stop 1	20[1]	Position (from left) of Name column
Tab stop 2	144[1]	Position (from left) of Size column
Tab stop 3	184[1]	Position (from left) of Kind column
Tab stop 4	280[1]	Position (from left) of Date column
Tab stop 5	376[1]	Position (from left) of Time column
Tab stop 6	424[1]	(not used)
Tab stop 7	456[1]	(not used)
Column Justification	$02	Justification of text views; $02 means only Size is right-justified
Reserved	$00	(not used)
Icon Horz. spacing	64[1]	Horizontal space between icons

continues

Table 11.2: Continued

Preset Item Name	Value	Purpose
Icon Vert. spacing	64[1]	Vertical space between icons
Icon Vert. phase	0[1]	Staggers every other column of icons (16 is a good value)
Sm. Icon Horz.	96[1]	Horizontal spacing for Small Icon view
Sm. Icon Vert.	20[1]	Vertical spacing for Small Icon view
Default View	1	Preset view for new directory windows:
	0 for by Small Icon	
	1 for by Icon	
	2 for by Name	
	3 for by Size	
	4 for by Kind	
	5 for by Date	
Text view date	$0200	Date format for text views:
	$0200:	"Mon, Apr 21, 1993"
	$0100:	"Monday, April 21, 1993"
	$0000:	"4/21/93"
Use zoom Rects	1	Set to 0 to disable "Open" zoom animation
		(Finder windows and applications open slightly faster)
Skip trash warnings	0	Set to 1 to skip trash warnings
		(Finder doesn't warn you if you throw away an application)
Always grid drags	0	Set to 1 for automatic clean-up (handy for keeping icons neatly aligned)

Preset Item Name	Value	Purpose
Unused 4	0	(not used)
Unused 3	0	(not used)
Unused 2	0	(not used)
Unused 1	0	(not used)
Unused 0	0	(not used)
Icon-text gap	0[1]	Distance between icon and its text label
Sort style	4	
Watch Threshold	120	Time before wristwatch hands spin (in 1/60-second units)
Unused 7	0	(not used)
Unused 6	0	(not used)
Unused 5	0	(not used)
Unused 4	0	(not used)
Use Phys Icon	0	
Title Click	0	If 1, you can double-click a window's title bar to open the window of the next-higher folder in the storage hierarchy.
Copy Inherit	0	
New Fold Inherit	0	
Color Style	0	Defines which colors are available in Finder's Color menu (color Macs only)
Max # of windows	13	Maximum number of windows Finder can open

[1]*This value is measured in pixels.*

Altering the LAYO Resource

You can use ResEdit to alter the LAYO resource, but there are easier ways. A free program called *Layout* (by Michael O'Connor) enables you to alter the LAYO resource by dragging icons and choosing menu commands (see figure 11.21). Layout is available through user's groups and information services.

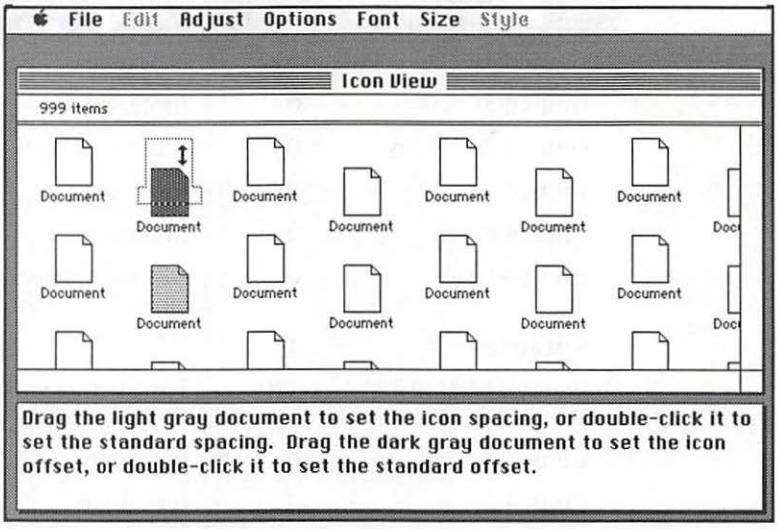


Figure 11.21: Adjusting vertical icon phase using Michael O'Connor's Layout utility.

The Norton Utilities for the Macintosh includes Layout Plus, a version of Layout that offers more customizing features.



Changing a New Alias Name

When you create a new alias, the Finder gives the alias the same name as the original item, with the word *alias* tacked on. You can customize the Finder so that it appends some other text to the alias' name.

We used to delete the word *alias* by hand—it seemed unnecessary because you can always spot an alias by its *italicized* name, for example. Using ResEdit, you can modify the Finder so that it simply appends a single word space to the end of an alias name. (You need to append *something* to the alias name because two items with the same name cannot exist in the same place.)

To perform this modification, open a copy of the Finder file (or quit the Finder using one of the techniques we described earlier). When the list of Finder resources appears, locate and double-click the STR# entry. When the STR#s from Finder window appears, locate and double-click the resource with an ID number of 20500. An editor window appears, and its first entry contains the text that the Finder appends to alias names (see figure 11.22).

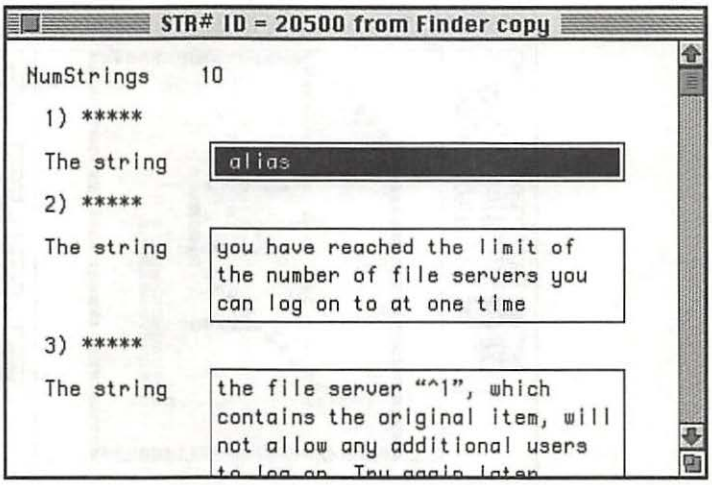
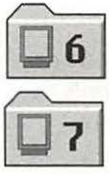


Figure 11.22: The highlighted text box contains the text the Finder appends to new alias names.

In this text box, type the text you want added to alias names. Do not use the colon character (:) and keep the text short so that your alias name does not exceed the Mac's 31-character limit for file names. Save the changes.

You also can perform this modification using Adam Stein's shareware*System 7 Pack*.



Other ResEdit Projects

Let's wrap up our look at resource customizing with a look at a few more customizing projects you may want to try.

Altering icons. The icons an application uses for its own file and its documents are stored in an application program's ICN# resource. You can edit those icons to give them a different appearance—perhaps to indicate that the application is modified, or to show its version number. As figure 11.23 shows, ResEdit's *icon editor* works similarly to the FatBits display that most painting programs provide—the icon appears enlarged, and you can turn individual pixels on or off. An icon has two components: the icon itself and the *mask*, which the Finder uses to indicate a selected icon. After altering an application or document icon, rebuild your disk's Desktop to update its icon list. (Remember that you will lose Get Info comments by rebuilding the Desktop.)

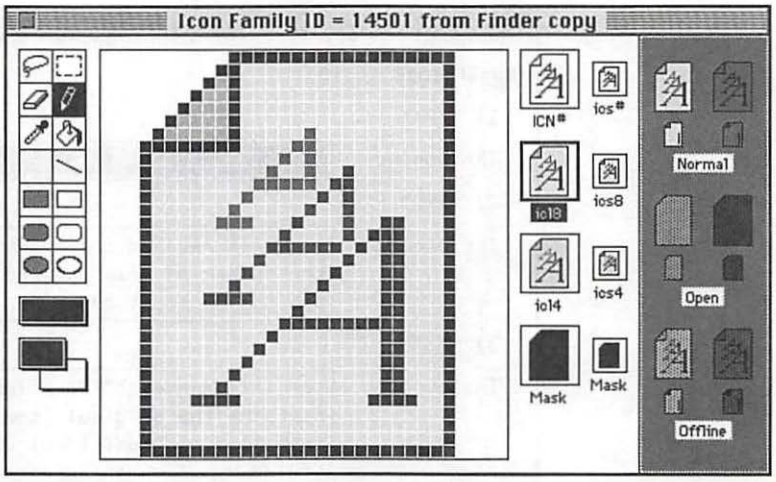


Figure 11.23: ResEdit's icon editor.

Altering cursors. The appearance of an application's pointers are stored in CURS resources. You can alter those resources to customize your cursors. ResEdit's *cursor editor* is similar to the icon editor. The CURS resource in the Finder contains seven wristwatch cursors that create the moving hands in the wristwatch. Try altering the cursor resources to create some other type of animation—perhaps a spinning beach ball, a smiling and frowning face, or an hourglass with sand running through it.

Adding version resources to documents. Most applications contain one or more *vers* resources that the Finder uses to report each application's version number in its Get Info window. You also can add a version resource to a document. You may use a version resource in a document to indicate which revision the document represents, or to add some descriptive text that you cannot change using the Get Info window. To add a version resource to a document, open the document using ResEdit. (If you're warned that the document doesn't contain a resource fork, read the second paragraph of this tip before proceeding). Next, choose Create New Resource from the Resource menu and select *vers* in the Select New Type list box. ResEdit's vers-editing window appears. Press Tab until the insertion point is in the Long Version String text box, and then type up to two lines of text, pressing Return after the first line. Close the vers-editing window and then choose Get Resource Info from the Resource menu. Change the vers resource's ID to 1, and then close the file and save your changes. Figure 11.24 shows the Get Info windows of two documents containing vers resources. You may need to rebuild your Desktop file (see

Chapter 17) to see the results in Get Info windows. As an easier alternative, copy the modified file to another disk, and then copy it back to your hard disk.



Figure 11.24: Get Info windows for documents containing vers resources.

Some applications (including PageMaker, Microsoft Word, and Microsoft Works) create documents that lack resource forks. You can create one, however, by clicking OK when asked by ResEdit. We successfully added resource forks to PageMaker, Word, and Works documents without damaging the documents, but not all applications may be as accommodating. You may want to experiment with some backup copies of documents before adding vers resources to important ones.

Altering fonts. ResEdit's *font editor* enables you to edit the FONT and NFNT resources that describe the appearance of bit-mapped screen fonts (see figure 11.25). You can, for example, replace a rarely used character with a special character, such as a fraction. Remember that the Mac doesn't use these fonts to produce output on PostScript printers; changes you make apply only to the screen and to QuickDraw printers. To edit PostScript printer fonts or TrueType, use one of the font-editing utilities described in Chapter 6.

Copying, pasting, and playing sounds. Does one of your programs play a particularly appealing sound that you would like to use as a system beep? Use ResEdit to copy the snd resource from the program and then paste the resource into your System file. Start ResEdit and open

the file containing the snd resource you want to add to the System file. Locate the snd entry in the file's resource window and open it. Locate the desired sound in the snds from *(file name)* window, and then select it and choose Copy from the Edit menu. (You also can use the Snd menu to play the sound if you like.) Close the file, open the System file and locate the snd entry in the System file's window, and then open it. With the snds from System window open, choose Paste, and then close the System file, saving your changes when asked. Now you an use the Sound Control Panel to select the new sound as the current alert beep!

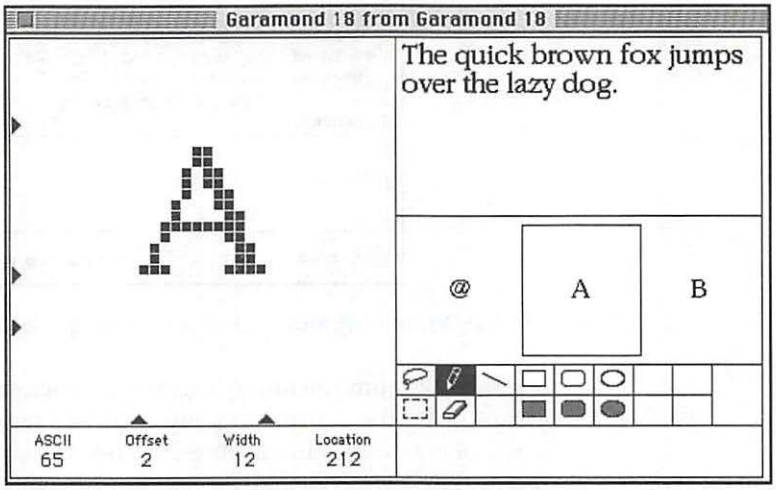


Figure 11.25: ResEdit's font-editor.

CHAPTER

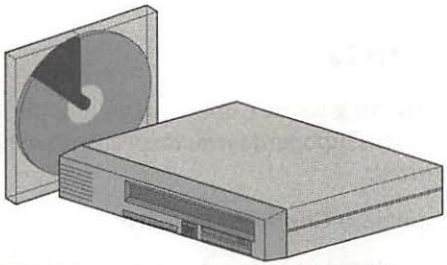
12

EXCHANGING DATA: THE CLIPBOARD AND BEYOND

WHAT'S INSIDE

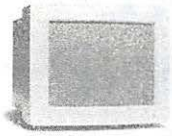
- Cutting and pasting: the fine points of the Mac's Clipboard
- Why pasted text often loses its formatting
- Common file formats you can use to exchange data between Macintosh programs
- The enhanced data-exchange features of System 7: publish and subscribe and AppleEvents

Regardless of how you use your Mac, chances are that you need to exchange data now and then. Perhaps you want to include a graphic created with a scanner in a desktop publication, or you want to include a bar graph created in a spreadsheet program in a report you are writing with a word processing program. Or maybe you want to give a document written with Microsoft Word to someone who uses WordPerfect.



In this chapter, we look at ways to accomplish these and other data-transfer tasks. As you will see, two basic goals are behind any data-exchange endeavor. Getting information from Point A to Point B while also retaining its formatting—its fonts, type sizes, margins, and so on is the first. The second goal is retaining formatting which isn't always easy.

This chapter concentrates on exchanging data between Macintosh programs and computers. In Chapter 14, you see how to transfer data between Macs and DOS PCs.



NOTE: Unless noted by margin icons, the information in this chapter applies to System 6 as well as System 7.



Clipboard Details

The Clipboard makes it easy to move text and graphics among documents and between programs. To recap from Chapter 3, the Clipboard relies on three Edit menu commands: Cut, Copy, and Paste. The Cut command removes whatever you have selected and puts it on the Clipboard, where it's ready to be pasted. The Copy command puts the selection on the Clipboard without removing it from the document. (Both Cut and Copy replace the Clipboard's previous contents.) The Paste command inserts the Clipboard's contents in the active document window.

Pretty straightforward, right? Most of the time. But sometimes, you cannot retain the formatting of the data you are transferring. You may move some text from one program to another, and find that it suddenly appears in a different font or size, or that you can no longer edit it. Or you might move a graphic from MacDraw to MacPaint and find that you cannot alter it as you had planned.

To understand why these formatting foibles can occur, let's step back and look at how the Clipboard handles the data that you cut, copy, and paste.

Clipboard Data Formats

When you cut or copy something to the Clipboard, your application program stores it in one or more *formats*. Clipboard formats specify how the information on the Clipboard is organized.

The Mac provides three standard Clipboard formats:

PICT. A QuickDraw picture is a series of commands that enables QuickDraw to recreate an image. The PICT Clipboard format can

represent monochrome or color bitmapped and object-oriented graphics. (If you aren't familiar with the differences between bitmapped and object-oriented graphics, see the technical backgrounder, "Graphics in Two Flavors.")

Styl. The styl format enables programs to place formatted text on the Clipboard—that is, text to which you have assigned various fonts, sizes, and styles. Any program that can read the styl format can accept the text with no loss of formatting information.

TEXT. Plain-text characters with no formatting information. Technically speaking, the TEXT format stores only *ASCII* characters. (ASCII stands for *American Standard Code for Information Interchange,* a standard that most computer manufacturers use for representing the alphabet, numerals, punctuation symbols, and certain rudimentary formatting codes, such as carriage returns and tab characters. We will encounter ASCII again later in this chapter.)

If you have the QuickTime extension installed, a fourth standard format is added: *moov,* short for *movie.* This enables you to cut, copy, and paste QuickTime movie frames between documents or programs that support QuickTime.

Backgrounder: Graphics in Two Flavors

If you use graphics and publishing programs extensively, it's important to understand the differences between *bitmapped* and *object-oriented* graphics programs.

Bitmapped graphics programs include Fractal Design Painter, Claris MacPaint, and SuperMac's PixelPaint Professional, to name a few. Although these programs differ in features and capabilities, they share a common trait. Each stores an image as a series of bits that are mapped to the pixels (the individual dots) on-screen. You cannot easily resize a shape or edit text that you have created in a bitmapped graphics program. You must erase the old shape or text and then replace it. Bitmapped graphics programs are often called *painting* programs or *paint-type* programs.

Object-oriented programs don't store pixel bit maps. Instead, they store QuickDraw commands that describe distinct objects—circles, lines, boxes filled with a pattern, text, and so on. It's easy to alter a shape or edit text in a drawing; when you do, the program replaces the QuickDraw commands that described the old object with ones

continues

continued

that describe its altered version. Object-oriented programs are often called *drawing* programs or *draw-type* programs. Drawing programs include Claris' MacDraw series, Computer Associates' CA Cricket Draw, Deneba Software's Canvas, Adobe Illustrator, and Aldus FreeHand. (Programs such as Aldus SuperPaint can handle both bitmapped and object-oriented graphics, each in its own layer.)

The differences between paint programs and drawing programs are similar to the differences between bitmapped and outline fonts. Bitmapped images generally become distorted when they're resized, while object-oriented images can be resized without distortion. Bitmapped images are tied to a specific resolution. Object-oriented images aren't locked into a specific resolution; like the outline fonts we explored in Chapter 6, object-oriented images can take advantage of the maximum resolution a printer provides.

But bitmapped graphics programs are generally able to render subtle shading and grey tones better than object-oriented programs; that's one reason why scanners create bitmapped images rather than object-oriented ones. Object-oriented programs are generally better for creating precise line art; that's why they're used for architectural drawings and technical illustrations.

Private Clipboard Formats

In addition to the PICT, styl, and TEXT Clipboard formats, the Clipboard also can work with *private* Clipboard formats—data formats defined by a specific program to handle the data that program creates. Generally, programs use private Clipboard formats to enable the Clipboard to hold more formatting information than the Clipboard's standard formats allow.

Aldus PageMaker, for example, uses a private Clipboard format called ALD4 that enables PageMaker to differentiate between formatted text, images, and graphic elements, such as lines and boxes. This private Clipboard format enables you to copy and paste combinations of text and graphics between PageMaker documents. Without the private Clipboard format, if you copied a combination of text and graphic elements to the Clipboard and then pasted them back into a PageMaker document, PageMaker wouldn't be able to treat each element separately. It would have to treat everything as text (thereby discarding the graphics) or as a graphic (eliminating the ability to edit the text).

Some programs use more than one private Clipboard format. Microsoft Excel 4, for example, uses four. Each Clipboard format contains a different type of formatting information about what you cut or copied.

Why All the Formats?

When you cut or copy something, a program generally places the data on the Clipboard in its private formats *and* in one or more of the standard Clipboard formats. (Some programs, however, use only the standard formats.) By storing Clipboard data in more than one format, an application program increases your chances of being able to move that information into another program while retaining its formatting information. If the program receiving the data can interpret the original program's private Clipboard format, you are in luck—you will be able to transfer the data without losing any formatting information. (The process of moving data out of a program is often called *exporting;* bringing data into a program is called *importing.)*

If the importing program cannot interpret the private Clipboard formats, it resorts to the standard Clipboard formats and reads the data as text or as a picture, depending on which format the program prefers (see figure 12.1). Word processing programs, for example, choose the TEXT format over PICT. Graphics-oriented programs, however, generally choose PICT rather than TEXT.

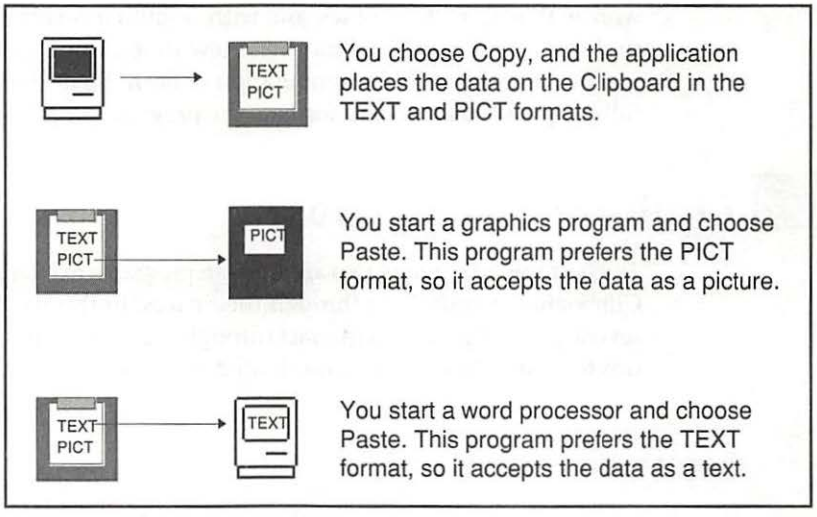


Figure 12.1: How application programs donate and receive data to and from the Clipboard.

How can you tell which Clipboard formats your programs use? Manuals rarely contain this information, but you can find out by using the Scrapbook Desk Accessory. Cut or copy something from a document, and then open the Scrapbook and choose Paste. The list of Clipboard formats in which the data is stored appears in the lower right corner of the Scrapbook window (see figure 12.2).

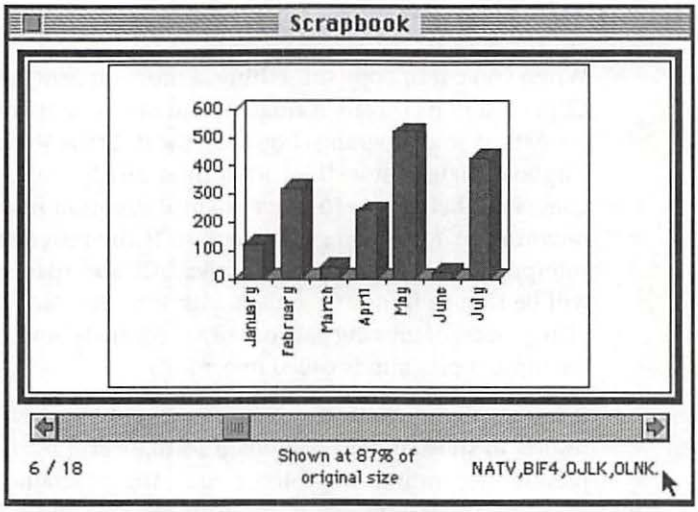


Figure 12.2: Clipboard data formats in the Scrapbook window.

If a given program supports a wide variety of data types (for example, if it can work with text, with graphics, and with combinations of both), you may need to do this copy-and-paste routine a few times, once with text, once with a graphic, and once with a combination of both. That's the best way to get the full story on the Clipboard formats the program supports.



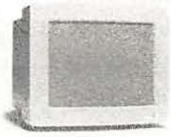
Clipboard Scenarios

The best way to see how two application programs exchange data through the Clipboard is to put them through their paces. In this section, we look at how several popular programs interact through the Clipboard, and we provide some tips for using their Clipboard-oriented features.

Microsoft Word 5

When you copy text to the Clipboard, Word 5 stores it in three formats: TEXT, CLAP, and *RTF*. CLAP and RTF are private formats; RTF is short for *rich-text format,* a format that enables text to retain all formatting information—assuming that the importing program can interpret RTF. One program that can read the RTF Clipboard format is Aldus PageMaker 4.2. Because Word can export to the Clipboard in RTF format and PageMaker can import the RTF Clipboard format, you can paste formatted text from Word into PageMaker without losing its formatting.

When you cut or copy spreadsheet cells in Microsoft Excel, the cells are stored in RTF format (among others), but Excel does not interpret the RTF format. Thus, you can copy formatted spreadsheet cells from Excel to Word, but you cannot copy text from Word to Excel and retain its formatting.

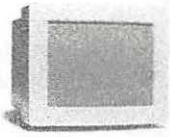


TIP: If you don't need to retain formatting information when you cut or copy text from Word, you can save memory by instructing Word to not include formatting in the Clipboard. Choose Preferences from the Tools menu and then uncheck the Include Formatted Text in Clipboard button. Better still, press Command+Option+plus sign and then click the check box; this adds an Include Formatted Text in Clipboard command to the Tools menu. When you want RTF data on the Clipboard, choose the command so that it's checked. When you don't need RTF, choose the command again to uncheck it. Disabling the RTF option also saves disk space when you paste cut or copied data into the Scrapbook.

Microsoft Excel 4

As just mentioned, Excel uses the RTF format when you copy or cut cells to the Clipboard. You can paste the cells into Word 5, where they become a table, with their typographic and border formatting intact. If you paste them into a word processing program that doesn't support the RTF Clipboard format, each column of cells is separated by a tab character, and text formatting is lost.

When you copy a chart in Excel, it's placed on the Clipboard in PICT format as well as in three private formats. You can paste the chart into any program that accepts PICT images. If you paste a chart into MacDraw, you can ungroup the chart and work with each chart element (lines, bars, legends, axis, labels, and so on) separately, changing its formatting or patterns. In this regard, Excel teams up nicely with a drawing program. You may want to use Excel to create your original charts, and then spruce them up using MacDraw. (This also applies to charts created in other spreadsheets, such as Claris Resolve, Lotus 1-2-3, and Microsoft Works.) You also can paste cells from Excel into a Microsoft Works spreadsheet or database document. In both cases, text formatting is lost.



TIP: You can copy one or more spreadsheet cells as a picture by holding down the Shift key and then choosing Copy Picture from the Edit menu. (When the Shift key isn't pressed, the command simply reads Copy.) If you have designed a fancy spreadsheet layout and you want to include a portion of it in another document, consider using Copy Picture. You will not be able to edit the text once you paste it into the second program, but you will not need to do any reformatting, either. (We look at other benefits of copying text as a picture later in this chapter.)

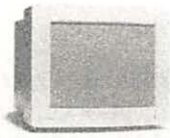
Microsoft Works 3

The Clipboard formats Microsoft Works uses depend on what you are cutting or copying:

- When you cut or copy text from a word processing document, Works uses four formats: MSWK (a private format), PICT, styl, and TEXT.
- When you cut or copy text from a database or spreadsheet document, Works uses only the MSWK and TEXT formats.
- When you cut or copy charts or graphics drawn with Works' drawing tools, Works uses three formats: MWDR (another private format), MSWK, and PICT.

Although Works uses the styl format when it puts word processing text on the Clipboard, it doesn't *read* the styl format when you paste text into a Works document. Thus, if you paste text from MacDraw II or another program that supports the styl format, you will lose the formatting of the text.

When you paste a PICT graphic into a Works document, you can use Works' drawing tools to alter it. (Choose Draw On from the Window menu.) If you have pasted a chart from a different spreadsheet program, you can use the drawing tools to embellish it. To work with the individual objects in the chart, select the chart and choose Ungroup from the Arrange menu. After you finish sprucing up the chart, you might want to group its objects together again. Select all the objects by enclosing them within a selection marquee, and then choose Group from the Arrange menu.



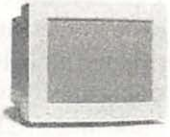
TIP: Works provides numerous cutting and pasting options that give you a great deal of flexibility in moving information between Works' various components. If you use Works extensively, you may want to spend some time mastering these options. They're described in detail in the Works manual.

Claris MacDraw II

MacDraw II uses a variety of Clipboard formats, depending on what you are cutting or copying. If you cut or copy a combination of text and graphics objects, MacDraw II places the items on the Clipboard in two formats: MDPL (MacDraw II's private format) and PICT. If you paste a combination of text and graphics into another program, all the items are treated as graphics.

If you cut or copy only text, however, MacDraw II puts it on the Clipboard in several formats: MDPL, PICT, styl, and TEXT. If you paste the text into a word processing program, the word processing program uses the styl or TEXT formats. If you paste it into another drawing program, the drawing program uses the PICT format. What happens to the text when you paste it into a publishing program, however, depends on the publishing program. Aldus PageMaker chooses the PICT format, giving you a picture of the formatted text. QuarkXpress 3.1, on the other hand, accepts the text as text, but discards its formatting information.

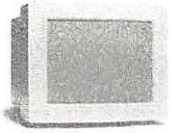
As for pasting information into MacDraw II, the program supports the styl format so that you can paste formatted text from other programs that support styl, such as Microsoft Works.



TIP: Normally, MacDraw II 1.1 removes the color information from color objects that you cut or copy to the Clipboard. If you want to retain the color information so that you can paste the colored objects into other programs that support color (such as PageMaker, QuarkXpress, and Aldus FreeHand), choose the Preferences command and select the Color Clipboard option.

Claris MacDraw Pro

If you cut or copy only text, MacDraw Pro puts it on the Clipboard in several formats: dPro (a private format), PICT, styl, and TEXT. If you cut or copy a combination of text and graphics objects, MacDraw Pro places the items on the Clipboard in two formats: dPro and PICT.

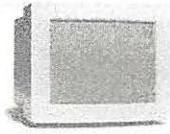


TIP: Like MacDraw II, MacDraw Pro has a Color Clipboard preferences option. To activate it, choose Preferences from the Layout menu and check the Color Clipboard box.

Aldus PageMaker

PageMaker supports the PICT, TEXT, and RTF Clipboard formats, as well as its own private format, ALD4. If you copy text from a PageMaker document, it's placed on the Clipboard in ALD4 and TEXT formats. If you paste that text into a PageMaker document, PageMaker reads the ALD4 format and, therefore, retains the text's formatting. As mentioned earlier, PageMaker also can interpret the RTF Clipboard format so that you can paste formatted text from Microsoft Word 5 into PageMaker. If you paste text from a different program into a PageMaker document, PageMaker uses the TEXT format.

PageMaker has an interesting quirk that can cause unexpected results when you paste text into a PageMaker publication. Some programs (including MacDraw II and Microsoft Works) place text on the Clipboard in PICT format as well as in TEXT format. If you paste this kind of multi-formatted text into PageMaker, PageMaker uses the PICT format and turns the text into a graphic. To coerce PageMaker into accepting the text as text, use this workaround: Copy the text in the original program (for example, MacDraw II), and then paste it into the Notepad Desk Accessory or into a word processing program. Copy the text again and paste it into the Scrapbook or into your PageMaker publication. By using a text-editing program as an intermediary, you will cause the PICT formatting to be discarded, enabling PageMaker to accept the text for what it really is.



TIP: PageMaker offers a unique Clipboard-related feature. You can import graphics directly from the Scrapbook file by choosing the Place command, and then opening the Scrapbook. This handy shortcut eliminates the need to first open the Scrapbook Desk Accessory, copy something, and then paste it into the document.

Taking Pictures of Text

Generally, when you paste text into a program, you want the receiving program to treat it as text, not as a picture of text. But if you use outline fonts, there is a benefit to pasting text as a graphic. You can resize the graphic to create special typographic effects. The resized text does not look very good on the screen, but because of the flexibility of font outlines, the printed output looks excellent. Figure 12.3 shows a few effects obtained by resizing a "text picture" in PageMaker.

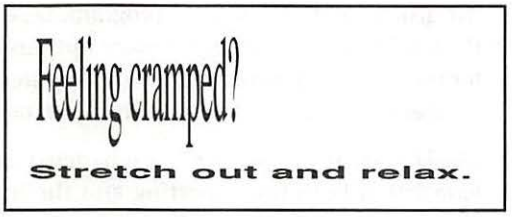


Figure 12.3: Type effects created by resizing a picture of text.

Most word processing programs also enable you to resize text pictures. Simply paste the text picture into a document, and then select it and drag the selection handles to resize it.

But how do you take these pictures of text? The previous section presented one technique for PageMaker users: pasting text that the original program placed on the Clipboard in PICT format. And as mentioned earlier in this chapter, if you use Excel, you can copy spreadsheet cells as a picture by selecting them, and then pressing Shift while choosing Copy Picture from the Edit menu.

If you have Microsoft Word, here's another technique. Select the text you want to turn into a picture and then press Command-Option-D. (This works in Word versions 3 through 5.) If you use Word 5, you can add a Copy as Picture command to the Edit menu: press Command+Option+plus and then press Command+Option+D. You also can create a text picture by typing text into Word's picture window.

If you have a drawing program other than MacDraw, such as Computer Associates' CA Cricket Draw or Aldus SuperPaint, you also can create pictures of text by typing text in the drawing program, and then copying it to the Clipboard.

Besides being useful for creating special typographic effects, text pictures also can be useful when you want a headline to fit within a specific column or margin width. Rather than laboriously experimenting with different type sizes in hopes of finding one that fits, simply turn the text into a picture and resize it until it fits exactly. Use this approach sparingly, however. Well-designed

publications have a consistent typographic appearance, and stretching each headline to a different width would destroy that consistency.

Exchanging Disk Files

The Clipboard isn't designed for transferring huge amounts of information between programs—if you try to cut or copy a great deal of data, you are likely to receive an out-of-memory error message. When you need to move large amounts of information, it's better to save the data in a disk file, and then open the disk file with the second program. Disk files have another advantage over the Clipboard: they give you more options for retaining text formatting. And for transferring data between two computers—especially between a Mac and a different computer—disk files are the data-exchange medium of choice.

The key to using disk files to exchange data between programs is to use a *file format* that both the exporting and the importing program can read. A file format specifies how the information is organized within the disk file; just as a Clipboard format specifies how programs access the Clipboard, a file format specifies how applications access and interprets the contents of a disk file.

This section concentrates on exchanging text and graphics files between Macintosh programs only. In Chapter 14, we look at exchanging disk files between the Mac and MS-DOS computers.

Exchanging Text Files

There are three basic categories of text file formats:

Native files. The format that a given program normally creates when you use its Save command. A MacWrite document and a Microsoft Excel spreadsheet are two examples of native files.

Interchange files. Files saved not in a program's native format, but in data-exchange formats designed to retain some or all formatting information. Several industry-standard interchange formats exist, including SYLK, DIF, RTF, and DCA. (We'll unscramble these acronyms shortly.)

Text-only files. Files containing only ASCII text characters, retaining only rudimentary formatting information, such as tabs and carriage returns.

Good, Better, Best

These three file categories form a "good, better, and best" hierarchy: Text-only files are a good data-exchange medium, interchange files are better, and native files are best.

When you need to transfer data through disk files, start by determining whether the importing program can read the exporting program's native format. If so, you will be able to retain the original document's formatting.

If the importing program cannot read the exporting program's native format, determine if there's an interchange format that both the importing and exporting programs support. (Microsoft Excel and ClarisWorks, for example, can both save and open files in the SYLK format.) If so, you will be able to retain at least some of the original document's formatting.

If the exporting and importing programs don't share a common interchange format, determine whether both programs can exchange text-only files. If you are transferring spreadsheet or database information, you will also need to consider how each spreadsheet cell or database field is separated from the others. We will explore this important point in detail shortly.

Native File Examples

Here's a sampling of file-swapping tasks where you can use native files. (Remember, if you aren't familiar with the types of applications discussed in this section, refer to Appendix A for some brief definitions.)

Word processing programs to publishing programs. Most publishing programs can read native files created by today's most popular word processing programs, including Microsoft Word, Claris' MacWrite, T/Maker's WriteNow, and WordPerfect Corporation's WordPerfect. Aldus PageMaker and QuarkXpress also can export text in several word processor native formats. This exporting feature is useful when you have made changes to text in a publication, and you want to update your original word processor files to reflect the changes.

Between word processing programs. Many word processing programs can open competing products' native files. Microsoft Word, for example, can open MacWrite and WordPerfect documents, and WordPerfect can open MacWrite documents as well as files created by numerous Microsoft Word versions.

Between outliners, word processing programs, and presentation programs. Symantec Corporation's MORE II outlining and presentation program can import outlines created by Microsoft Word. The Aldus Persuasion and Microsoft PowerPoint presentation programs can open MORE outlines. Symmetry Corporation's Acta Desk Accessory outliner can open and save MORE outlines.

Between OCR programs and word processing programs and publishing programs. Optical-character recognition programs, such as Caere Corporation's OmniPage series, often enable you to save recognized text in common word processor formats.

Between spreadsheet programs. Microsoft Excel and Claris Resolve can open worksheets created by several Lotus 1-2-3 versions, and Lotus 1-2-3 can open Microsoft Excel 3.0 worksheets and save worksheets in Excel 3.0 format.

Between programs from the same company. Many software firms design their programs so that they can read each others' native formats. Microsoft Works, for example, can open and save word processing files created by Microsoft Word, and Claris Resolve can open worksheets created by ClarisWorks.

More About Interchange Files

There aren't many standards in the personal computer industry, especially where file formats are concerned. But over the years, several file formats have become unofficial standards for exchanging text between programs. The most popular include the following:

DCA. Short for *document content architecture,* this format was developed by IBM for exchanging word processor and other text documents. The DCA format doesn't save font and size information, but it does save bold, underline, strike-through, superscript, and subscript information. Several IBM PC word processing programs can open and save DCA files. The Macintosh and PC versions of Aldus PageMaker also can import and export DCA files. Macintosh file-translation utilities (described in Chapter 14) can usually interpret DCA files. The DCA format is sometimes called DCA-RFT, with RFT standing for *revisable-form text.*

DIF. Short for *data-interchange format,* the DIF file format is intended for transferring spreadsheet and database information. DIF files do not retain character formatting information.

RTF. Short for *rich-text format,* the RTF format is a complex format designed by Microsoft for transferring formatted word processing documents. Unlike DCA files, RTF files can retain point-size and font information. RTF files can even retain graphics and color formatting information.

SYLK. Short for *symbolic link,* the SYLK format, like DIF, is designed for transferring database and spreadsheet information. Unlike DIF files, however, SYLK files can retain a great deal of formatting information, including numeric formats, column widths, and alignment within cells.

Table 12.1 lists several popular applications that support some or all of these formats. An *R* means the program can read the format; a *W* means the program can write the format.

Table 12.1: Interchange formats supported by several popular programs.

Program	DCA	DIF	RTF	SYLK
Acius 4th Dimension	—	R/W	—	R/W
Aldus PageMaker	R	—	R/W	—
Claris FileMaker Pro	—	—	—	R/W
Claris Resolve	—	R/W	—	R/W
ClarisWorks	—	R/W	R	R/W
Informix WingZ	—	R/W	—	R/W
Lotus 1-2-3	—	—	—	—
Microsoft Excel	—	R/W	—	R/W
Microsoft Word	—	—	R/W	—
Microsoft Works	—	—	R/W	R/W
T/Maker WriteNow	—	—	R/W	—
WordPerfect	—	—	R	—

Translation Filters and XTND

Many programs (including PageMaker, WordPerfect, and WriteNow, to name a few) use separate files, often called *filters* or *translators*, that enable the programs to import and export files. Many software firms release new filters from time to time to allow their products to read and write additional file formats. If you have a program that uses filters and you need to read a specific file format, contact the program's developer to determine if a filter has been released for that format. Similarly, if you are having trouble importing or exporting documents with a program that uses filters, contact its developer to see if the filters have been updated.

Many products also support a file-translation technology called XTND. Originally developed by Claris, the XTND technology relies on standardized file translators that are stored in your System Folder and can be accessed by any program that supports XTND. Most programs that support XTND include several translators for common file formats; DataViz Corporation sells a large set of XTND translators called MacLink Plus Translators. XTND is supported by

a growing number of products, including most of Claris' programs as well as WordPerfect, Symantec's GreatWorks, and Symmetry's Acta.

The Lowest Common Denominator: The Text-Only File

If the two programs you are exchanging data between don't support a common interchange format, you may need to resort to the lowest common denominator—the *text-only file*. You will lose formatting information, but you will not need to retype any text.

When you are using text-only files to swap database or spreadsheet data between programs, you need to be aware of how the exporting program separates each spreadsheet column (or database field) and each spreadsheet row (or database record). So that the importing program can differentiate between each cell and row (or field and record), the exporting program must separate them with *delimiters*. Most programs use a tab code as a column or field delimiter, and a carriage return code as a row or record delimiter. A text-only file formatted in this way is often called a *tab-delimited* file. Figure 12.4 shows a tab-delimited text file as it appears in Microsoft Word 5 with the Show ¶ option active. The right-pointing arrows indicate tab codes.

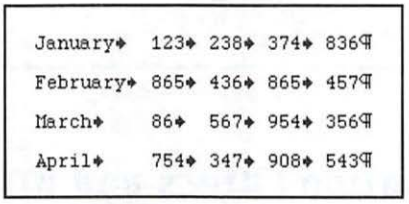


Figure 12.4: A tab-delimited text file.

Some programs use a different delimiting technique called *comma-separated values*, or *CSV*. A CSV file uses commas (,) rather than tabs to separate cells or fields. If a given cell or field contains a comma itself (as in "Raynak, Margaret"), the program writing the CSV file places the entire cell within quotes (see figure 12.5).

If you are using a text-only file to exchange information between database managers or spreadsheet programs, be sure that the importing and exporting programs support the same scheme of delimiters. If they don't, you can still move data between them by using a word processing program's search-and-replace feature to change the file's delimiters as necessary (changing the quote-comma-quote delimiters of a CSV file to tab codes, for example). Most file-translation programs also can translate between both types of delimited text-file format.

	A	B	C
1	Raynak, Margaret	975	
2	Kelly, Scott	764	
3	Norton, Trixie	975	
4	Taylor, Roy	709	
5	Cole, George	896	
6	Williams, Suzanne	975	
7			
8			

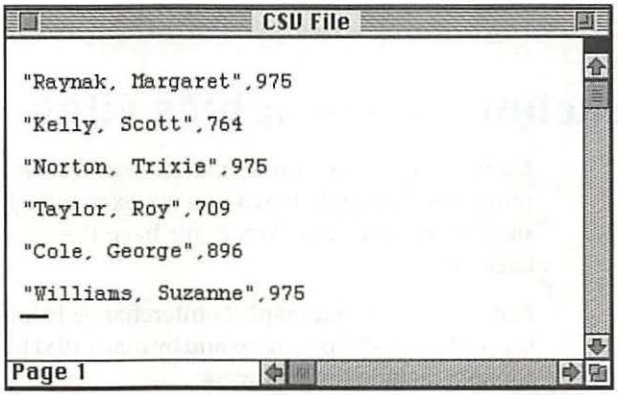


Figure 12.5: A spreadsheet file (top) and a comma-separated values (CSV) file containing its data (bottom).

Table 12.2 lists the delimited text-only formats that several spreadsheet programs and database managers can read (R) and write (W).

Table 12.2: Some programs that support tab-delimited and CSV files.

Program	Tab	Delimited	CSV
Acius 4th Dimension	R/W	R/W[1]	
Claris FileMaker Pro	R/W	R/W	
ClarisWorks	R/W	—	
Claris Resolve	R/W	—	
Lotus 1-2-3	R/W	R	
Informix WingZ	R/W	—	

continues

Table 12.2: Continued

Program	Tab	Delimited	CSV
Microsoft Excel	R/W	R/W	
Microsoft Works	R/W	—	

[1]To import or export comma-delimited data with 4th Dimension, choose Import or Export, and then type the comma character's ASCII value (44) in the End of Field text box. This technique will not work with data containing embedded commas (as in "Taylor, Roy").



Exchanging Graphics Files

Many of the same considerations you face when exchanging text between programs also apply when you are exchanging graphic images. There is one significant difference: You don't have the safety net of text-only files to fall back on.

Fortunately, several graphics interchange formats exist, and most are widely supported by Mac programs and by many IBM PC programs. These interchange formats include the following:

EPS. Short for *encapsulated PostScript,* an EPS file contains the PostScript-language instructions that describe an image's appearance. In addition to containing PostScript instructions, EPS files also can contain a PICT version of the image that enables the importing program to display the image on the Mac's screen. Whether an EPS file also contains PICT information depends on the program that created it. An EPS file created by IBM PC program generally will not contain a PICT version of an image. When you import such a file, the importing program generally displays only a *bounding box,* a rectangle indicating the PostScript image's size (see figure 12.6).

EPS files are most commonly used to exchange illustrations created by programs, such as Adobe Illustrator and Aldus FreeHand, and special typographic effects created by programs, such as Altsys Metamorphosis Professional. EPS files can be used to exchange scanned images, but the TIFF format, described shortly, is better suited to this task.

PICT. This common file format is similar to the PICT Clipboard format. PICT files contain QuickDraw instructions that describe an image. PICT files can contain object-oriented graphics, bitmapped graphics, text, or combinations of all three. Most Mac graphics programs can create PICT files. A cousin to the PICT format, *PICT2,* stores color or grayscale images.

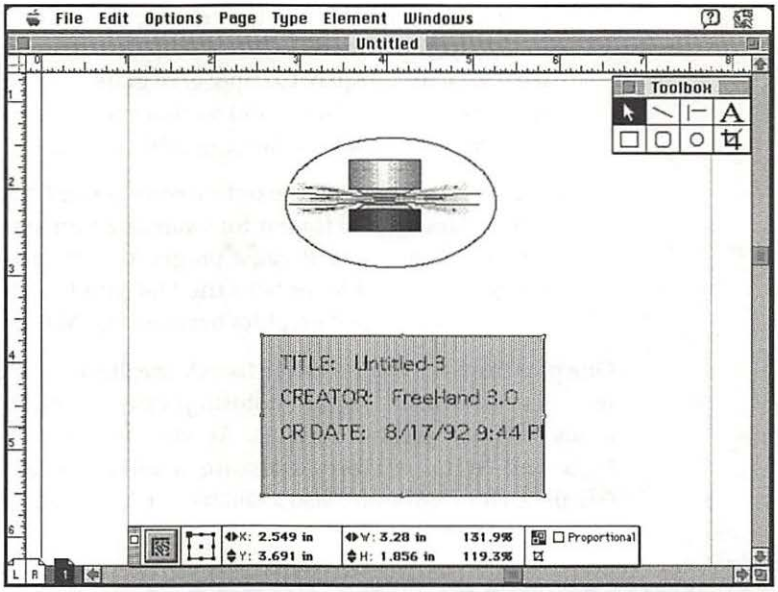


Figure 12.6: EPS images in Aldus PageMaker: with a PICT version (top) and without a PICT version (bottom).

RIFF. Short for *raster-image file format,* the RIFF format first appeared in LetraSet's ImageStudio image-retouching program. RIFF files are designed to store grayscale bitmapped images, and can represent up to 256 levels of gray (8 bits per pixel). RIFF files are supported by most publishing and image-processing programs.

TIFF. Short for *tagged-image file format,* the TIFF format is primarily used for exchanging bitmapped graphics, such as scanned images. TIFF files contain pieces of information called *tags* that describe an image's characteristics: its height and width, resolution, and whether it contains color and grayscale information. TIFF files can contain bitmapped images of virtually any resolution. A set of tags within the file instruct the importing program of the resolution of the image.

MacPaint. Technically, the MacPaint file format isn't an interchange format, but because it's supported by so many programs, it can be used to exchange bitmapped graphics. The biggest drawbacks of the MacPaint format are that it supports only one image resolution, a relatively coarse 72 dots per inch, and that it cannot store color or grayscale information. Thus, you wouldn't want to use the MacPaint format to save a high-resolution image created by a scanner.

GIF. In 1987, the CompuServe information service developed a file format for exchanging bitmapped graphics and called it the *graphics*

interchange format, or *GIF* (pronounced *jiff*). CompuServe created GIF so that its subscribers—whose computers' graphics capabilities vary widely—could display CompuServe graphics, such as weather maps and stock market charts, and so that subscribers with different types of computers could exchange graphic images.

GIF has gone beyond the online confines of CompuServe has turned into a standard file format for swapping bitmapped graphics between different computers. Because programs that enable you to view GIF images are available for both the Mac and PC, you can use GIF files to move bitmapped graphics between the Mac and PC.

One popular GIF viewer for the Mac is Steve Blackstock's Giffer ($20 shareware fee—or a case of beer). Adobe Photoshop also can read and write GIF files as well as most other graphic formats. As you see in the next chapter, several DOS and Windows programs are available that can read and write GIF files. GIF viewers are also available for Amiga and Atari computers.



Which Programs Support Which Formats?

Table 12.3 lists the graphics file formats that can be read (R) and written (W) by a variety of popular programs.

Table 12.3: Graphics interchange formats and some programs that support them.

Program	EPS	PICT	RIFF	TIFF	MacPaint
Adobe Illustrator	R/W	R	—	—	R
Adobe Photoshop	R/W	R/W	—	R/W	R/W
Aldus Digital Darkroom	W	R/W	—	R/W	R/W
Aldus FreeHand	R/W	R/W[1]	—	R	R
Aldus PageMaker	R	R	—	R	R
Aldus SuperPaint	W	R/W	—	R/W	R/W
Claris MacDraw II	—	R/W	—	—	—
Claris MacDraw Pro	R/W	R/W	—	R	R
Claris MacPaint	—	—	—	—	R/W
Microsoft Word	—	R	—	R	R

Program	EPS	PICT	RIFF	TIFF	MacPaint
QuarkXpress	R	R	R	R	R
SuperMac PixelPaint	R/W	R/W	—	—	R/W
WordPerfect	R	R	—	R	R

[1]*To export a FreeHand image in PICT format, select it and press Option while choosing Cut or Copy from the Edit menu. Then paste the image into the Scrapbook.*



How to Open and Save Files in Other Formats

When you use a program's Save or Save As command, your document is saved in the program's native file format. Similarly, when you choose a program's Open command, it generally lists only its native files in the Open dialog box. (There are exceptions to this rule, particularly with word processing programs; they usually list text-only files as well as any other programs' native files that they can access.) Let's look at the techniques behind saving documents in foreign file formats and opening documents saved in foreign formats.

Saving a File in a Foreign Format

Before saving a document in a foreign format, first choose the Save command to ensure that you saved the latest version of the document in the program's native format. (It's always a good idea to have a copy of a file in the program's native format in case you need to revise it later.) Next, choose Save As. In the dialog box that appears, select the desired format (most programs display available formats in a pop-up menu or a list of buttons).

Some programs require other techniques, such as choosing an Export or Save As Other command. To export data with some database managers, you must use a technique called *printing to disk*. Printing to disk causes the program to sort and organize the database as if a report was going to be printed, except that the data is saved in a disk file rather than sent to the printer. Printing to disk can be an effective way to export only certain database records, or to export records sorted in a specific order. (This process differs from the PostScript print-to-disk technique described in Chapter 7; that technique creates a file containing not only data, but also the PostScript commands that specify the document's formatting.)

Because data-exporting techniques vary between programs, you might want to check your program's manuals for specific instructions on saving files in other formats.

Opening Documents Saved in Foreign Formats

Generally, you cannot open a document saved in a foreign format by double-clicking the document's icon in the Finder. If you try, one of two things usually happens: the Finder starts the program that created the foreign file rather than the program you want to use to open the file; or, you receive an error message that tells you the file couldn't be opened because the program in which it was created couldn't be found.

To coerce the Finder into using a specific program to open a foreign file, use the System 7 drag-and-drop technique we introduced in Chapter 9 (drag the file you want to open to the icon of the program). When the program's icon highlights, release the mouse button (see figure 12.7).

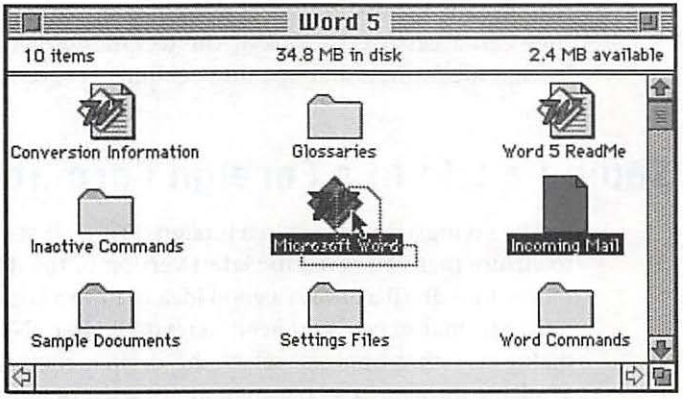


Figure 12.7: Using drag-and-drop to force Microsoft Word to open a MacWrite document from the Finder.



HandOff II

If you frequently find yourself using one program to open another program's documents, consider an extension for System 7 called HandOff II, from Software Innovations. HandOff II enables you to specify that a given type of file always be opened by a given application program. You can specify that TIFF files always be opened with Adobe Photoshop (not the scanner software that created them); that text-only files always be opened by Microsoft Word (instead of TeachText); and that Microsoft Works files always be opened by Microsoft Word (rather than Works), for example.

Exchanging Data with Publish and Subscribe

In Chapter 3's introduction to the Macintosh interface, we mentioned that System 7 gives programs another way to exchange data: the publish and subscribe mechanism. From a data-exchange viewpoint, *publish and subscribe* is the best thing to come along since the Clipboard.

Why? Consider the example we presented in Chapter 3. When you copy a spreadsheet graph from Program A and then paste it into Program B, the graph no longer has ties to the program that created it. If your original data changes and you need a revised graph, you must return to the spreadsheet program, change the graph, copy it to the Clipboard, and then return to Program B and paste. That routine can get old if you work with data that changes often.

With System 7's publish and subscribe features, you can establish links between documents created by the same program or by different programs. After you establish this link, when your data changes in the original document, the Mac updates it in other open documents in which the data appears. In this section, we recap the basics behind publish and subscribe, and outline some scenarios where it can be useful.

A Publish-and-Subscribe Scenario

Let's flesh out the spreadsheet graph example with which we have been working to show just how publish and subscribe works. You have been working on a spreadsheet using Lotus 1-2-3 and you have created a graph that you want to include in a Microsoft Word report. You know the graph's data is going to change between now and the due date of the report, so you have decided to use publish and subscribe rather than the Clipboard. (We're using 1-2-3 and Word in this example, but you can substitute any two programs that support publish and subscribe.)

After saving the spreadsheet document containing the graph, your first step is to make the graph available—to *publish* it. To do so, select the graph and choose Create Publisher from the Publishing submenu (in the Edit menu). A dialog box appears asking for a file name (see figure 12.8). Type a name and click Publish, and you have created an *edition*.

Like most programs that support publish and subscribe, 1-2-3 draws a gray border around information that you just published (see figure 12.9). If you select something else, the border disappears.

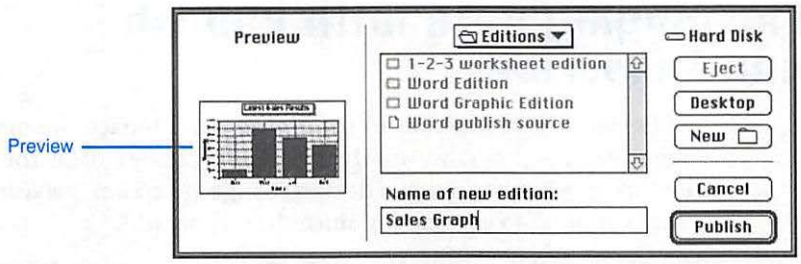


Figure 12.8: Creating an edition.

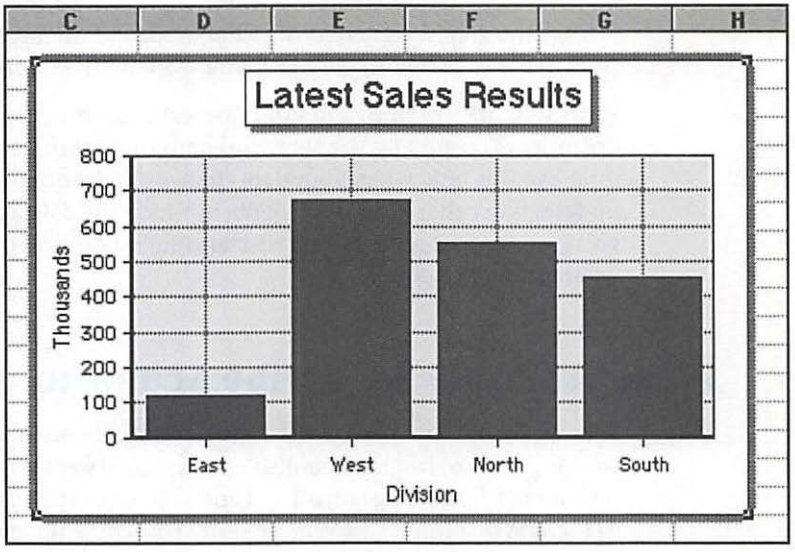
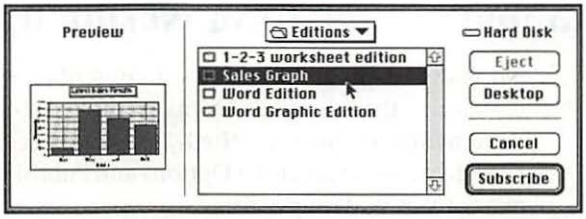


Figure 12.9: 1-2-3 draws a gray border around the graph to show that it has been published.

Now you have switched to your word processing program and you are ready to include the graph in your report. To do so, you need to *subscribe* to the edition you just created. Choose Subscribe To from the Edit menu, and the Mac selects the last edition you created automatically (see figure 12.10). Click Subscribe or press Return, and the edition is inserted in your document.

As figure 12.10 shows, information you have subscribed to is indicated by a dark gray border. This border disappears if you click outside of the information you have subscribed to. The border is the Mac's way of saying, "This information is special—it isn't just a normal part of the document that you can edit." And indeed, that's true—as you will see shortly, you can perform some modifications to subscribed information, but to make major changes, you need to return to the original document.



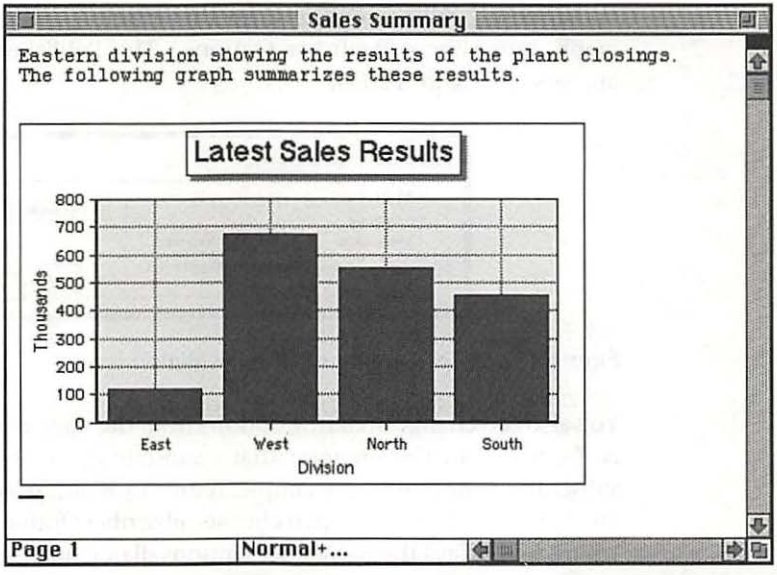


Figure 12.10: Subscribing to an edition. Choosing the edition (top). The edition inserted in the document (bottom).

Updating a Subscriber

So far, you have moved the graph into the word processing program. Although the steps were different from copying and pasting, the end result appears to be the same—but it isn't. Through System 7, the 1-2-3 graph and the Word report have established a link. Let's see this link in action.

Just as you suspected, some new sales figures have come in and you need to change the 1-2-3 spreadsheet and its graph. You return to 1-2-3, make the necessary changes, and then save the graph. When you return to Word, you will notice that the graph has been updated to the latest version automatically—no copying and pasting required.

Changing Publish/Subscribe Options

Normally, a program updates a subscriber when you save the document containing the subscriber. In this example, 1-2-3 updates the graph in the Word document when you save the 1-2-3 worksheet containing the graph. But using the Edit menu's Subscriber Options and Publisher Options commands, you can change this updating routine.

To change update options for a publisher, select the information you published and choose Publisher Options. (In this example, return to 1-2-3, select the graph, and choose Publisher Options.) The Publisher Options dialog box appears (see figure 12.11).

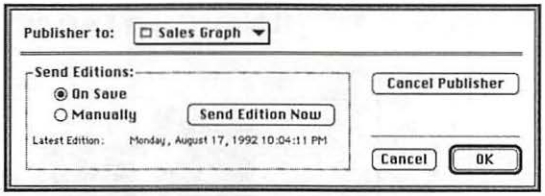


Figure 12.11: The Publisher Options dialog box.

You also can change updating options from the opposite end of the line—that is, from within the program that's subscribing to the edition. To change subscriber options in this example, return to Word, select the graph to which you have subscribed, and then choose Subscriber Options from the Edit menu. Doing so displays the Subscriber Options dialog box (see figure 12.12).

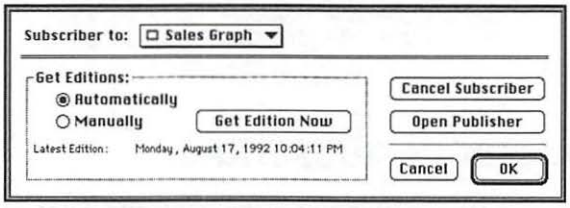


Figure 12.12: The Subscriber Options dialog box.

A Closer Look at Edition Files

Following are a few fine points to note about edition files.

- An edition file contains a copy of the information you published. The information in the edition file can be stored in a variety of formats—much like information cut or copied to the Clipboard. And as with the

Clipboard, there are three standard data formats for editions: PICT, TEXT, and styl. A program also can use private formats. When you publish something, the program you are using can elect to store the data in the edition using standard formats, private formats, or a combination of both. Similarly, when you subscribe to an edition, the subscribing program chooses the format it prefers. Text-oriented programs generally prefer text-oriented data formats, such as TEXT and styl, while graphics-oriented programs usually prefer PICT. In this regard, edition files work a lot like the Clipboard.

- An edition file may have a generic edition icon or a unique icon that is similar to the icon a program gives to its documents. Figure 12.13 shows some edition file icons.

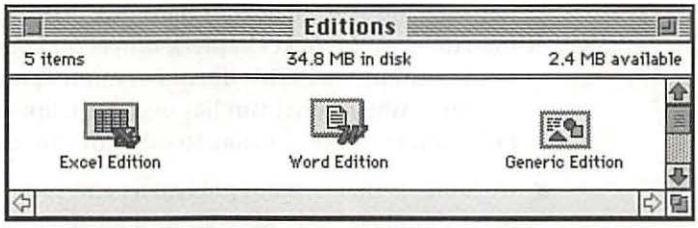


Figure 12.13: Edition file icons.

- If you double-click an edition file's icon, a window appears providing information about the edition. If you click the Open Publisher button, the document containing the published information is opened. As figure 12.14 shows, the window also lists the formats in which the edition's information is stored. This is similar to the way the Scrapbook displays Clipboard formats.

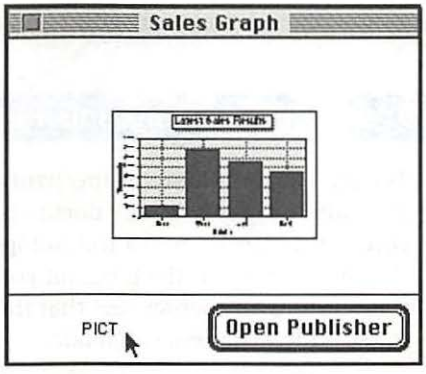


Figure 12.14: This window appears when you double-click an edition file.

- You can perform only limited alterations to information that you have subscribed to. If the edition contains text, you can generally reformat all of the text—changing its font from, say, Geneva to Times. You cannot, however, change one word from bold to italic, nor can you edit the text itself. For these jobs, you must open the original publisher. (Select the edition, choose Subscriber Options, and click the Open Publisher button.) If the edition contains an image, you can generally resize or crop the image, but you cannot alter its contents.
- Any number of subscribers can subscribe to a single edition. If you create a graphic for a newsletter and then publish it, for example, you can subscribe to that edition as many times as you want, from as many documents or programs as you want. If you change the graphic, the Mac updates it everywhere it appears. If you are connected to a network and you share your hard disk using the Sharing command (described in the next chapter), others on your network can subscribe to the edition, too. (This illustrates another advantage the publish-and-subscribe mechanism has over the Clipboard: It enables you to make information available to other machines on a network.)
- Documents that contain publishers and subscribers don't need to be open simultaneously in order to share data. Consider the 1-2-3 and Word example we have been working with. If you change the graph in 1-2-3 when the Word document is not open, the changed version of the graph appears in the Word document the next time you open the document.

As slick as it is, the publish and subscribe feature doesn't replace the Clipboard—not by a long shot. The Clipboard is still the best data-exchange medium for those times when a link isn't necessary—or when one program doesn't support publish and subscribe. The Clipboard is also much more straightforward—copy something from Point A and paste it at Point B. Publish and subscribe requires more effort and a certain degree of advance planning.

Trend: Getting Programs to Talk to Each Other

The publish and subscribe mechanism relies on System 7's capability to send messages from one document or program to another. At the core of this capability is a technology called *AppleEvents*. When you change a publisher, the program you are using transmits a message that informs any subscribers that they must update their documents to reflect the changes you made.

The AppleEvents mechanism enables programs to communicate with each other and send not only data but also instructions. This capability enables multiple programs to work together to perform tasks that

no single program can. Soon, it will enable you to assemble various programs to create your own customized, integrated software.

Suppose that a company introduced a spelling checker and thesaurus program that supported AppleEvents. If all your application programs also supported the same AppleEvents, you could use your single spelling checker and thesaurus from within each of your other programs—you wouldn't need to waste disk space by storing several companies' spelling checker dictionaries. Your drawing program might send AppleEvents to the spelling checker saying, in effect, "check the spelling of the word *linnoleum.*" Your spelling checker might respond, "That's misspelled—change it to *linoleum.*" Besides making life easier for you, this scheme eliminates the need for every software developer to write, test, and debug a spelling checker for each one of its products.

AppleEvents enables programs to communicate even if they're running on different machines in a network. This capability is leading to new *distributed processing* applications that take advantage of multiple central processors to tackle complex computing tasks. One example is Pixar Corporation's NetRenderMan, a program that generates (or *renders)* photorealistic three-dimensional graphics. NetRenderMan can split up a rendering job among several machines on a network, dramatically decreasing rendering times. It's the old "two heads are better than one" adage—updated for the computer age.

AppleEvents also makes possible scripting languages, such as UserLand's Frontier and Apple's AppleScript (in development at this writing), both of which enable you to write scripts that automate repetitive tasks.

As of late 1992, the potential of AppleEvents is only starting to be realized. As Apple refines the AppleEvents mechanism and as more software developers take advantage of it, you are likely to find more and more of your programs talking to each other—and saying things we haven't even imagined yet.



Ways to Use Publish and Subscribe

This section spotlights several scenarios in which the publish and subscribe feature may be useful. We don't mention specific programs in this section; you can apply these techniques using any program that supports publish and subscribe. (How can you tell if a program does? Pull down its Edit menu and look for Create Publisher and Subscribe To commands or for a Publishing submenu.)

Automate a Monthly Report

Your company requires you to produce a monthly status report that consists of smaller reports produced by various departments. Using publish and subscribe, you can automate the process of assembling the report. Here's how:

- Each department manager writes his or her report, and then publishes its contents, creating the edition files on a shared hard disk.
- Using a word processing program, you create a new, untitled document, and then use the Subscribe To command to insert each manager's report. When the department managers fine-tune and revise their reports, you don't need to fuss with obtaining the latest versions and inserting them in your master report.

Streamline a Publishing Project

You're preparing a series of brochures, posters, and advertisements for a new client's grand opening. There's just one problem. The client hasn't picked a final logo design. The solution? Use your illustration program's Create Publisher command to publish the preliminary logo design, and then subscribe to that edition each time you need the logo. As you refine the logo in your illustration program, each successive version will automatically appear in the flyers, posters, and brochures.

Update a Catalog

You use a spreadsheet program to keep track of the latest widget prices, and a publishing program to produce a price list. Rather than cutting and pasting or exporting and importing every time the prices change, select the price list in the spreadsheet and create a publisher. Then, subscribe to that edition using your publishing program. When the prices change in the spreadsheet, your desktop-published price list will be revised, too.

Link an Accounting Program to a Spreadsheet

You use an accounting package to track inventory, and a spreadsheet to analyze sales and produce graphs. Rather than copying and pasting the inventory data, select it and create a publisher. Then, subscribe to the edition using your spreadsheet program. Each time you run a new inventory report, your spreadsheet and graphs will be updated accordingly.

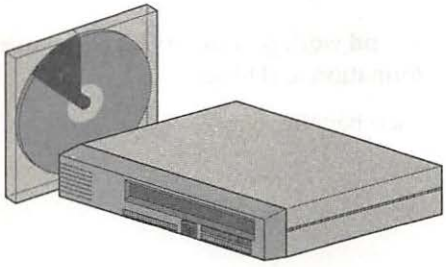
CHAPTER

13

NETWORKING

WHAT'S INSIDE

- The benefits and potential pitfalls of networks
- How to share printers, hard drives, modems, and more
- Networking concepts and terminology
- How to set up a network
- Share and share alike: System 7's built-in file sharing software
- Apple's AppleShare file-server software
- Networking on the road: remote access concepts and products



When you work in an office, you share. You share photocopiers and other office equipment with your co-workers. You share information, relying on a central library or file cabinets that everyone uses. And you share ideas as you brainstorm with colleagues in conference rooms, on the telephone, and at each other's desks.

A *local area network* (LAN), or *network* for short, enables you to extend these same categories of sharing to your computers. In this chapter, we look at how networks can unite a collection of computers and their users. We take a hands-on, step-wise look at how you can set up a small network to share hardware and data between a group of Macs. We also provide some tips and guidelines for keeping your network running smoothly. In the next chapter, we look at what's involved in adding DOS PCs to your network.

Networking is a complex topic that would be difficult to cover fully in a single book, much less in a single chapter. This chapter gives you an idea of what to expect from a network and helps you determine what to look for when shopping for network products. If you're interested in setting up a small network—perhaps a few Macs and a laser printer—this chapter shows you how to get started. If you're planning to set up a complex network containing dozens of computers, the information here can help you work with a network consultant to determine your needs.



Why Network?

Regardless of how many computers you have, a network can provide four basic benefits.

- Your computers can share expensive add-ons, such as laser printers and hard disks.
- Co-workers can communicate with each other using *electronic mail* software.
- Users can share data that everyone in the office uses, such as mailing lists, inventory databases, and boilerplate templates for desktop publications.
- People can join forces and work on projects together, using the network to share information and ideas.

Let's take a closer look at each benefit.

Resource Sharing

Imagine if you had to buy or lease a separate photocopier, postal meter, and water cooler for everyone in your office. That's not an appealing thought, but it illustrates the problem personal computer users faced until recently. If Eric in engineering had to print documents, he needed his own printer. If Amy in accounting had something to print, she needed one, too. Or she had to carry her disk to Eric's desk and interrupt him. Each person who used a communications service, such as CompuServe, needed his or her own modem. The end result was either hefty hardware expenditures or inefficiency.

Networks change this. After you string the wires between machines, each member of the network can share printers and other add-ons. As you may remember from Chapter 7, PostScript printers, such as the Apple Personal LaserWriter NTR and LaserWriter IIf and IIg, contain hardware and software that enables them to be shared on a network. Equip an ImageWriter II with an optional expansion board, and you can share it on a network, too. With some additional software, you also can share hard disks and modems. Each piece of hardware that's tapped into the network—whether a computer, a printer, or a hard disk—is called a *node.*

A network's resource-sharing benefits don't eliminate the need to buy additional hard disks or printers as your office grows, but the capability to share expensive add-ons can cut costs and make it easier to justify an expensive purchase.

File Sharing

In most offices, certain people need access to the same information. A sales staff needs access to a company's product fact sheets and price lists. The legal department needs access to case histories, government regulations, and boilerplate legal text. The shipping department needs access to inventory information.

With a network, you can place this kind of information on a shared hard disk, called a *file server,* where it can be accessed by everyone—or, if you like, by only certain people. You don't need to pass files around on floppy disks (the so-called *sneakernet),* and you don't need to worry about whose version of a file is the most current. By using software designed for *multi-user* access, several people can even use the same file simultaneously. Popular database programs, such as Claris FileMaker Pro, support multi-user access.

Depending on the programs you use—and on their developers' licensing agreements—you can even share software on a network. Rather than buying five copies of a program, you can buy only one, and then purchase additional manuals for each user.

Electronic Mail

With *electronic mail*, co-workers can communicate with the same immediacy that the telephone provides, but without the interruptions. What's more, because electronic mail uses that endangered species—written communication—it gives you a chance to organize your thoughts and it gives you a written record that can refresh your memory. Your communiqués can even include *enclosures*—disk files that accompany your message. And you don't have to worry about delays caused by sluggish interoffice mail delivery.

Collaborative Computing

By combining resource sharing, file sharing, and electronic mail, you provide the foundation for *collaborative computing*, in which documents and ideas flow between workers and departments. In a publishing department, for example, a writer can send drafts to others for approval. After receiving electronically marked-up copy, he or she can make revisions and then drop the files in a designer's electronic in box (a folder), which may already contain illustrations created by an artist. The designer can combine these components into a publication, and then leave it in an out box (another folder), where others can retrieve it for review. The final product may be assembled using the System 7 publish and subscribe features we explored in the previous chapter.

It's Not All Rosy

Before going further, it's important to inject a dose of reality. A network's benefits are the result of careful advance planning. To reach the rosy world of collaborative computing, you need to plan your electronic work flow, and then you need to stress to everyone on the network that it's important to work within the system.

To keep the network running smoothly, you need to devote time to network-management chores, such as backing up the network's hard disks and making sure all network cables are snug and tucked away from areas where users may kick them loose. Finally, you need to stress the importance of cooperation to everyone on the network. People shouldn't disconnect their machines from the network without notifying others, nor should they perform tasks that bog down the network's hard disk and prevent others from accessing it efficiently.

We elaborate on these guidelines throughout this chapter. But as you develop your networking plans, keep in mind that ultimately, you're not putting *computers* on a network, you're putting *users* on a network. Make your network a logical extension of the way you work now—sharing equipment and ideas.



Network Concepts

The networking equation has two sides.

Network hardware. The ports and cables you use to connect each node to the network.

Network software. Which type each computer on the network uses to communicate, and which you use to access shared resources and exchange electronic mail.

Networking hardware and software work together to determine the network's performance, the number of nodes it can accommodate, and in many cases, its cost.

Network Hardware

To share data and hardware resources, the computers in your office must be connected by cables. Apple supports three types of network cabling schemes for the Mac:

LocalTalk. The least expensive and most popular cabling scheme for Mac networks, LocalTalk is the cabling most commonly used to attach Macs to LaserWriters and other PostScript printers. For small networks comprising several Macs, PCs, and laser printers, LocalTalk is a sensible, economical choice. We concentrate primarily on it in this chapter. In fact, if you plan to set up a small network using LocalTalk, you may want to skim or skip the rest of this section and move on to the section "Network Software."

Token-Ring. A network standard developed by the Institute of Electrical and Electronic Engineers (IEEE), Token-Ring is especially popular in the IBM world.

EtherNet. You may recall this term from Chapter 2—it's the networking system developed at Xerox for the pioneering Star workstation. EtherNet remains a popular network standard, especially in the minicomputer and mainframe world. Digital Equipment Corporation (DEC) VAX minicomputers often use EtherNet networks. The Mac Quadra family and the LaserWriter IIg contain built-in EtherNet ports. EtherNet expansion cards or boxes are available for other Mac models, from the Plus to the PowerBook Duo 230.

Network Performance: How Important is It?

As figure 13.1 shows, these three networking media transfer information at dramatically different speeds. With Apple's LocalTalk cabling and connectors, data travels at roughly 230 kilobits per second—faster than a Mac's floppy disk, but many times slower than a fast SCSI hard disk. With Apple's Token Ring 4/16 NB Card, a NuBus board for Token-Ring networks, data travels at a swift 4 megabits per second. EtherNet can transfer data at up to 10 megabits per second.

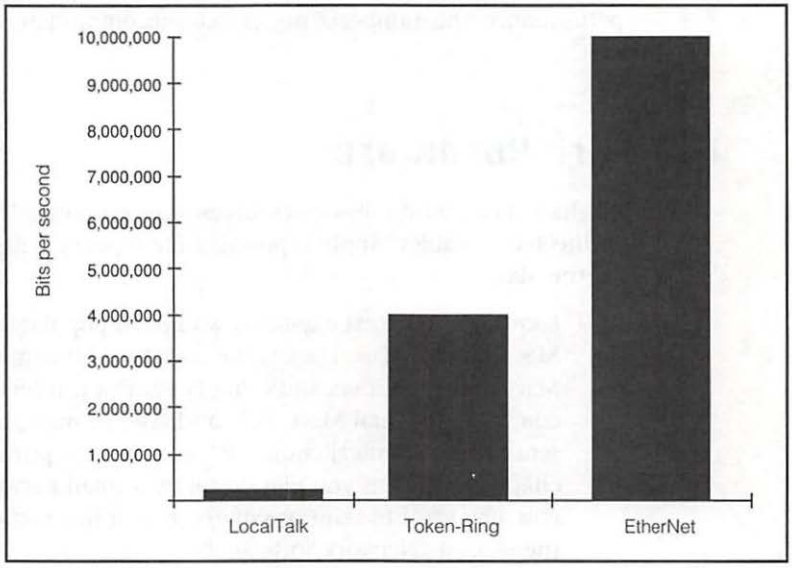


Figure 13.1: Network data-transfer speeds compared.

These performance figures don't always reflect how well a network performs in the real world. A network's actual performance, sometimes called its *throughput,* isn't always easy to quantify. It depends on many factors, including the number of nodes you have, how heavily they're used, and the type of demands each node places on the network.

Just how important is performance, anyway? That depends on how you plan to use your network. Tasks such as printing text-oriented documents, sharing small document files, and exchanging electronic mail don't place heavy burdens on a network. For these applications, performance is not critical. A relatively slow network cabling scheme like LocalTalk is adequate for these light-duty needs.

Speed becomes a bigger factor for multi-user software applications, such as sharing a large database file among several users. The faster the network, the better the database program will be able to respond to each user's requests for

information. Speed is also an important factor if you routinely print large, high-resolution grayscale or color scanned images. Printing graphics like these requires the Mac to move megabytes of data across the network's cabling, and a faster network will translate into faster printing times.

Speed becomes most critical if you have a large network or if you plan to store application programs, large color graphic images, QuickTime movies, and digitized sounds on a file server. On a LocalTalk network, starting a large program stored on the file server or copying large files to and from the server can slow the network significantly, and it doesn't provide very satisfying performance. (We provide some guidelines for working within LocalTalk's speed limitations later in this chapter.)

Network Topologies

Topology is a buzzword that simply describes the way the cables physically interconnect the network's nodes. There are several types of network topologies:

Daisy-chain. You encountered this term when looking at the Mac's SCSI expansion bus and Apple Desktop Bus. With those buses, one device's output is connected to the next device's input. A daisy-chain network is arranged similarly, as shown in figure 13.2. One potential drawback of a daisy-chain network is that the network can be disrupted when a node is disconnected. If the Mac labeled *Eric* in figure 13.2 is removed from the network, for example, the ones labeled *Mary* and *Denny* become disconnected, too. LocalTalk uses a daisy-chaining topology.

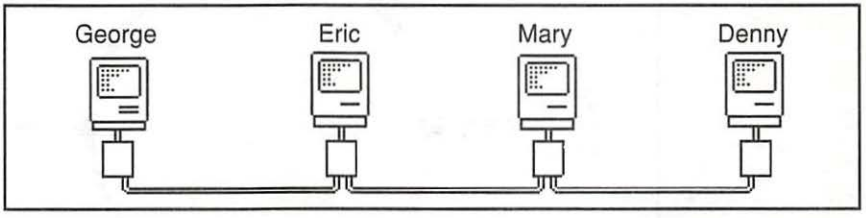


Figure 13.2: The daisy-chain network topology used by LocalTalk.

Bus. This topology, also called *backbone,* uses a central cable that each node taps into—just as the houses in a neighborhood tap into a community's cable TV system (see figure 13.3). With a bus network, you can generally disconnect one node without affecting others—just as one house's cable TV can be disconnected without affecting others. EtherNet uses the bus topology.

Ring. In the ring topology, the nodes are connected in a loop, as shown in figure 13.4. A kind of electronic messenger called a *packet* travels continuously around the ring. Sometimes the messenger isn't carrying anything; other times, it's carrying information addressed to a specific node. Each node examines the packet for information addressed to it. When a node finds some, it reads the information, and then sends the empty packet along. When a node needs to send information, it waits until an empty packet arrives, it loads the packet with data, addresses it, and then sends it along. One drawback of the ring topology is that adding or removing a node disrupts the network because the ring must be momentarily broken. IBM's Token-Ring network uses the ring topology.

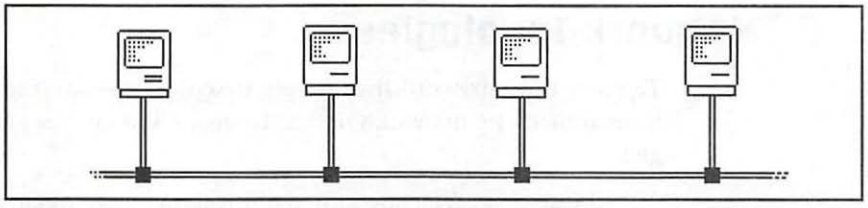


Figure 13.3: The bus network topology.

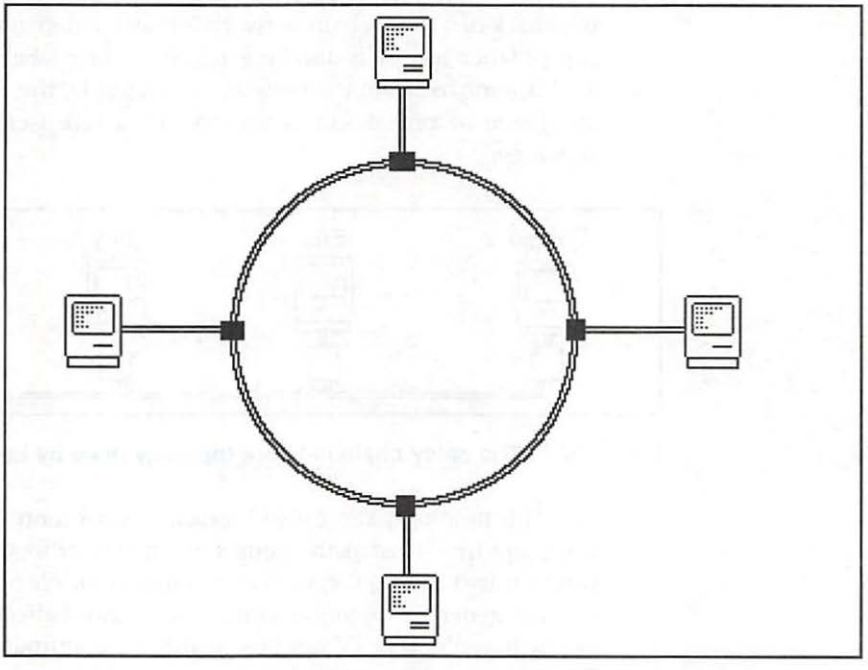


Figure 13.4: The ring network topology.

Star. With the star topology, all nodes are tapped into one central node, which controls the entire network (see figure 13.5). The telephone system is a good example of a star topology: all the phones are connected to the phone company's central switching station, and all calls are routed through that station. Farallon Computing's PhoneNet cabling system can be wired in a star configuration, and can use the spare wires in a building's existing telephone wiring to carry data between each network node. PhoneNet has become a popular alternative to LocalTalk.

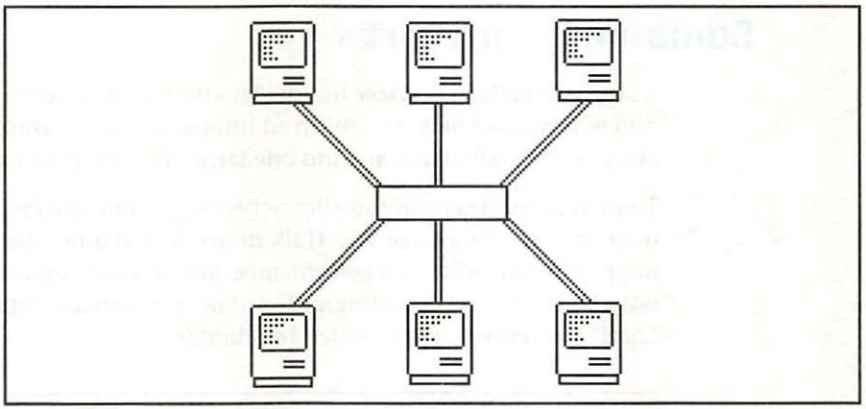


Figure 13.5: The star network topology.

The type of networking cabling arrangement you choose will depend on several factors:

The number of nodes in your network. LocalTalk, for example, is limited to a maximum of 32 nodes. (And that's a theoretical limit; because of LocalTalk's relatively slow speed, a more practical limit is 20 to 25 nodes.) EtherNet and Token-Ring can easily accommodate hundreds of nodes.

The performance you require. As mentioned earlier, LocalTalk, EtherNet, and Token-Ring each transfer data at different speeds.

The physical set up of your computers. LocalTalk has a maximum distance of approximately 1000 feet. Farallon's PhoneNet supports network distances of up to 3000 feet. EtherNet and Token-Ring support similarly large distances.

Your computing environment. Your choice of networking hardware may be influenced by the types of computers to which you want to connect your Macs. In an IBM-oriented business, you may lean toward Token-Ring. For Mac networks, EtherNet may be a more appropriate

choice. EtherNet is also more appropriate for connecting to Digital Equipment Corporation VAX minicomputers.

Your networking budget. LocalTalk hardware is built into every Macintosh and every PostScript printer. To connect a device to the network, you need add only a LocalTalk cabling kit, which retails for $75. (PhoneNet connectors cost even less.) EtherNet and Token-Ring, by contrast, require their own expansion boards, which can cost several hundred dollars or more for each node.

Combining Networks

A large institution may have hundreds or thousands of computers using several different types of networks. With additional hardware, you can unite this vast array of disparate hardware into one large network, called an *internet.*

To interconnect separate smaller networks, you need a *bridge.* Bridges can be used to break up a large LocalTalk network into a number of smaller *zones,* improving reliability and performance, and working around LocalTalk's limitations of 1,000 feet of cabling and 32 nodes per network. Figure 13.6 shows two LocalTalk network zones united by a bridge.

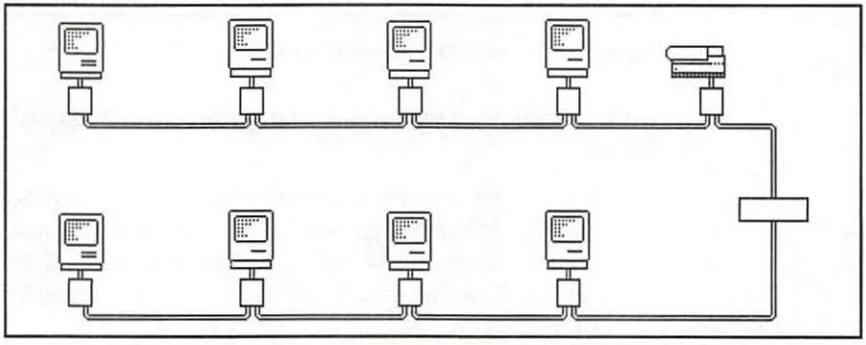


Figure 13.6: Two LocalTalk networks connected by a bridge.

A bridge connects similar networks; a *gateway* connects dissimilar ones. Figure 13.7 shows a large internet that uses gateways to unite a LocalTalk network, an EtherNet network, and a Token-Ring network. In this diagram, an EtherNet *backbone* serves as a main freeway connecting each network. A Macintosh equipped with appropriate boards and Apple's Internet Router software can serve as a gateway between LocalTalk, EtherNet, and Token-Ring networks.

Network Software

A network's hardware is only a medium, a way for data to travel between nodes physically. To take advantage of that medium, you need the following two types of networking software:

- The fundamental software that determines how the nodes communicate with each other and how data travels on the network. Macintosh networks use a set of communication rules called *AppleTalk*. You don't see the AppleTalk software as you use a network, but it's there, working behind the scenes to govern the flow of data between nodes.
- The specialized network software you use to access a file server, send and receive electronic mail, print to networked printers, and so on. This software—the kind you *do* see—works together with AppleTalk.

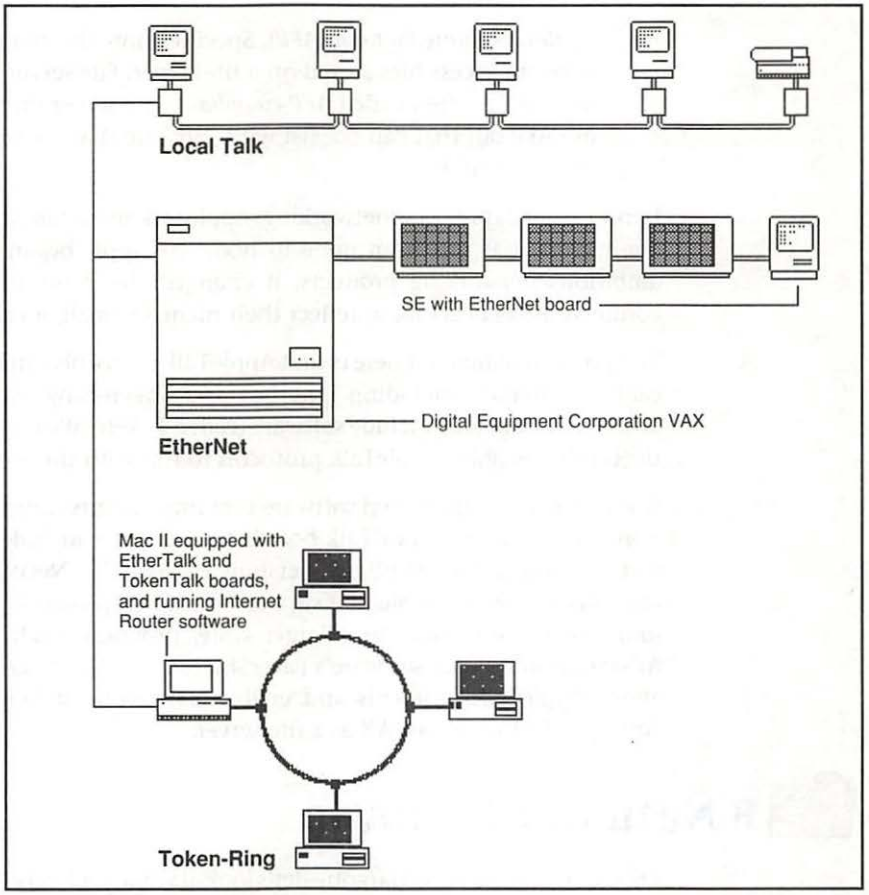


Figure 13.7: Three different types of networks united via gateways by an EtherNet backbone.

Put another way, AppleTalk provides the rules that enable nodes to communicate, and network software gives them a reason to communicate.

AppleTalk

If a network is a freeway for data, AppleTalk is the driver's manual—it specifies the rules of the road. AppleTalk controls the format of the data packets that travel between nodes. AppleTalk provides several sets of rules, or *protocols,* for governing network communications, but two are especially important from our standpoint as network users:

> *Printer-Access Protocol* (*PAP*). Specifies how the computers on a network access a printer. When you print to a PostScript printer or to AppleTalk-equipped ImageWriters, your Mac and the printer use PAP to communicate.
>
> *AppleTalk Filing Protocol* (*AFP*). Specifies how the computers on the network access files stored on a file server. File server software that uses AFP is often called *AFP-compliant.* File server software that doesn't use AFP but that can coexist with software that does is often called *AFP-compatible.*

In the earlier days of Mac networking, AppleTalk also referred to the cabling and connectors that run from node to node. As Apple began developing more ambitious networking products, it changed the name of the cabling and connectors to LocalTalk to reflect their niche in small, localized networks.

The point to remember here is that AppleTalk protocols can run on a variety of cabling schemes, including EtherNet and Token-Ring. Apple's Token-Ring and EtherNet boards include software (called TokenTalk and EtherTalk, respectively) that enables AppleTalk protocols to run with these networks.

Several firms sell their own software that implements AppleTalk protocols on non-Apple systems. LocalTalk boards for DOS PCs include AppleTalk driver software, for example. Similarly, versions of Novell's NetWare network operating system are available that support AppleTalk protocols, enabling Macs to join Novell networks. On a larger scale, products, such as Alisa Systems' AlisaShare and Pacer Software's PacerShare, teach DEC's VAX minicomputers about AppleTalk protocols and enable a network of Macs and LocalTalk-equipped PCs to use a VAX as a file server.



A Network Scenario

Enough of concepts and jargon—let's look at what's actually involved in setting up a LocalTalk network. In this section, we develop a complete network step-by-step. We will use LocalTalk to interconnect several Macs and a laser printer,

and we sample some networking software. In the next chapter, we let a DOS PC into the party.

The network we set up is a typical small LocalTalk network, the kind you may see in any small business or department. It contains three Macs—a Classic II, a IIsi, and a Quadra 700—and a LaserWriter IIg PostScript laser printer.

Like many businesses, we start out by simply sharing the laser printer. Then we add electronic mail service and a file server. By adding network services in phases, troubleshooting is easier.

We have broken each phase down into steps, and concluded each step with some tips and guidelines. If you want a quick overview of the entire network-installation process, you may want to just read the tips or notes at the end of each section.

Phase 1: Printer Sharing

In this phase, we plan the network and set it up to share the laser printer.

Step 1: Planning

The first step in setting up a network isn't attaching wires or running software installation programs. It's *planning*. By planning your network, you will know exactly what hardware you need and you will be able to lay out your cables to accommodate future network expansion.

Initially, your network will be used for printing, so advance planning involves simply deciding how many nodes you will have and where they'll be located. So, with notepad in hand, ask yourself a few questions:

- How many network nodes will you have? You will need to know how many LocalTalk connector kits to buy. In this example, your network will have four nodes: three Macs and one printer.
- What kinds of LocalTalk connectors do your nodes use? Some third-party laser printers use older-style DB-9 connectors, but in this example, you're using all-Apple gear, so you need only DIN-8 connectors.
- How many nodes may you have in the future? You plan to buy another Mac when you hire an assistant, so you will plan your cable layout to accommodate the new machine.
- Where will the nodes be located? For the computers themselves, the answer is obvious: at each desk that has a computer. But the printer is a special case. You want to move it to a central location, where

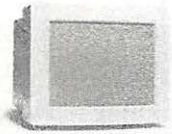
everyone will be able to access it easily, but you also want to locate it so that it will not distract anyone as it churns out pages from each machine in the network.

Plan ahead. Anticipate your future needs, and verify that your present hardware purchases will be able to accommodate them. Don't overlook the little details, such as what kinds of connectors your equipment needs.

Step 2: Assembling the Pieces

You have visited a local Apple dealer and bought four LocalTalk Connector Kits, each with DIN-8 connectors (Apple part number M2068). Each connector kit includes a connection box, which plugs into a node's LocalTalk connector, a six-foot cable, and a small connector called a *cable extender.*

And to have some flexibility in locating your laser printer, you bought Apple's LocalTalk Cable Kit, which includes a 30-foot LocalTalk cable and a cable extender.



TIP: Try to buy all your network components from one source, preferably a knowledgeable local dealer or consultant who can help you troubleshoot problems. By purchasing locally, you can quickly exchange faulty cables and connectors or take them into the shop for testing.

Step 3: Wire the Nodes

Now every node-to-be is ready for wiring. To plan your network's wiring, you may use MacDraw to draw a simple floorplan of your office, as shown in figure 13.8.

The first step in wiring the network is verifying that everything is shut off. Next, unpack each LocalTalk connector kit and attach the connector box to each machine. (Be sure to plug the connector boxes into the Macs' printer ports, not their modem ports.) Next, connect each machine using LocalTalk cables, taking care to push each cable firmly into its connector box until you hear the cable-locking mechanism click. Tuck the cables behind each desk, where they will not get tangled in someone's feet or desk chair. When you get to the desk labeled *To Be Hired,* simply connect two LocalTalk cables with one of the cable extenders that came with your LocalTalk kits. When you hire that new assistant, you will be able to add another node by simply unplugging the extender (after warning everyone in advance) and replacing it with another connector box.

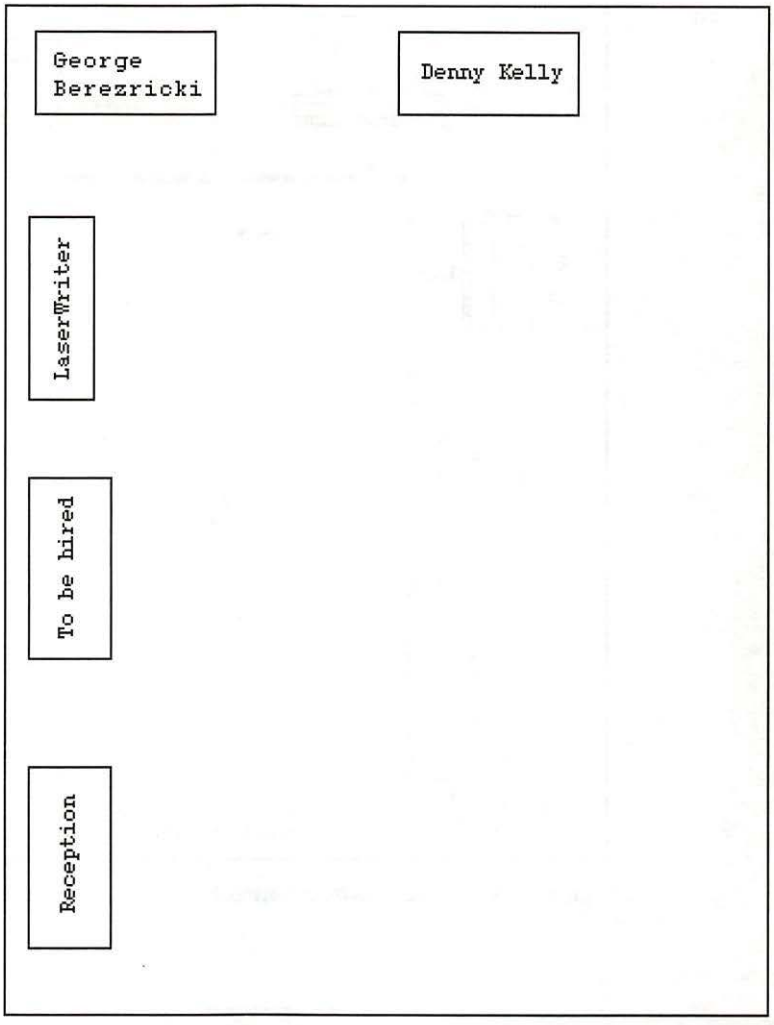


Figure 13.8: A floorplan for planning the network's layout.

When you're finished, the network is wired (see figure 13.9). Notice that the network's wiring doesn't form a complete circle; that is, the station named Denny doesn't directly connect to the station named Reception. LocalTalk networks will not work if they're wired in a circle. If you added a wire (the dotted line) from Denny's desk to the reception desk, the network would work unreliably (or not at all) because of electrical reflections within the cables.

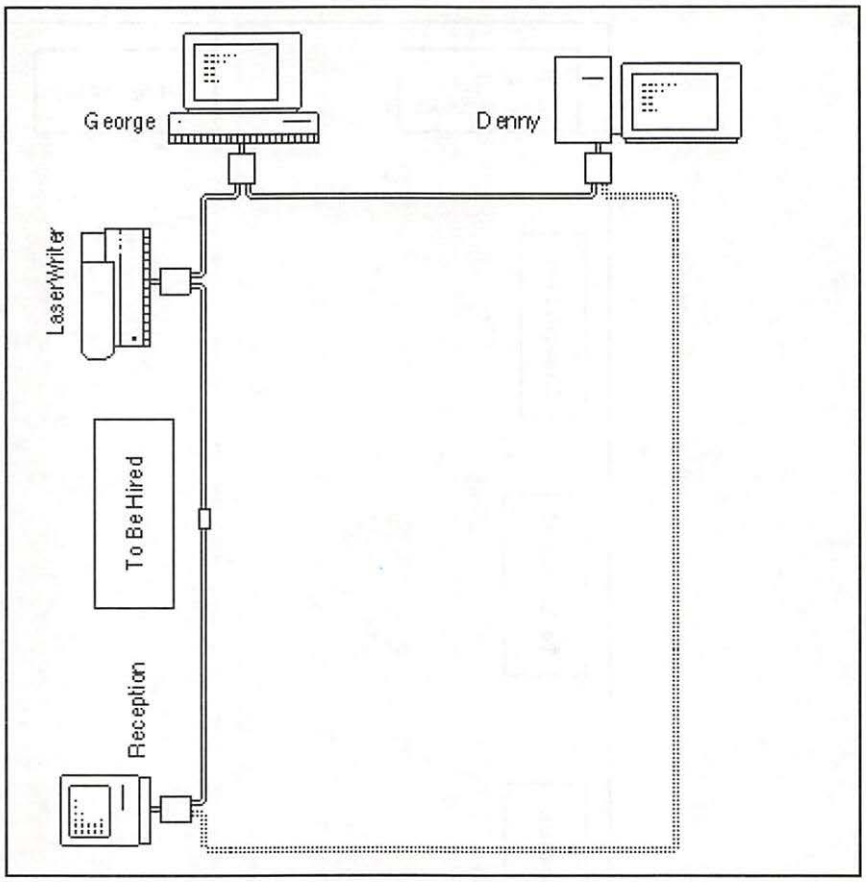
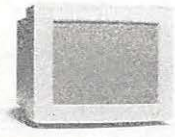


Figure 13.9: The fully-wired network.



TIP: Attach network cables firmly, pressing them into their connector boxes until you hear a click. With DB-9 connectors, tighten the thumbscrews so that the connector is snug. Position cables where they will not be knocked loose, and avoid attaching the last node in the network to the first, creating a circle.

Step 4: Check System Software

If you're the anxious type, you're probably tempted to plow right in and try to print a document. Resist the urge. Your next step should be to use the Finder's About command to verify that each Mac has the same version of the system

software and LaserWriter drivers. A few minutes spent on this important task will help prevent troubleshooting headaches later. (See Chapter 5 for details on checking version numbers.)

While you're at it, use each Mac's Chooser Desk Accessory to activate AppleTalk (see figure 13.10). Then, open the Sharing Setup Control Panel and type a name for that workstation in the User Name text box. If you're at someone's desk, type that person's name. If you're at a desk that different people use, choose a descriptive name that reflects the workstation's purpose, such as *Publishing Desk* or *Reception*.

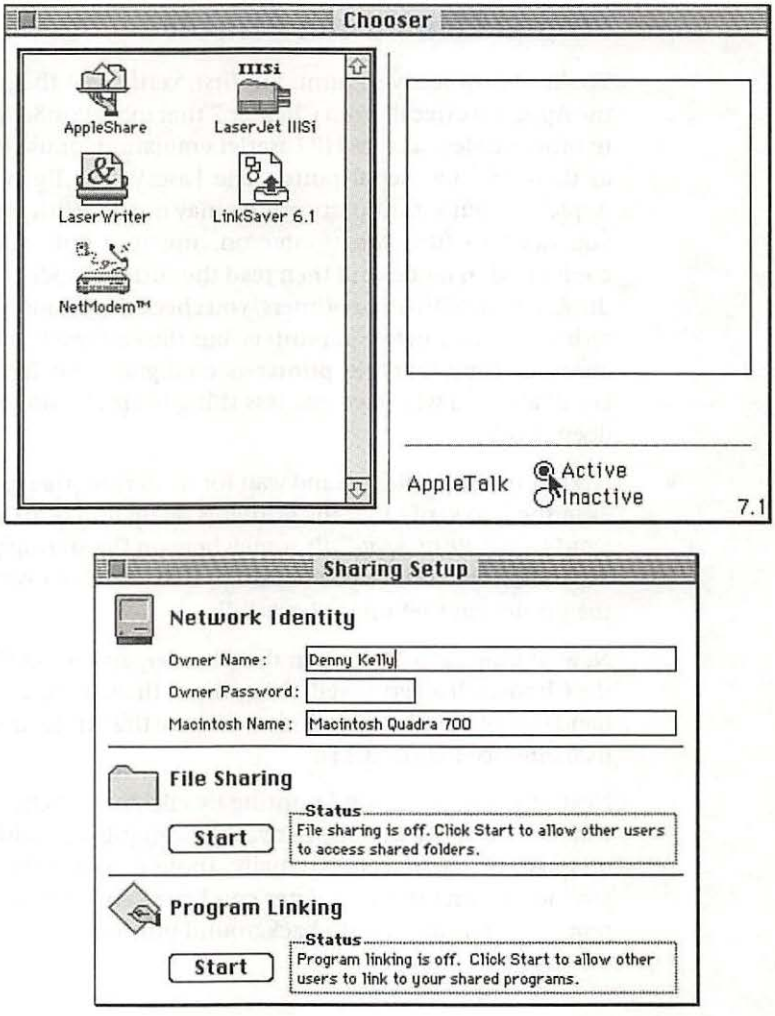
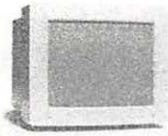


Figure 13.10: Activating AppleTalk using the Chooser (top) and specifying a user name in the Sharing Setup control panel (bottom).



TIP: Networks require homogeneity. Verify that all Macs are using the same version of the system software and LaserWriter drivers. During this step, you also may want to install on each Mac the screen fonts for the LaserWriter's built-in fonts as described in Chapter 6. Use the Chooser (System 6) or the Sharing Setup Control Panel (System 7) to give each workstation a descriptive name. Make a note of the names you chose so you can use them later as you add new services.

Step 6: Fire Up the Printer

You're almost ready to print. But first, verify that the printer is configured to use AppleTalk (recall from Chapter 7 that most PostScript printers can operate in other modes, such as HP LaserJet emulation, or use other connectors, such as their RS-232C serial ports). The LaserWriter IIg is preconfigured to use AppleTalk, but a third-party printer may not be. With some PostScript printers, you need to turn the printer on, use its front-panel keypad to enter a configuration mode, and then read the current mode from the printer's status display. Still, with other printers, you check the position of a rotary switch. The techniques vary between printers, but the end result is the same: by verifying ahead of time that the printer is configured for PostScript operation and LocalTalk, you will have one less thing to troubleshoot if the first document doesn't print.

Next, turn the printer on and wait for its startup page to appear. When it does, examine it to verify that the printer is set up for LocalTalk. You should see the word *LocalTalk* or *AppleTalk* somewhere on the startup page. (Its location will depend on the printer you're using.) If *RS-232C* or *Centronics parallel* appears, the printer isn't set up for LocalTalk.

Now sit down at a Mac, open the Chooser, and select the LaserWriter icon in the Chooser. If all goes well, the name of the laser printer appears in the right-hand side of the Chooser window. Be sure the printer is selected by clicking on its name (see figure 13.11).

Next, disable background printing by clicking the Off button in the Chooser window. To verify that the network is working, you will want to see the status messages on the screen. Normally, those messages don't appear when background printing is active. After you have verified that everything is working properly, you can turn on background printing.

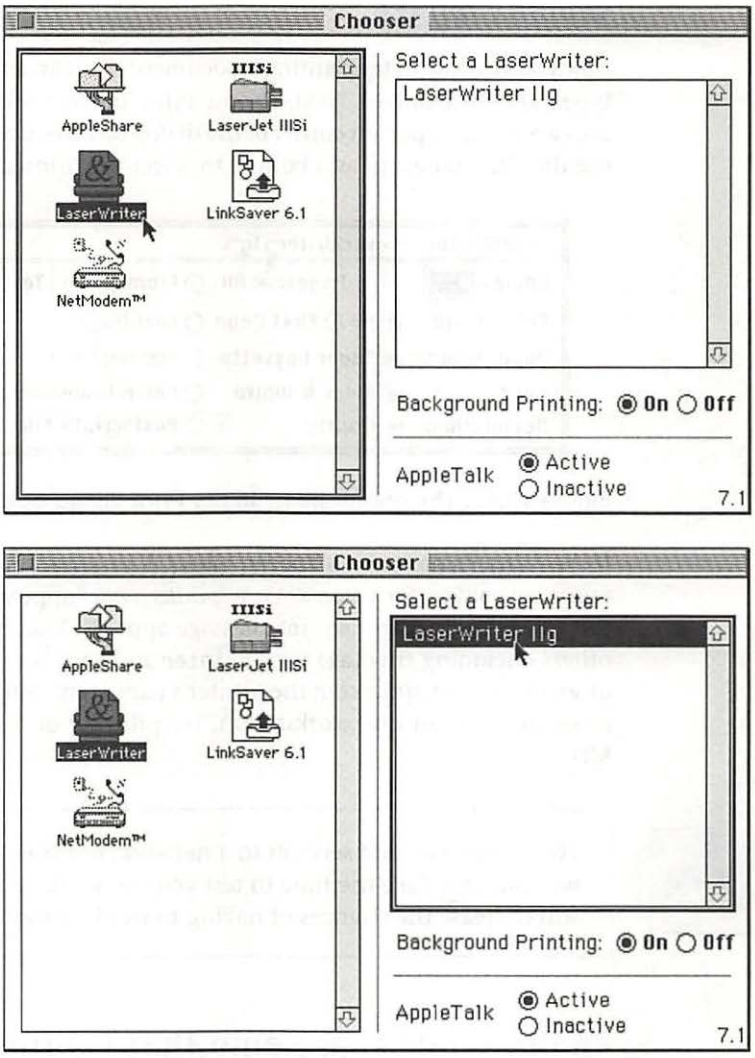
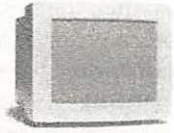


Figure 13.11: Two steps to selecting a laser printer: choose the LaserWriter driver (top) and then select the printer's name (bottom).



TIP: Check your printer's settings in advance to avoid troubleshooting hassles. When you use the Chooser to choose a printer, be sure to select the LaserWriter driver and to click the printer's name. When you're printing your very first document, disable the background printing option so that you can see the status messages coming from the printer.

Step 6: Try it!

Now you're ready to try printing a document. Start an application program and type a sentence or two. Next, choose Print and verify that the printer's name appears in the upper left corner of the dialog box (see figure 13.12). If it doesn't, use the Chooser again and be sure to select the printer's name.

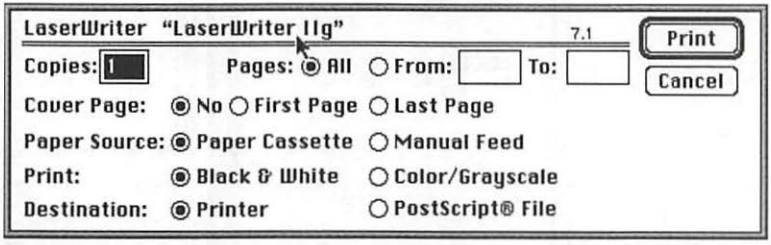
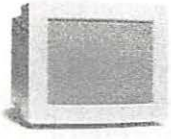


Figure 13.12: The printer name in the Print dialog box.

If the printer's name does appear, click OK or press Return. In a moment, the message `Looking for LaserWriter` *"printer name"* appears. A few moments after that, a `Status: starting job` message appears. That message is followed by others, including `initializing printer` and `processing job`. After a minute or so, the output appears in the printer's paper tray. After successfully printing a document from one workstation, try printing documents from the other Macs.



TIP: When you add services to a network, test them from each workstation. Take the time to test your network in advance, and you will decrease the chances of having to troubleshoot it under pressure.

An Optional Step: Name that Printer

Many printers include an Apple utility called The Namer that enables you to change a PostScript printer's name. (The name appears in the right side of the Chooser as well as in status messages displayed by the LaserWriter driver or PrintMonitor.) Most printers have their model numbers as their names: LaserWriter IIg, LaserJet IIIsi, and so on. Using The Namer, you can change a name to something more descriptive: Marketing Printer, 5th Floor Printer, Pat's Printer. If you have more than one PostScript printer on your network, giving each a descriptive name will avoid confusion as to which printer is which (see figure 13.13).

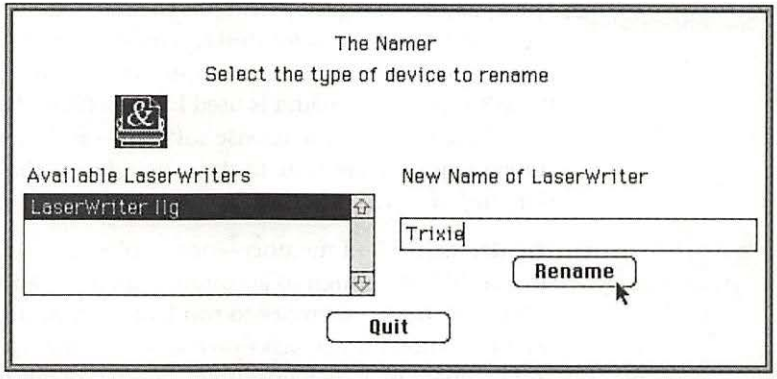


Figure 13.13: Renaming a printer using The Namer.

After you change a printer's name, the new name is saved in the printer's non-volatile memory. You will not need to use The Namer again unless you need to rename the printer again.

Phase 2: Electronic Mail

At this stage, your network is wired and set up for printing from each Mac. Now you will add electronic mail services. For these examples, we have chosen Microsoft Mail, an easy-to-use electronic mail system available for the Mac and for DOS machines. Microsoft Mail is also nicely supported by Microsoft Word, Excel, and Works as well as by Aldus PageMaker; you can send and receive mail directly within these programs by using Open Mail and Send Mail commands. Another popular electronic mail package that's available for both Macs and DOS PCs is CE Software's QuickMail.

Step 1: Software Setup

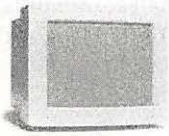
Your first step in adding electronic mail is to decide which Mac will be the *mail server,* which holds mail being sent and routes it to the proper workstation. Microsoft Mail can use any Mac from a Plus on up as a server. Microsoft Mail doesn't require you to dedicate a Mac to mail serving; you can still use the mail server for other tasks.

In this scenario, your office has a 4MB Mac Classic II, a 5MB Mac IIsi, and an 8MB Quadra 700. Any one of the three can act as the mail server—which should you use? To determine that, step back and assess each machine's capabilities and present workload:

- The Quadra 700 is fastest and has the most memory, but it also works the hardest. You use it for desktop publishing, CAD, and image processing work—tasks that devour memory and processor time. What's more, the Quadra is used by the office Mac guru, who often tests shareware and pre-release software—and therefore, falls victim to system crashes from time to time. You decide that you would rather not burden it with another task, especially one that requires reliability.
- The IIsi has 5MB of memory—not a colossal amount by today's standards, but enough to accommodate the Mail server extension and still leave enough memory to run larger application programs. It's used for general office tasks—word processing, spreadsheet analysis, and database management. It gets moderate but not intense use, so it's a good candidate for a mail server.
- The Classic has 4MB of memory and a 40MB hard disk that's nearly full. Your receptionist uses it only occasionally to write letters and memos. Its speed is adequate for mail server duty, but because there just isn't room on its hard disk for a digital post office, it isn't in the running.

Based on these evaluations, you decide to use the Mac IIsi as your mail server. So, you copy the Microsoft Mail Server extension to the IIsi's System Folder and then restart the IIsi to load the extension.

Next, you install the Mail workstation software on each machine, a job that involves running an installer program that installs a Desk Accessory and system extension in the System Folder. Restart each machine after installing.



TIP: When choosing which machine to use as a server, don't just consider each machine's capabilities—consider how each machine is used, too. You don't want to bog down an already hard-working machine with additional duties, nor do you want to use a Mac that may be prone to crashing. Finally, be sure the machine you choose has enough free disk space to accommodate each user's needs. As a general rule, plan on allocating roughly 500K to each user—more if they will be exchanging large disk files, less if they will be sending only short messages.

Step 2: Mailbox Setup

After creating the server, you need to create a mailbox for each workstation. To do so, you must sign on to the server as the network manager—the person with the authority to create new mailboxes—and then use the Mail Desk Accessory

to create the mailboxes (see figure 13.14). As you create each user's mailbox, be sure to use the exact same user name that you typed in each Mac's Sharing Setup Control Panel when you set up the Macs for printing. You could create passwords for each mailbox at this stage, but it's better to leave that job up to each individual. That way, each person can choose a password that he or she will remember.

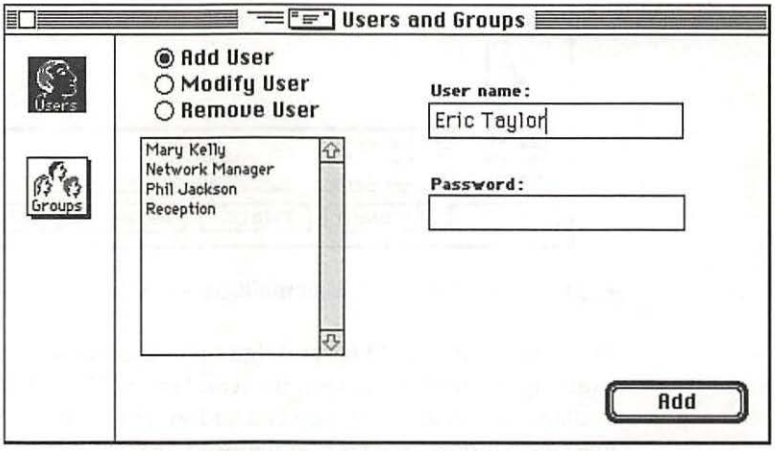
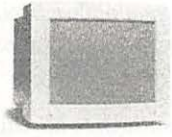


Figure 13.14: Creating a mailbox with Microsoft Mail.



TIP: Consistency is important in networks. Standardize user names, and use the same ones in every network service you have. Allow users to choose their own passwords; they will be less likely to forget passwords they think of themselves. At the same time, though, be sure to tell them not to use obvious passwords, such as a nickname everyone knows.

Step 3: Trying the Mail Server

To try the mail server, go to a Mac and open its Microsoft Mail Desk Accessory. A dialog box appears asking for a user name and password. The user name previously entered in that Mac's Sharing Setup Control Panel appears in the dialog box; you can accept it or type a different name. After you enter a name and password, the Microsoft Mail mailbox window appears (see figure 13.15). This process of supplying your user name and password in order to display the mailbox window is called *signing on*. For this test, leave the mailbox window open after you have signed on.

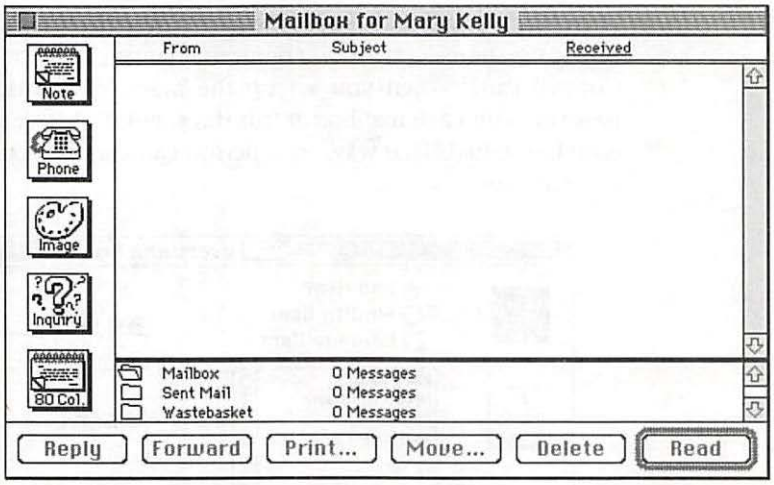
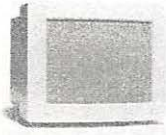


Figure 13.15: Microsoft Mail mailbox window.

Now, go to a different Mac and sign on to the mail server. Next, begin creating a message by double-clicking the icon labeled Note. A window appears listing available nodes to which you can address the message. Select a node, and the message window appears (see figure 13.16).

Next, type a word or two in the Subject text box, then type a few words in the large text box at the bottom of the window. Finally, send your message by clicking Send. If all goes well, the other Mac beeps and displays a dialog box. Move to that Mac, and you see the subject of the message you sent (see figure 13.17). Double-click it to read it.

Repeat this testing process with each computer until you're sure that all the machines can access the mail server.



TIP: When you add a new network service, test it from each machine to make sure it's working properly.

Step 4: Basic Training

When you're sure the mail server is working and that each user can access it, make sure everyone knows how to operate the e-mail software. Show them

how they can change their preferences to tailor the way they're informed of new mail (see figure 13.18).

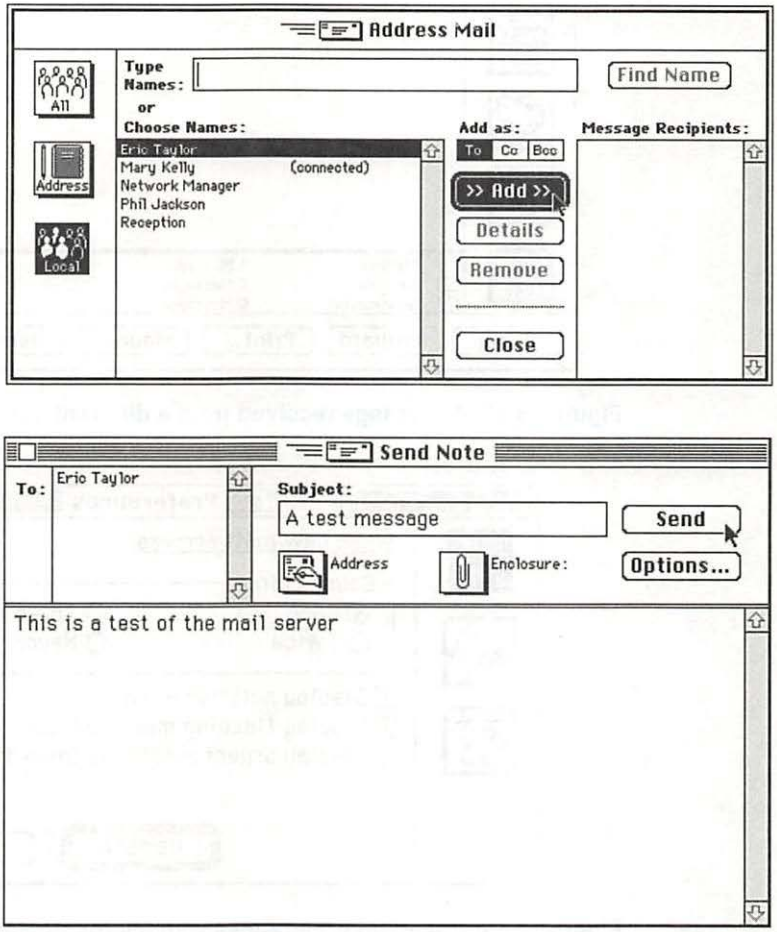


Figure 13.16: Addressing a message (top) and the standard message window (bottom).

Also make sure each user knows about the types of messages that can be sent. Microsoft Mail, for example, enables you to send text messages, graphics messages, and telephone messages (see figure 13.19). The text message (called *note*) also enables you to send any disk file, called an *enclosure*.

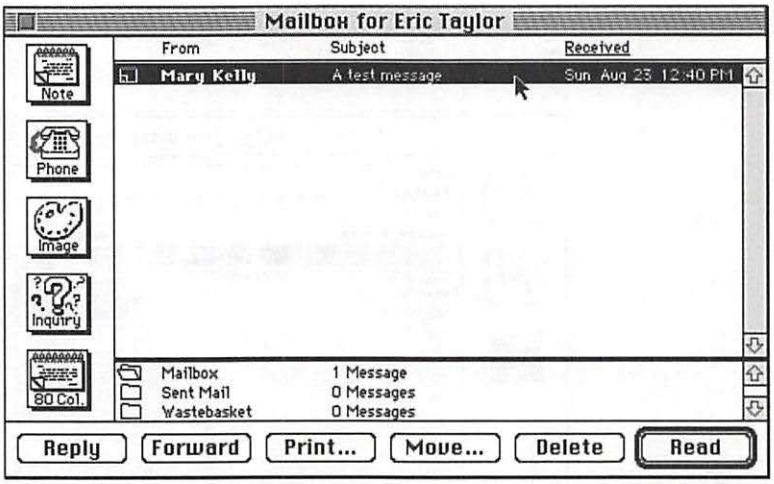


Figure 13.17: A message received from a different node.

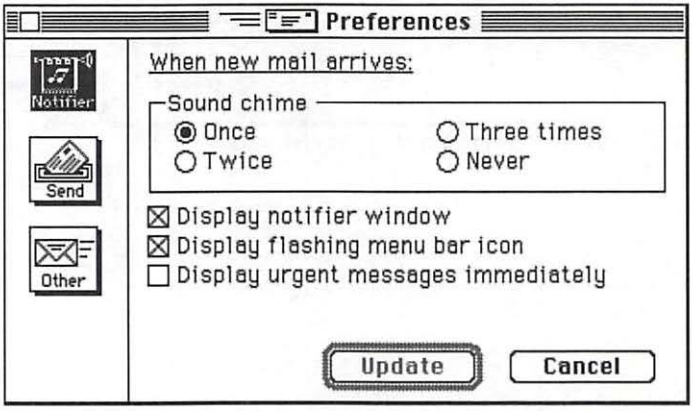
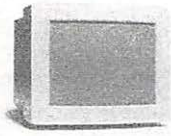


Figure 13.18: Changing preferences with Microsoft Mail.



TIP: Your network will operate more smoothly if you take the time to educate everyone in its operation. Don't force people to simply pick it up as they go along; they will be less likely to take advantage of the network's services and more likely to cause problems by performing tasks improperly. Also, develop guidelines for deleting mail that's no longer needed. Messages that have been read still take up space on the mail server unless they're deleted. If people want to save messages indefinitely, they should use the e-mail's Desk Accessory to save them on their own hard or floppy disks, and then delete them from the server.

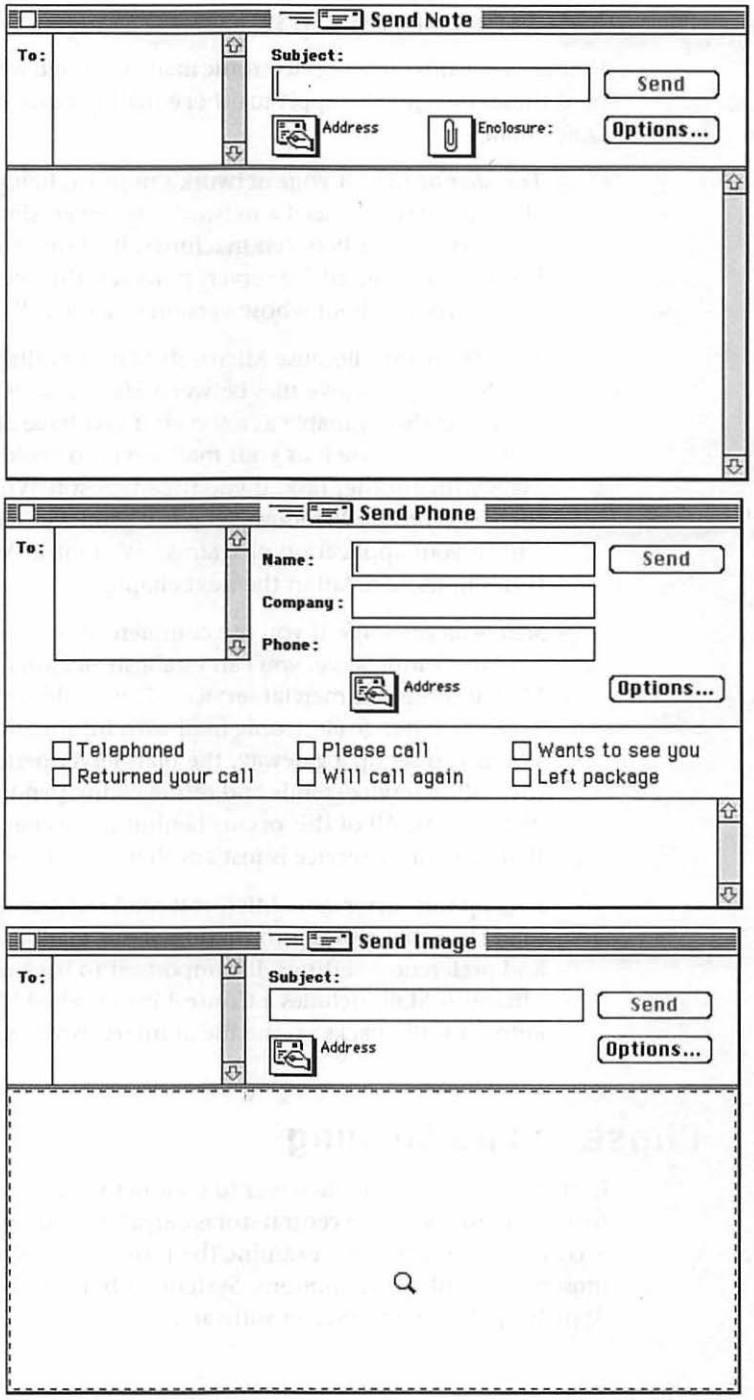


Figure 13.19: Microsoft Mail message types: Note (top), Telephone (middle), and Graphic (bottom).

Electronic Mail Tips

Here are a few tips for using electronic mail. Although we refer to Microsoft Mail here, these concepts also apply to other e-mail systems, including CE Software's QuickMail.

Transferring files. If your network's users exchange files only occasionally, you may not need a network file server; simply use file enclosures to exchange files between machines. It's faster than swapping disks. Unlike a centralized file server, however, this scheme doesn't eliminate worrying about whose version of a file is the most current.

From PC to Mac. Because Microsoft Mail is available for DOS PCs, it's an ideal way to move files between Macs and DOS machines. The PC version is also available as a server; if you have an underused PC, you may choose to use it as your mail server to avoid saddling one of your Macs with another task. If you use Microsoft Windows applications, such as Word for Windows, you can send and receive mail directly within your application programs. (We look at Mac-PC file-exchange issues in more detail in the next chapter.)

Setting up gateways. If you use commercial online services, such as MCI Mail or CompuServe, you can establish *gateways* between Microsoft Mail and the commercial services. This enables you to use Microsoft Mail to exchange electronic mail with information service subscribers. When you set up a gateway, the mail server periodically connects to the online service, sends and retrieves any pending mail, and then disconnects. All of this occurs behind the scenes, making it appear that the online service is just another part of your mail system.

Back up your server data. Microsoft Mail relies on a file named Microsoft Mail Data that stores information about mailbox names, passwords, and preferences settings. It's important to back up this file regularly. Microsoft Mail includes a Control Panel called MS Mail Backup that automatically backs up the file at intervals you specify.

Phase 3: File Serving

In this phase, we add a file server to your network. We use file server software to turn a hard disk into a central storage area for holding files that everyone can access. In the process, we examine the pros and cons of the Mac world's two most popular file server options: System 7's built-in file sharing software and Apple's AppleShare file server software.

Two Approaches to File Serving

As you see in this section, there are two basic approaches to file serving.

- The *distributed server* approach, in which the file-serving duties are *distributed* among several machines on the network. System 7's built-in file sharing uses this approach, which is also sometimes called *peer-to-peer* file serving.
- The *dedicated server* approach, in which one Mac and its hard disk act as a centralized file server that all other machines on the network can access. AppleShare uses this approach.

First, we examine the pros and cons of each file server approach, then we take a closer look at System 7 file sharing and at AppleShare. Finally, we look at some other file-server options you may consider.

System 7 File Sharing: Pros and Cons

First, let's look at the advantages of System 7's distributed file server approach.

It's inexpensive. If you have upgraded to System 7 or if your Mac came with it, you already have all the software you need. By contrast, AppleShare costs $1,199 for up to 120 nodes. Unlike earlier versions, AppleShare 3.0 does not require a dedicated Mac and hard disk—if the server Mac has 4MB of memory or more, you also can use it to run application programs. But the server will be faster and more reliable if it runs on a dedicated Macintosh, and if you have a small network, you may not be willing to dedicate a Mac and hard disk to file serving.

It's flexible. With System 7, anyone can make part or all of his or her hard disk accessible to other people on the network. If Wendy needs to access the files in Eric's Work in Progress folder, for example, Eric can make that folder available through the Finder's Sharing command. When Wendy needs to access the folder, she uses the Chooser Desk Accessory to connect to Eric's machine. The folder then appears on Wendy's Desktop as if it was a disk (see figure 13.20).

It's easy. You can learn System 7's file sharing features in an hour or so. For basic file sharing, you don't need to learn new ways of accessing files or folders.

System 7's file sharing has some drawbacks, too:

Security is minimal. You can assign passwords to shared folders and disks and you can govern who can see and modify folders and their contents, but you don't have the full range security options that AppleShare provides.

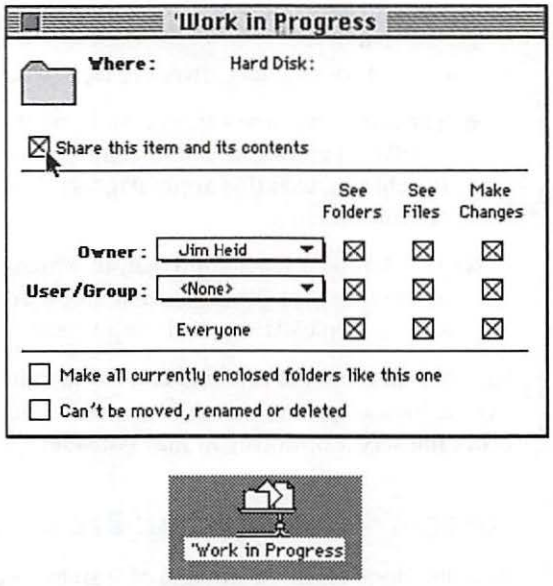


Figure 13.20: Using System 7 file sharing: Sharing a folder (top), and the folder as it appears on the remote machine (bottom).

Anarchy is possible. Networks thrive on uniformity and consistency, and System 7's distributed approach doesn't encourage either. Anyone can become a file server at any time and more significant, anyone can *stop* being a file server at any time. If Eric decides to shut down or if his Mac crashes, anyone who has connected to his hard disk is in trouble. You can encourage greater uniformity by dedicating a Mac and hard disk to System 7 file serving, but at that point, you would probably be better off using AppleShare.

Performance can suffer. If you share your hard disk, you will notice that your Mac slows down when others are accessing it—the mouse pointer will not move as smoothly, programs will run more slowly, and windows will open in slow motion. Similarly, when you perform time-consuming tasks on your Mac (such as formatting a floppy disk), users who are sharing your hard disk will notice delays when they try to open and save files on your hard disk.

AppleShare Pros and Cons

Now let's look at AppleShare's strengths.

Security is good. As you see later, AppleShare enables you to specify several levels of *access privileges*—rules governing who can access the contents of folders.

It enforces structure. With AppleShare, you don't have to contend with the file-serving anarchy that can occur with System 7 file sharing. Everything is stored on the central file server, making it easier to enforce structure in your network and back up the contents of your file server.

However, on the negative side:

It's expensive. The $1,199 that AppleShare costs will buy a few application software packages. What's more, the fact that AppleShare benefits greatly from a dedicated Mac and hard disk boosts the final cost of your file server significantly. For a small network containing only a half-dozen or so nodes, you may not be willing or able to buy at least a Mac Classic and hard disk just for a server. For large networks, the cost per node drops, but you may need a faster—and more expensive—file server, such as a Mac IIsi or LC II.

It's regimented. AppleShare's enforced structure and uniformity are essential in large networks, but may be overkill for small, informal ones in which people swap files only occasionally.



A Closer Look at System 7 File Sharing

For your fledgling network, you decide that System 7's built-in file-sharing software is the more appropriate—and more affordable—choice for file server software. There's another bonus to starting out with System 7's built-in sharing: if you decide to upgrade to AppleShare later, you can use many of the same server settings you made when configuring System 7's file sharing features.

Installing File Sharing

Check each Mac's Control Panels folder to see if it has Control Panels named Sharing Setup, Users & Groups, and File Sharing Monitor. If these Control Panels aren't present, the System 7 file-sharing software isn't installed. To install it, run the Installer program on the System 7 Install disk, click the Customize button, and select the file-sharing software option.

Using System 7 File Sharing

In our network scenario, your receptionist uses a Mac Classic with a nearly full hard disk. You would like her to be able to store the correspondence and memos she writes on your IIsi's hard disk. That way, you will be able to access them when you need to.

To start up System 7 file sharing, open the Sharing Setup Control Panel. If you didn't specify an owner name when setting up electronic mail, type a name now. If you like, also specify a password and a name for the Macintosh itself. Then, in the File Sharing area of the Control Panel, click the Start button. The Status area of the Control Panel will notify you when sharing is on (see figure 13.21).

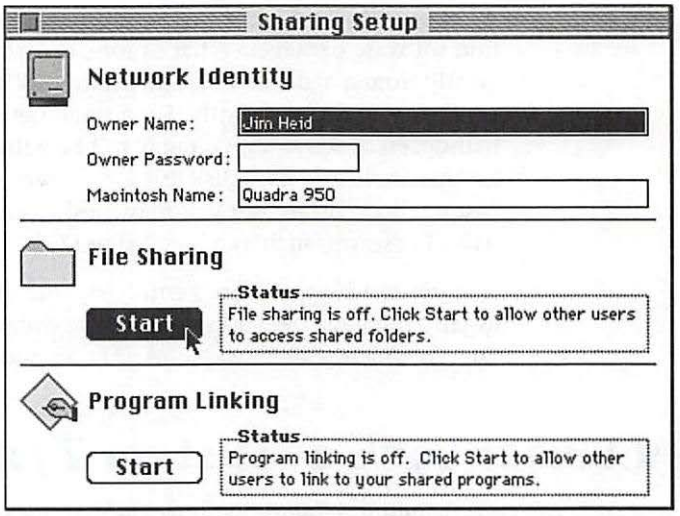


Figure 13.21: Activating file sharing with the Sharing Setup control panel.

To make an entire disk available to other machines on the network, select its icon and choose Sharing from the Finder's File menu. In the window that appears, click the Share this item and its contents check box. When you close the window, you're asked if you want to save the changes to the access privileges. Click Save or press Return.

In many cases, you may not want to make an entire hard disk available to other Macs—perhaps you have some confidential files you don't want others to see. In this example, you want to share only one folder named Correspondence. If the folder doesn't exist, create it using the Finder's New Folder command, and then select the folder and choose the Sharing command.

At this point, the IIsi is a file server. To access the shared Correspondence folder, your receptionist opens the Chooser on her machine and selects the AppleShare icon. The IIsi appears in the right side of the Chooser. She double-clicks the IIsi's entry and a connection dialog box appears. She clicks Guest (we explain why shortly) and clicks OK. In the dialog box that appears next, she selects the folder and clicks OK. In a moment, an icon for the shared folder appears on her Desktop. Figure 13.22 summarizes the connection process.

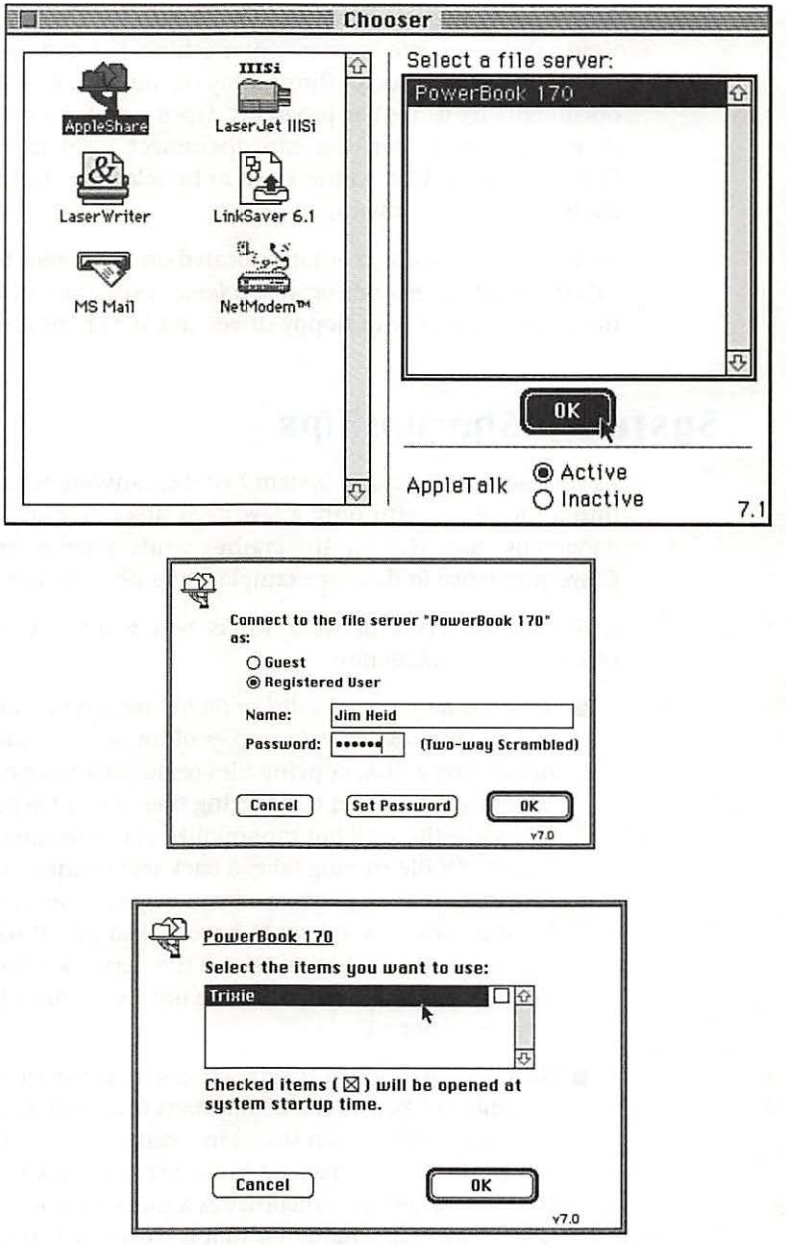


Figure 13.22 Connecting to a shared folder. Use the Chooser to select AppleShare and the server name (first), specify your user name and password (second), and then choose the items you want to use and click OK (last).

At this point, the receptionist can work with the Correspondence folder as if it were a disk connected to her own machine. She can copy files to and from it using the Finder, she can throw away documents, and she can open and save documents by using her programs' Open and Save commands. When she's done with the folder, she can disconnect from the IIsi by dragging the Correspondence icon to the Trash or by selecting the icon and choosing Put Away from the File menu.

In the network world, a volume located on a different machine is sometimes called a *remote volume* or a *network volume.* A volume connected directly to your machine—such as your floppy drives and SCSI hard disks—is a *local volume.*

System 7 Sharing Tips

As you see in this section, System 7 enables anyone to turn his or her machine into a file server with only a few steps. It's quick and easy, but potentially dangerous, too. If your IIsi crashes while your receptionist is using the Correspondence folder, for example, she's likely to lose work.

A distributed server network works best when everyone on the network observes a few guidelines:

- *After you have shared a disk or folder, avoid performing time-consuming tasks on your machine.* Examples of time-consuming tasks include initializing a disk, copying files (especially to or from floppies), installing fonts, and transferring files over a telephone modem. Tasks like these all but monopolize your machine's processor, and System 7's file sharing takes a back seat to them. If someone else is accessing your hard disk and you begin a time-consuming task, his or her machine may appear to have locked up—it will not respond to typing or other commands, and the network-activity arrows will flash. This waiting game will continue until your machine's workload returns to normal.

- *Back up often.* One of the drawbacks to distributed file serving is that an office is likely to have important files scattered across several machines, rather than stored in a central server. This makes it imperative that everyone back up his or her hard disk frequently. But because backing up certainly qualifies as a time-consuming task, no one should back up a hard disk that is currently being used as a server by another machine.

- *After you share a folder or disk, use your Mac carefully.* Don't perform tasks that may cause it to crash, such as running untested shareware or

pre-release software. Avoid performing system-modifying tasks, such as installing fonts or modifying the System file with ResEdit.

- *Think twice about running large applications that are stored on a remote volume.* If a file server volume that you have mounted contains applications, you can run them, but because of LocalTalk's speed limitations, they'll start and run slowly. Generally, it can take more than twice as long to start a program stored on a remote volume. This performance gap can grow even larger if the person who shared the volume is using his or her Mac while the application program is starting. For these reasons, you're better off not running large applications stored on a remote disk, especially if that server is being used for other tasks.

Notice that last guideline began with *think twice,* not *don't ever.* There are few carved-in-stone rules where file serving is concerned, especially with System 7's distributed operating style. Depending on the size of your network and on how you use its nodes, it may be perfectly acceptable to run a large application from a remote server volume. As a general rule, if a given server isn't being used locally and if it isn't being accessed by more than two nodes, you can run a large application from it. If a server is being used locally, or if it's being accessed by several nodes, however, each node should use the server for storing document files only.

Creating Users and Groups

For occasional file sharing, the steps we just outlined may be all you need. But what if you want to add more structure to your file-sharing system? You may want to require a user to type a password before being granted access to a shared disk or folder, for example. Or maybe you want to set up specific folders for specific groups of people—one folder for the marketing team, one for the engineering team, and so on.

You can accomplish these tasks by using the Users & Groups Control Panel. This Control Panel enables you to create a list of *registered users,* people who will be accessing the server. You also can create *groups,* collections of users who will be able to share information. The users within a group can use System 7's security options to set up folders that each group member can access, but that members of other groups cannot. Figure 13.23 shows the relationship between users and groups.

Group	Users
Engineering	Roy Taylor
	Wendy Gorgenson
	Trixie Norton
	Bill Martin
Testing	Mary Kelly
	Kevin Fraser
	Peter Remy
	Margaret Raynak
Sales	Suzanne Williams
	Tina Buchanan
	Jack Campellone
	Scott Kaufman

Figure 13.23: Users belong to groups.

When you open the Users & Groups Control Panel, a window appears that looks a lot like a Finder directory window. Rather than icons for application programs, folders, and documents, however, the Users & Groups window contains icons for people (see figure 13.24).

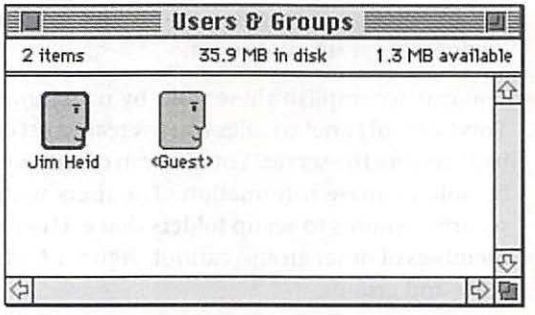


Figure 13.24: The Users & Groups window.

Creating a New User

Let's create some registered users for the people on your network. Creating a registered user (or *user*, for short) is easy: choose New User from the Finder's File menu. An icon labeled New User appears in the Users & Groups window. The icon's name is highlighted and bordered, indicating that you can rename it. Type the name of the person you want this icon to represent. Use the same name that you typed in that person's Sharing Setup Control Panel. Double-click the icon, and that person's user window appears (figure 13.25).

You can supply a password for a new user by typing the password in the user window's User Password box, but as mentioned earlier, it's often better to let people come up with their own passwords.

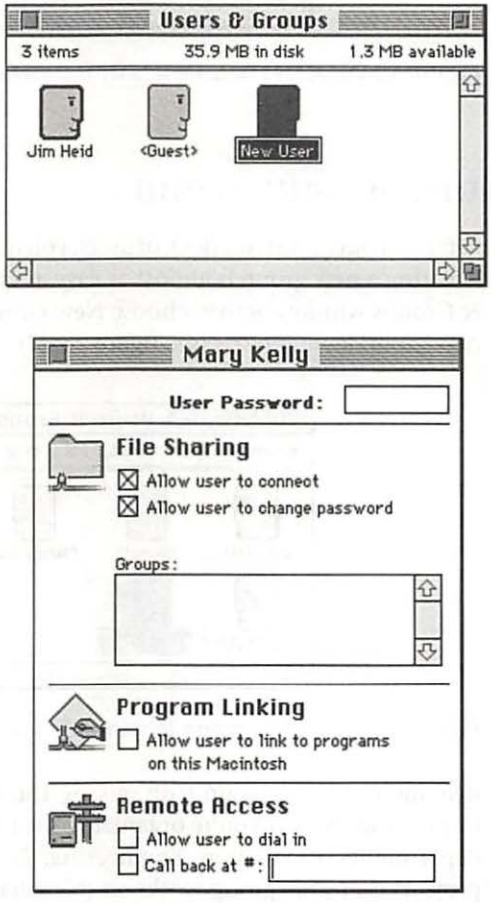


Figure 13.25: Creating a new user with Users & Groups. The new user's icon (top). The user window (the remote-access entries at the bottom of the window appear only if you have AppleTalk Remote Access software installed) (bottom).

Repeat the steps we just outlined for each member of your network. When renaming a New User icon, remember to use the same name that you entered in each person's Sharing Setup Control Panel. Figure 13.26 shows a Users & Groups window with numerous users.

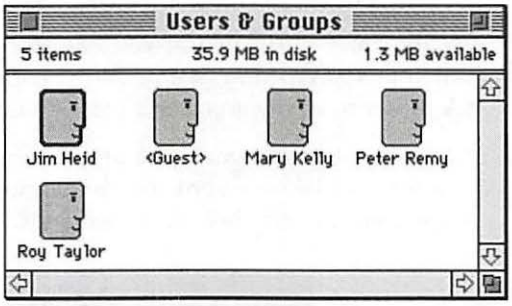


Figure 13.26: A Users & Group window with several users.

Creating a New Group

After you have created a flock of users, you may want to lump them into groups. Creating a new group is almost as easy as creating a new user. With the Users & Groups window active, choose New Group from the Finder's File menu. A new group icon appears (see figure 13.27).

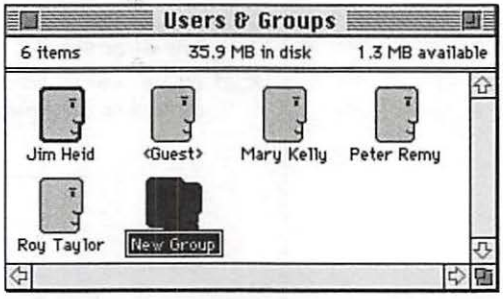


Figure 13.27. A new group icon, ready for renaming.

Rename the New Group icon, giving the new group an appropriate name. Depending on how you're organizing the network, your group names may be departments (Production, Engineering, Testing), or they may reflect certain projects that each group works on (Newsletter, Catalog, Manuals).

After creating a group, specify its members by dragging their user name icons to the group icon, as shown in figure 13.28.

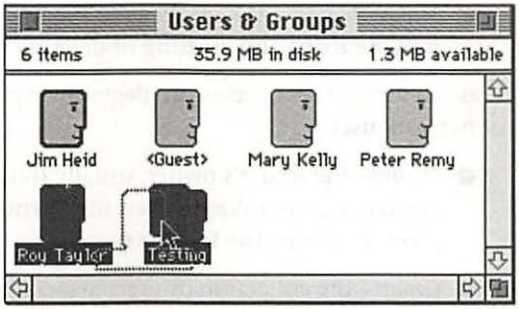


Figure 13.28: Adding a user to a group.

Keep in mind that you don't have to specify a list of registered users. If you don't, the users in your network will access the server as *guests*. A guest cannot *own* a folder—that is, he or she cannot create a folder and then specify security options for it. Guests, however, can still create folders. If your office doesn't require these security options, you may just want to operate your server in guest-only fashion.

Similarly, don't feel obligated to divide your workforce into groups. If everyone in the network performs similar tasks, you may want to create a list of registered users, but no groups. With this approach, registered users will still be able to own folders, but they will not be able to create "communal" folders that only a certain group of people can access.

This stage of server set up sounds complex, but it isn't. It simply involves determining how people work together in real life, and then implementing that working style on the server.

By the way, you can remove a user by dragging his or her user name icon to the Trash. You also can remove a group by dragging its icon to the Trash.

Setting Access Privileges

Users and groups are only half of the security picture; *access privileges* are the other half. Access privileges enable you to control who can see and alter the contents of the folders on a shared volume. Access privileges also determine the kinds of modifications a registered user or a guest can make to a given folder.

There are three categories of access privileges.

- *See Folders*—the privilege to see any folders within a given folder.
- *See Files*—the privilege to see and open documents or applications within the folder.

- *Make Changes*—the privilege to modify the folder's contents, including moving icons and creating or deleting files.

You can assign these access privileges in any combination to three categories of network user:

- *Owner*—the folder's owner, usually (but not always) the user who created a given folder. When the Owner check box is selected for a given privilege, the folder's owner has that privilege.
- *Group*—the collection of users associated with a specific folder. When Group is checked for a given privilege, members of that group have that privilege.
- *Everyone*—anyone with access to the server, including guests. When Everyone is checked for a given privilege, anyone who accesses the server, whether a registered user or a guest, has that privilege.

The owner of a particular Macintosh can set access privileges for any folder on his or her drive by selecting the folder and then choosing Sharing from the File menu. Registered users can view privileges and set privileges for their own folders by selecting a folder and then choosing Sharing. This displays the Sharing window (see figure 13.29).

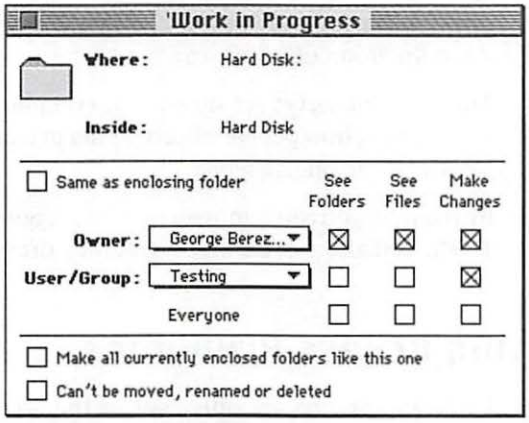


Figure 13.29: The Sharing window.

In figure 13.29, the owner of the folder—George Bereznicki—has all three access privileges. The members of the group to which George belongs, Testing, can copy files into the folder, but they cannot open the folder to see its contents. Thus, for the group members, this folder serves as an electronic drop box—network members can put files and folders into it, but only George can

retrieve them. Finally, because none of the privileges are selected in the Everyone column, anyone who is not in the Testing group cannot open the folder or copy files to it.

System 7 indicates a folder's access privileges using a variety of folder icons. Similarly, when you open a folder's directory window, access privilege icons appear in its upper-left corner.

Quick Reference to Access Privileges

Table 13.1 shows some ways you may configure access privileges for certain types of projects or tasks.

Table 13.1: Some typical access privilege settings.

To do this		Set privileges like this		
Give everyone on the network all access privileges	Owner	•	•	•
	User/Group	•	•	•
	Everyone	•	•	•
Share a folder with one person or group	Owner	•	•	•
	User/Group	•	•	•
	Everyone			
Keep a folder private so that only you can access it from other machines	Owner	•	•	•
	User/Group			
	Everyone			
Keep a folder private but enable others to drop files or folders into it	Owner	•	•	•
	User/Group			•
	Everyone			•

Table 13.2 shows which access privileges you need for various tasks.

Table 13.2: Access privileges required for various tasks.

If you want to...	Set privileges like this... See Folders	See Files	Make Changes
Copy a file to a folder			•
Copy a file from a folder	•	•	
Copy a folder to a folder	•		•
Copy a folder from a folder	•		
Create a file	•	•	•
Create a folder	•		•
Delete a file		•	•
Move a folder to a folder	•		•
Move a folder from a folder	•		•
Open a file		•	
Save changes to a file		•	•

Monitoring Sharing

You can keep an eye on who's sharing your files and folders by using the File Sharing Monitor Control Panel. When you open the Control Panel, the window in figure 13.30 appears.

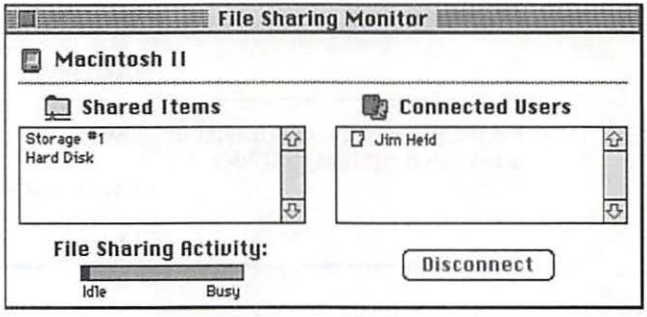


Figure 13.30: The File Sharing Monitor control panel.

You can disconnect a user by selecting his or her name and then clicking the Disconnect button. A dialog box appears in which you can specify an amount

of time before disconnection. To disconnect someone immediately, type 0 (zero) and click OK. Be sure to warn someone in advance before you disconnect him or her.

Turning Off File Sharing

If you need to turn off file sharing, first be a good network citizen and inform anyone who may be sharing your hard disk. Next, open the Sharing Setup Control Panel and, in the File Sharing area, click Stop. A dialog box appears in which you can specify an amount of time before stopping. To stop immediately, type 0 (zero) and click OK.

When you specify a value other than zero, a dialog box appears on the screens of users who are sharing your hard disk (see figure 13.31). This gives them a chance to save their work and drag the shared volume's icon to the Trash.

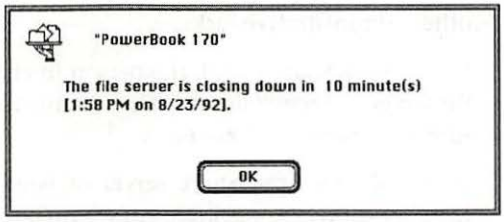


Figure 13.31: Hurry up and save.

If you pull the sharing rug out from under your co-workers before they have a chance to drag the icon to the Trash, a dialog box appears on their screens notifying them that the file server has shut down (figure 13.32).

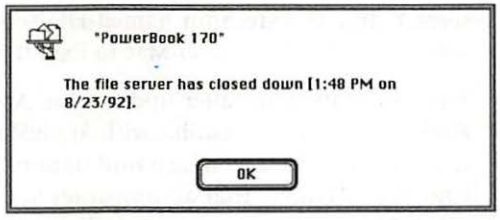


Figure 13.32: The server has shut down.



A Close Look at AppleShare

Let's leave the flexible, do-you-own-thing world of System 7 file sharing to examine the more-regimented, centralized file-serving approach of AppleShare. In this section, we show how to set aside a Mac to be a file server, and we show how you can use AppleShare's additional security options to control access to the server's contents. We will wrap up the section with some AppleShare tips and guidelines.

Installing AppleShare

Installing AppleShare is a multi-step process. First, you need to install the server software on one Macintosh, and then you need to install the workstation software on each of the others. Finally, you need to configure the server by supplying user and group names, specifying access privileges, and performing other administrative tasks.

In the AppleShare world, the person in charge of setting up and maintaining the server is the *administrator*. The administrator uses a program called AppleShare Admin to perform these tasks.

To install the AppleShare server or workstation software, you use Apple's Installer utility. AppleShare comes with one file server installation disk, one print server installation disk, and one workstation installation disk. Also in the package is an Apple II setup disk: computer labs that have LocalTalk-equipped Apple II computers can set up their Apple IIs to start up using system software located on the server.

The server disk's installer script copies to the Mac's hard disk the AppleShare Admin program, the AppleShare File Server program (which actually starts the server), and an extension named File Server Extension. After installing this software, restart the server Mac to load the extension.

The workstation installer updates the AppleShare extension in the System Folder to be fully compatible with AppleShare 3.0. Technically, you don't *have* to install this software on each workstation; you can use the standard AppleShare Chooser extension that accompanies System 7. But AppleShare 3.0 has the capability to send messages to individual users, and if you want users to see these messages, you will need to update the workstation software.

The AppleShare workstation installer also works with System 6. You must run the AppleShare server software under System 7, but System 6 users can access the server. We will look at the issues behind mixing system versions on a network later in this chapter.

Server Setup

After you have installed the server software and restarted the server Mac, you're ready to create users and groups. With AppleShare, you do this using the AppleShare Admin program. If you had previously set up users and groups on the server Mac using System 7's file sharing features, AppleShare Admin will offer to convert the users and groups into its own format. Thus, you can cut your teeth on System 7's file sharing features, and then progress to AppleShare without losing users and groups and their access privilege settings.

While you're setting up the server, you may want to take advantage of the additional security options AppleShare provides. Figure 13.33 shows the File Server Preferences dialog box, where you can specify that passwords expire after a certain amount of time, and more.

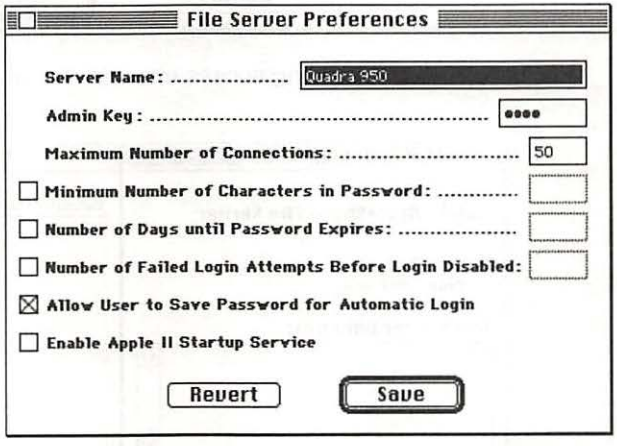


Figure 13.33: AppleShare's File Server Preferences dialog box.

Another aspect of AppleShare security involves specifying access information for individual programs and documents. Using the Access Information command, you can specify that documents and programs be copy protected so that users cannot copy them from the server to their machines. You can specify that only certain folders—not the entire hard disk—be available to others on the network. You also can specify the maximum number of users that can access a given program or document (see figure 13.34).

After you set up your server and create or update your user and group lists, you're ready to put the server into action by running the AppleShare File Server program. When you do, the windows shown in figure 13.35 appear. The server is up and running.

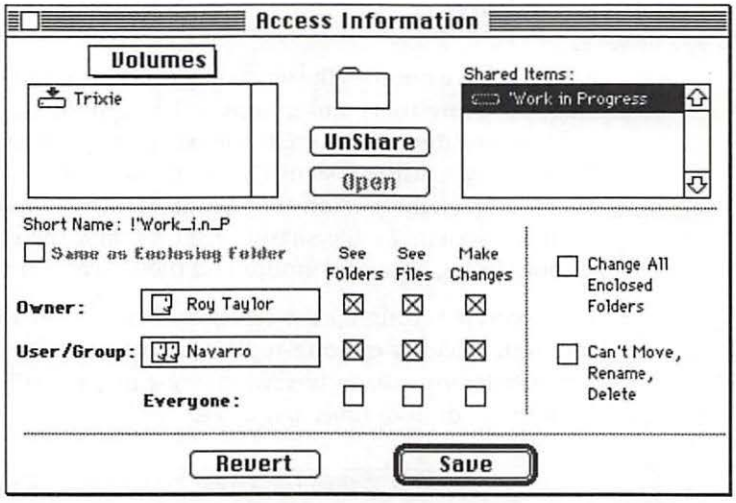


Figure 13.34: Specifying access information with AppleShare Admin.

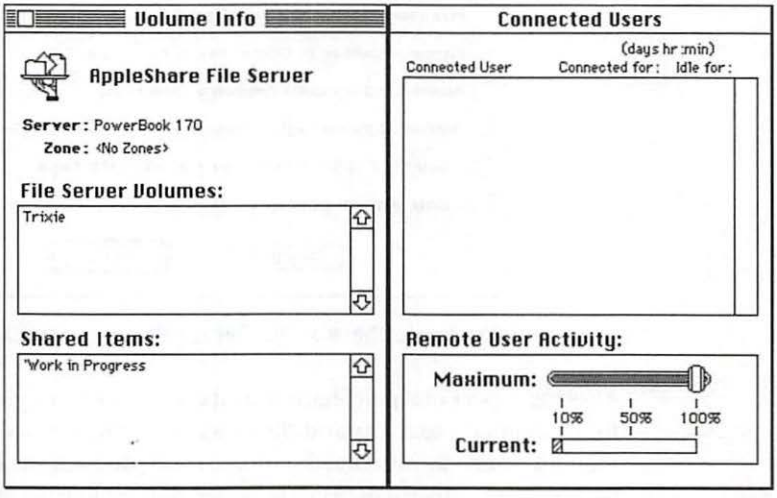


Figure 13.35: The AppleShare server windows.

Accessing the Server

As with System 7's file sharing, you access the file server using the Chooser Desk Accessory. First, select the AppleShare icon to display a list of file servers. Next, select the file server you want by double-clicking it. Finally, select the server volume (or volumes) you want to mount, click OK, and the volume appears on the Desktop.

AppleShare Tips

We conclude our look at AppleShare with a few tips.

Back up your Users & Groups Data File. AppleShare's Admin utility creates a file called Users & Groups Data File that stores the user and group names you have created. When you alter your user and group settings, you should make a backup copy of the Users & Groups Data File. If you switch hard drives or if something happens to your old file server, you can copy the backup file to your new server and be spared the chore of recreating all your user and group names. To back up the Users & Groups Data File, open the server's System Folder and then open the Preferences folder. Drag the Users & Groups Data File to a floppy disk. Keep your backup in a safe place—preferably in the same safe place you use to store your server backups.

Fine-tuning the server. If your server's hard disk was used as a local disk drive before you turned the Mac into a server, consider using a defragmentation utility to defragment its contents as described in Chapter 9. You will get better performance if the server's files are contiguous.

Choose backup software carefully. We have already stressed the importance of backing up a server's contents. When choosing backup software for this important task, be sure the software you buy retains AppleShare's access privileges information. Otherwise, you will need to respecify all access privileges when you restore the server's contents. Two backup programs that retain access privilege information are Dantz Development's Retrospect and the Norton Backup program that accompanies Symantec's Norton Utilities for the Macintosh.

Combining AppleShare and System 7 file sharing. AppleShare and System 7 file sharing can coexist on the same network—to an extent. You cannot start System 7 file sharing on the server Mac; if you open the Sharing Setup Control Panel, you will notice the File Sharing area is gone. The only way to share folders on the server Mac is through AppleShare. The server Mac can, however, access shared folders that other Macs have made available.



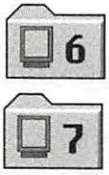
File Serving and Removable Media

Both AppleShare and System 7's file sharing software enable you to share removable media, such as SyQuest and Bernoulli cartridges and CD-ROMs. (Neither enables you to share a floppy disk.) With AppleShare, you use the AppleShare Admin program to mount and unmount removable media and make it available to the network.

Sharing removable media through System 7's file sharing software is a bit trickier. You need to insert the cartridge or CD-ROM *before* using the Sharing Setup Control Panel to turn file sharing on. If you turn file sharing on, insert a cartridge or CD-ROM, and then choose Sharing, you will see an error message saying that `not all volumes are available for file sharing`. That's System 7's less-than-clear way of saying that you inserted the cartridge *after* turning on file sharing. The solution: turn off file sharing, insert the cartridge, and *then* turn file sharing on.

You will run into a similar snag if you need to eject a cartridge after sharing it. If you drag the cartridge's icon to the Trash (or select the icon and choose Put Away), an error message appears saying that the disk `could not be put away because it is being shared`. Interestingly, this message appears even if you never used the Sharing command to make that cartridge available. Again, the solution is to turn off file sharing.

You can avoid both of these quirks by remembering this rule: To share a cartridge, insert the cartridge before turning file sharing on. To eject that cartridge, first turn file sharing off.



Mixing System Versions on a Network

Earlier in this chapter we said that networks thrive on homogeniety, and that you shouldn't mix system versions on a network. Actually, you *can* mix system versions—to a degree. A Mac running System 6 can access an AppleShare file server as well as a disk or folder that has been made available through System 7's Sharing command.

If your network contains a PostScript printer, however, all Macs should use the same version of the LaserWriter driver. Install the System 7 versions of the LaserWriter and LaserPrep files on each Mac that's running System 6.

If you mix System 6 and System 7 LaserWriter drivers on the same network, you will encounter what's often described as "LaserPrep wars"—a conflict between the two drivers. The result of the conflict is an error message saying that you need to restart the printer. To avoid the dueling drivers, standardize on the System 7 versions of LaserWriter and LaserPrep.



Network Miscellany

We wrap up our introduction to Mac networking by looking at using a modular Mac as an AppleShare server, how to share a modem and other hardware on a network, and choosing software to run on your network.

The Modular Mac Server

If you use a modular Mac—a member of the LC, II, or Quadra families or a Performa 600—as a dedicated server, you can cut the cost of your server by several hundred dollars or more by not buying a monitor or keyboard for that Mac. To set up what is sometimes called a *headless server*, use the monitor and keyboard from a different Mac in your office. Place the AppleShare File Server icon (or an alias of it) in the Startup Items Folder. Then, shut down the server Mac, disconnect the monitor and keyboard (remove the video card, too, if applicable), and then start the server up again.

Unlike earlier versions, AppleShare 3.0 enables you to run the AppleShare Admin program from another Mac on your network, so you will not have to reinstall the video hardware and keyboard to perform minor maintenance on the server. If you want to run the Admin program or perform any other work using the server itself, you will need to reinstall the video hardware and keyboard.

Remote Control with Timbuktu

To avoid the chore of having to set up video hardware—or if you don't have another Mac II whose video hardware and keyboard you can steal for a while—consider using Farallon Computing's *Timbuktu* software that enables you to control one Mac from a different Mac. Equip the server and another Mac on your network with Timbuktu, and you can run the AppleShare Admin utility from the other Mac.

Timbuktu has other benefits. You can use it for training: take over everyone's screens and show them how to copy files, set access privileges, or zap aliens. You also can use it to troubleshoot a problem without having to stroll over to someone else's Mac. Microcom's *Carbon Copy/Mac* is another remote-control package.

Sharing a Modem on a Network

If more than one person on your network uses communications services, such as MCI Mail or CompuServe, you can eliminate buying multiple modems (and paying for multiple phone lines) by using a network modem, such as Shiva Corporation's *NetModem*. You attach the NetModem to your LocalTalk network, and then run an installation program on each Mac that needs access to the modem. After installing the NetModem software, the Mac can access the modem as if it were attached directly. The NetModem even uses the Mac's speaker to recreate the scratchy, squealing sounds that modems make when

connecting. The NetModem V.32 is a 9600-baud modem and it responds to industry-standard Hayes modem commands, so you can use it with virtually all communications software.



Remote Access

By equipping your network for *remote access,* traveling employees or freelancers scattered across the country can exchange files and messages with people who normally sit next to them. A remote Macintosh connected to your network through a telephone modem can do everything that a local Mac can—send and receive electronic mail, access a file server, and even print documents on a PostScript printer. If you think it's a small world now, wait until you start copying files to a hard disk located thousands of miles away—as though it was connected directly to your Mac.

In this section, we spotlight some remote access products and provide some tips for computing by remote control.

AppleTalk Remote Access

Apple's *AppleTalk Remote Access* is a software package that enables a remote Macintosh to connect to another Macintosh that's also running AppleTalk Remote Access. When connected, the remote Mac can access all the network services available to the networked Mac, including printers, file servers, and electronic mail systems (see figure 13.36).

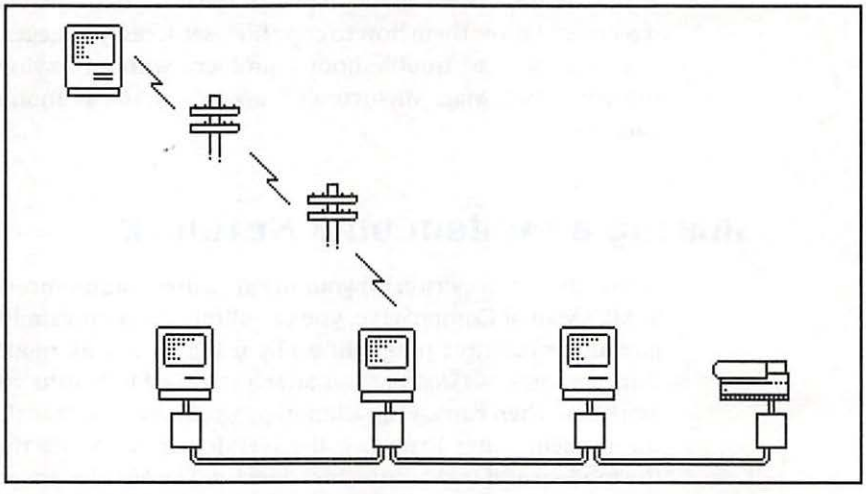


Figure 13.36: AppleTalk Remote Access lets a remote Macintosh access the files and network services of another Macintosh.

To use AppleTalk Remote Access, you need two modems: one connected to the office-based Macintosh and one connected to the remote Macintosh. AppleTalk Remote Access works with 2400-baud modems, but you will get much more satisfying performance if you use 9600-baud modems on both ends. (If you're not familiar with modem terminology, see the section "About Modems" in Chapter 16.)

You can use one copy of the AppleTalk Remote Access software on up to three Macintoshes. If you need remote access on more than three Macs, you will need to buy additional copies of AppleTalk Remote Access.

Setting Up to Accept Calls

After installing the AppleTalk Remote Access software on one of your office-based Macs, you need to configure it to accept calls. Open the Remote Access Setup Control Panel and check its Answer Calls box. As figure 13.37 shows, you also can specify whether you want to grant remote access to only the Mac that's running AppleTalk Remote Access, or to the entire network that the Mac is attached to. The second option provides more security by preventing access to other machines on your network.

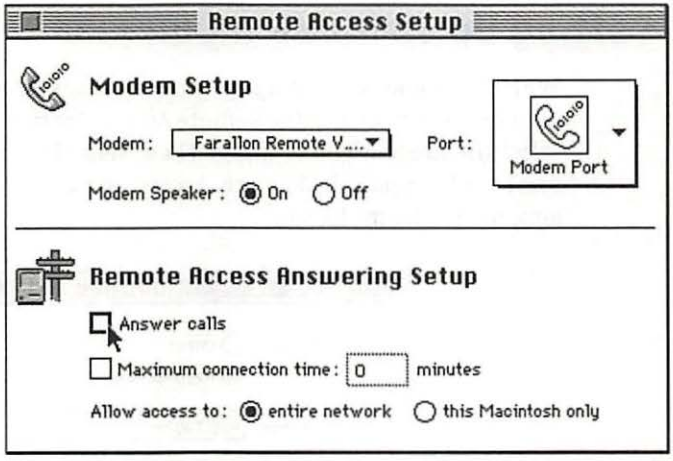


Figure 13.37: Setting up AppleTalk Remote Access to answer calls.

AppleTalk Remote Access enables you to use the standard System 7 Users & Groups Control Panel to create lists of users and groups who are eligible to access the network from a remote location. For added security, you can specify a *call-back number* for each user (see figure 13.38). When a user for whom you have specified a call-back number dials in, your modem temporarily disconnects the user and then immediately dials the call-back number to reestablish the connection.

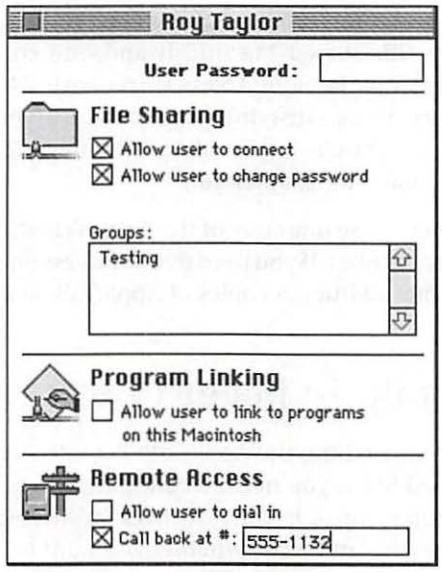


Figure 13.38: Specifying a call-back number in the Users & Groups Control Panel.

Setting Up to Make a Call

With the home base set up to receive calls, you're ready to connect from a remote Macintosh. Use the Remote Access Control Panel on the remote Mac to select the modem you're using. Then, start the Remote Access program that came with AppleTalk Remote Access. A new, untitled *connection document* appears (see figure 13.39).

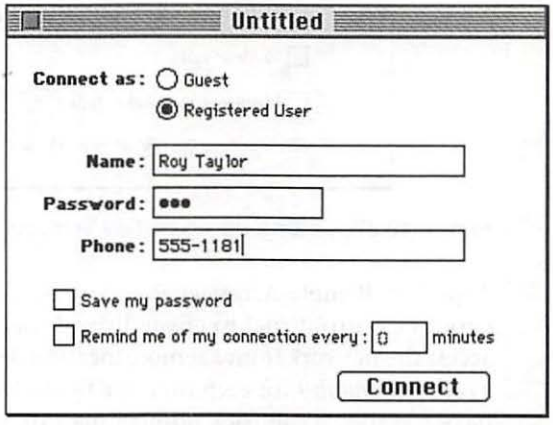


Figure 13.39: Preparing an untitled connection document using AppleTalk Remote Access.

Select the Guest or Registered User option as appropriate. If you're connecting as a registered user, type your user name and password in the appropriate text boxes, and then type the phone number for the home base's modem. To make the connection, click Connect. Your modem dials, and when a connection is made, the status window in figure 13.40 appears.

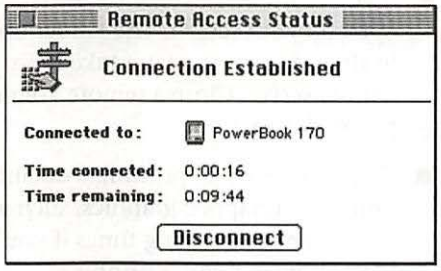


Figure 13.40: AppleTalk Remote Access status window.

Using Remote Network Services

With a connection established, you can use the Mac's Chooser Desk Accessory to select remote printers, file servers, and electronic mail systems. Everything works as though you're connected to a local network, except that the remote network responds slowly, even if you're connected at 9600 bps. File server directory windows take longer to open and documents take longer to print.

Remote Access Tips

Slow-motion networking is one of the drawbacks of remote access computing. Here are some tips for minimizing waiting time and getting more out of remote access connections.

- Don't run an application program stored on a remote file server. It will start slowly and run slowly. If you try, you will see the dialog box in figure 13.41.

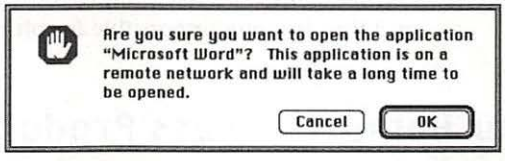


Figure 13.41: Think twice before running a remote application program.

If you need to run a program stored on a remote server, consider copying the program to your local hard disk and then running it. This may not work with complex programs that rely on a battery of support files that may be scattered throughout the remote server's hard disk. (Microsoft Word relies on files located in the Word folder as well as in the System Folder, for example.)

- If you're using a remote file server, don't leave its directory windows open on your screen. The Finder updates directory windows from time to time, and the updates take more time when you're connected to a remote server. Close a remote volume's directory window as soon as you're done with it.
- Think twice about printing a document containing downloadable fonts or bitmapped graphics, such as scanned images. You will get the fastest remote printing times if you stick with fonts that are built into the remote network's printer.
- If you will be exchanging electronic mail with the remote system, prepare your outgoing messages before connecting.
- As soon as you're done with a remote volume, drag its icon to the Trash. Note that this does not disconnect you from the remote Macintosh.
- Use the connection-reminder option in the remote access connection document window (it's labeled *Remind me of my connection*). When you choose this option, a notice appears at specified intervals reminding you that you're connected to a remote machine. This way, you will not forget that you're connected—and racking up phone charges all the while.
- If you will be copying files to a remote server, consider compressing them first using a utility, such as Aladdin's *StuffIt*, Salient's *DiskDoubler*, or Bill Goodman's shareware *Compact Pro*. If you compress the files first, they will take less time to transfer over the phone lines.
- You can use the call-back option to reverse the phone charges on lengthy remote access sessions. You will need to make a brief call to establish initial contact, but then the remote system will call you back, and thus become responsible for phone charges.

Other Remote Access Products

Another way to establish remote access connections is by equipping one of your office-based Macs with a *Shiva NetModem*. The NetModem includes software that enables you to dial into the network from a remote Macintosh. Shiva also

sells a DOS program called *DOS Dial-In* that enables DOS machines to dial into a LocalTalk network. DOS Dial-In could be of special interest to people who use DOS portable computers and want to exchange documents and e-mail with remote networks.

To operate a distant Mac by remote control, there's Farallon Computing's *Timbuktu/Remote*. Timbuktu/Remote is similar to the Timbuktu software we mentioned earlier, except that it operates over modem connections. It works, but you need a 9600-bps modem—and some patience—to get acceptable results.



Other Hardware You Can Share

We already mentioned that you can buy network modems to cut down on communications hardware costs. You also can share an Apple StyleWriter inkjet printer on a network by using a program called *Shadow Writer*, from Gizmo Technologies. A StyleWriter is no speed demon, so you wouldn't want to build a network print station around it. Still, if you have two or more Macs that occasionally need StyleWriter output, ShadowWriter is an inexpensive way to avoid having to juggle cables. ShadowWriter 2.0 and later versions also can share other serial devices, such as plotters and ImageWriter printers, that do not have a LocalTalk card installed. ShadowWriter also supports SCSI laser printers, such as Apple's LaserWriter IISC and Personal LaserWriter SC.

Shiva's *NetSerial* is a hardware add-on that enables you to share nearly any serial device—pen plotter, daisy wheel printer, a conventional modem—on a network.



Network Software Issues

It's likely that you will be storing application programs—word processors, publishing programs, data managers, and so on—on your network's file server, where everyone will be able to access them. Some users may run applications directly from the file server (although as mentioned earlier, performance will always be better if programs are stored and run from a local hard disk), while others may use the server as a library, electronically signing out applications by copying them to their local hard disks. Storing and running programs on a server introduce technical and legal issues you may need to consider when shopping for software.

From the technical standpoint, you need to determine whether the software is designed to operate from a shared volume. If it is, then several people can run the same program simultaneously. If it isn't, then only one person can run the program.

Two things can prevent a program from working properly in a shared setting:

- Saving information, such as your working preferences, in its own resource or data fork as it operates.
- Creating temporary work files that always have specific names.

A program that does either of these things is likely to cause unexpected results or crash completely if two people try to run it at the same time. Apple has published recommendations for developers to enable them to create software that operates in a shared environment. One such recommendation is that a program store working preferences in a separate file located in the startup disk's Preferences folder (within the System Folder), not in the folder where the program is stored. Programs that follow these guidelines are often described as being *AppleShare-aware.*

Another factor you should consider when shopping for network software is whether you're legally permitted to use a program on more than one machine at a time. Every software developer has a license agreement whose terms you accept when you open the disk package. Generally, these license agreements state that you're allowed to run the program on only one machine at a time. In order to run the software on several machines simultaneously, you will need a special licensing agreement, often called a *site license.* When you purchase a site license, you also can purchase additional copies of a program's documentation for each user.

CHAPTER

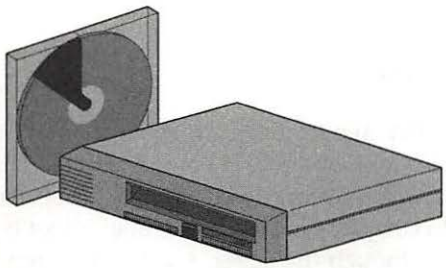
14

EXCHANGING FILES WITH DOS COMPUTERS

WHAT'S INSIDE

- Strategies for moving files between Macs and PCs
- File format issues behind Mac-PC data exchange
- How to add a PC to a LocalTalk network
- The fully windowed office: choosing Mac and Windows programs
- Running PC software on a Mac

You have seen how to exchange data between Mac programs. In this chapter, we look at what's involved in exchanging files between Macs and DOS PCs. We also show how to add a PC to a LocalTalk network so that it can access a file server and share a PostScript printer. Finally, we describe some programs that are available for both the Macintosh and Microsoft Windows and that share similar operating styles and file formats.





Transferring Files

Exchanging files between Macs and DOS machines involves many of the same file-format considerations we discussed in the previous chapter, with an extra wrinkle thrown in: moving the files from one computer to the other. In this section, we spotlight four techniques for moving files from a Mac to a PC, or from a PC to a Mac:

- A SuperDrive. You may already have all the file-transfer hardware you need. Almost all Macs made after August 1989 are equipped with a SuperDrive floppy drive that can read and write to 3-1/2-inch DOS disks. You also can attach an external DOS-compatible floppy drive to the Mac, or a Macintosh disk drive to the PC. With this approach, you can directly access disks formatted for the other computer. It's a convenient approach for occasional file sharing—provided that you work with files that fit on floppy disks.
- If the computers are close to each other, you can connect them using a cable, and then use communications programs on both computers to transfer the files.
- If both computers have telephone modems, you can transfer files over the phone lines. You can transfer the files directly between the two computers, or you can use a communications service, such as America Online, as an intermediary.
- You can connect the two computers to a network to enable them to share not only disk files, but also expensive peripherals, such as hard disks and laser printers.

Disk Drive Transfers

In some ways, attaching a PC drive to the Mac or a Mac drive to the PC is the easiest file-transfer approach because you don't have to contend with communications or networking concepts. Equip a Mac to read DOS disks, and you can access PC files using the same basic techniques you use to access Mac files.

The Apple SuperDrive

Almost all Macs made after August 1989 are equipped with a SuperDrive. (Exceptions include the PowerBook 100 and PowerBook Duo series—an external floppy is available—and some Macintosh LC models that were sold only to schools. As mentioned in Chapter 4, a SuperDrive upgrade kit is also available for the original Mac II.) Although the larger, 5 1/4-inch floppy disks are still

popular in the DOS world, most of today's DOS machines are equipped with 3-1/2-inch drives.

You cannot simply insert the PC disk in a SuperDrive drive and view its contents using the Finder. If you try, you will see the familiar `This disk is unreadable do you want to initialize it?` message.

Apple File Exchange

One way to access 3-1/2-inch PC disks with a SuperDrive is to use the *Apple File Exchange* program, included with the Mac's system software. Start Apple File Exchange, and then insert the DOS disk.

Apple File Exchange uses separate files called *translators* to convert data between different file formats. Translators tell Apple File Exchange how data is organized in a specific file format. Apple File Exchange includes only one translator—one that converts between DCA-format and MacWrite documents. Some programs, however, include translators for their own files; libraries of Apple File Exchange translators are available from DataViz and other firms. By adding translators, you can extend Apple File Exchange's file-translation talents. Apple File Exchange translators also work with programs that support the XTND file-translation technology that we examined in Chapter 12.

Apple PC Exchange

Apple File Exchange works, but it can be awkward. Wouldn't it be more convenient if you could simply insert a DOS disk and work with it using the Finder?

With Apple's PC Exchange software, you can. PC Exchange is an extension for System 7 that enables DOS disks to appear on the Macintosh desktop. You can use the Finder to copy files to and from DOS disks, and you access DOS disks using an application's Open or Save dialog box (see figure 14.1). DOS subdirectories even appear as Macintosh folders.

PC Exchange also enables you to format 720K or 1.4MB DOS disks using the Finder's Erase Disk command. As figure 14.2 shows, PC Exchange modifies the Erase Disk dialog box to include the DOS formatting options.

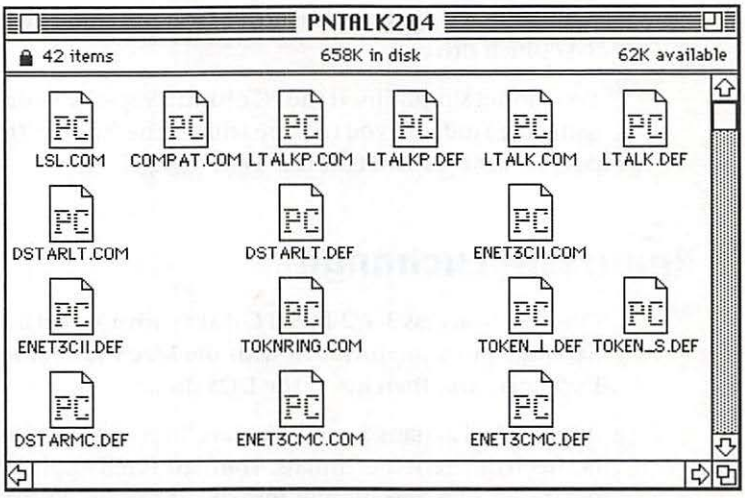


Figure 14.1: Accessing a DOS disk using Apple PC Exchange.

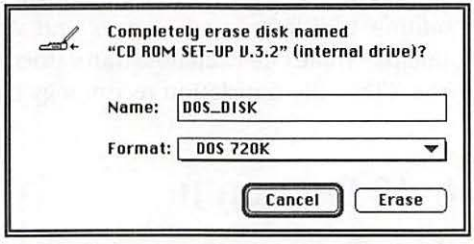


Figure 14.2: Choosing a disk format with PC Exchange.

We will look at PC Exchange again later in this chapter.

DaynaFile II and DOS Mounter

Dayna Communications' *DaynaFile II* is an external DOS floppy drive for the Mac. DaynaFile II is available with one 5 1/4-inch 360K drive, one 5 1/4-inch high-density drive, or one 3 1/2-inch high-density drive.

The DaynaFile connects to the Mac's SCSI port and includes *DOS Mounter*, an extension that, like Apple's PC Exchange, enables you to view and work with DOS disks using the Finder. DOS Mounter is also available separately and supports other removable media, including Iomega Bernoulli cartridges and SyQuest cartridges. If you use these with your Macs and PCs, you can use DOS Mounter to swap cartridges.

A DaynaFile II costs several hundred dollars. For less money, you can equip a PC with a LocalTalk expansion board and software that will allow it and a Mac

to share a hard disk. You will need to contend with the complexities of setting up and maintaining a network, but as you see later in this chapter, the benefits may make the extra effort worthwhile.

Kennect Rapport and Drive 2.4

Kennect Technology offers two products of interest to Mac-and-PC file swappers. *Rapport* is an adaptor that attaches between the Mac's external floppy drive connector and an external floppy drive and enables the drive to read from (but not write to) 3 1/2-inch MS-DOS floppy disks.

If you want to write to MS-DOS disks, connect the Rapport to Kennect's Drive 2.4, a high-density external floppy disk drive. By combining Rapport with Drive 2.4, your Mac can read to and from DOS, Mac, and Apple II disks. The Drive 2.4 supports 1.44MB MS-DOS and Mac formats, and includes special software that enables you to format high-density Mac disks to store 2.4MB.

Copy II Deluxe Option Board

So far, we discussed hardware that enables a Mac to read DOS disks. Central Point Software's *Copy II Deluxe Option Board* takes the opposite approach: it allows DOS computers equipped with 3 1/2-inch disk drives to read and write Macintosh disks. The board includes software that enables you to format Macintosh disks and copy files to and from them.

MicroSolutions MatchMaker

Here's another product that approaches file-swapping from the PC's perspective. MicroSolutions Computer Products' *MatchMaker* is an expansion board that plugs into an IBM PC and enables you to attach an external 800K Macintosh floppy drive to the PC. MatchMaker includes software that enables you to format Mac disks on the PC, copy files to and from them, delete files, and read text-only files.

The Cable Transfer Approach

If you need to transfer more files than will fit on a floppy disk—or if your PC has 5-1/4-inch drives and you don't want to buy a DaynaFile II—you may want to connect your Mac and PC directly using a cable and then use communications software to transfer files.

If you choose this approach, you have two options. You can make or buy a cable and use general-purpose communications software to transfer the files, or buy a cable-and-software product designed specifically for swapping files between Macs and PCs. Let's look at some products in the latter category first.

LapLink Mac

Traveling Software's *LapLink Mac* includes a cable as well as software for both the PC and the Mac. You can control the transfer of files using the Mac or the PC; a split-screen display shows the files on each side. You also can transfer files over telephone modems.

You also can use LapLink Mac to transfer files between Macs using the included cable, via modem, or over a LocalTalk network. LapLink Mac also supports SCSI cable transfers between Macs—handy for PowerBooks that don't support the SCSI disk mode.

LapLink Mac also includes a file-translator utility that can convert between MacWrite, Microsoft Word (Mac), and WordPerfect (Mac) formats and numerous PC formats, including Microsoft Word, Q&A Write, MultiMate, IBM DisplayWrite, XyWrite III Plus, WordStar, and WordPerfect.

The MacLink Series

DataViz's *MacLink Plus/PC* is the latest version of the pioneering MacLink, one of the first file-transfer products available for the Mac. Like LapLink Mac, MacLink Plus/PC includes Mac and PC software that work together to transfer files. MacLink Plus/PC includes more file translation features than does LapLink Mac, however.

If you use the Apple File Exchange utility or application programs that support the XTND file-translation technology described in the previous chapter, you may be interested in another DataViz product, MacLink Plus/Translators, a collection of translators for Apple File Exchange.

Software Bridge/Mac

Argosy Software's *Software Bridge/Mac* translates between any combination of more than 30 Macintosh and DOS word processing formats. Software Bridge/Mac provides a unique click-and-launch feature that enables you to translate and open DOS documents simply by double-clicking. Software Bridge/Mac identifies the file, translates it, and then opens your word processing program and the file. Software Bridge/Mac also can translate between Macintosh

formats, from Macintosh to DOS, or DOS to Mac. The program includes an extension that, like Apple's PC Exchange, gives you Finder access to DOS disks inserted in a SuperDrive.

The Do-It-Yourself Approach

If you have communications programs for your Mac and PC, you can make or buy a cable to connect both computers and then use the communications programs to transfer files. If you already have the communications software, this approach is the least expensive. But it's trickier than simply using a product like LapLink Mac or MacLink Plus.

To connect the two computers, you need a *null-modem* cable, a cable whose wiring tricks both computers into thinking that they're connected by a telephone modem. If you have an ImageWriter I, you're in luck—its cable happens to work as a null modem cable for IBM computers and for many laptop machines. (You may need some adaptors to plug the cable in, however. For IBM machines, which have male serial connectors, you will need a *gender changer*. For PCs and PS/2s with 25-pin male connectors, use Radio Shack's part number 26-1495. You also may need an adaptor for the Macintosh end of the cable. To attach an ImageWriter I cable to a Plus or later Mac, you will need a DB-9 to DIN-8 adaptor, Apple part number M0199.) If you don't have an ImageWriter I cable, you can buy one from an Apple dealer (its part number is M0150), or you can order one from a computer supply house, such as Inmac Corporation. (See Appendix B for its address.)

If you're comfortable with a soldering iron, you also can make your own cable. Figure 14.3 shows which pins to connect.

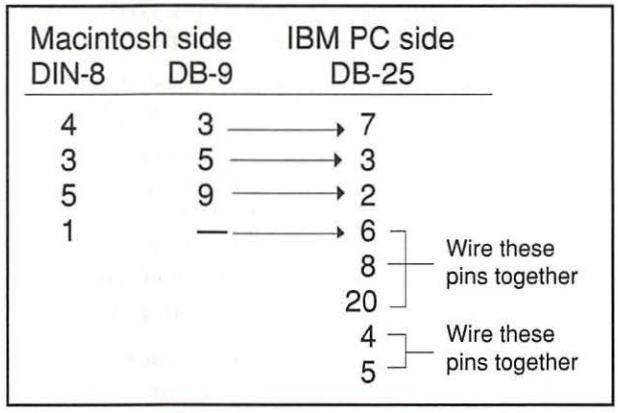


Figure 14.3: Wiring diagram for Mac/PC null modem cable.

After connecting your cable, you need to adjust both the Mac and PC communications programs to put the machines on speaking terms. Follow these steps:

1. Adjust both programs' serial communications settings to match the following: 9600 baud, 8 data bits per character, 1 stop bit, and no parity. (If you're interested in knowing what all this jargon means, see Chapter 15.) Figure 14.4 shows these settings in one popular Mac communications program, Hayes' *Smartcom II*.

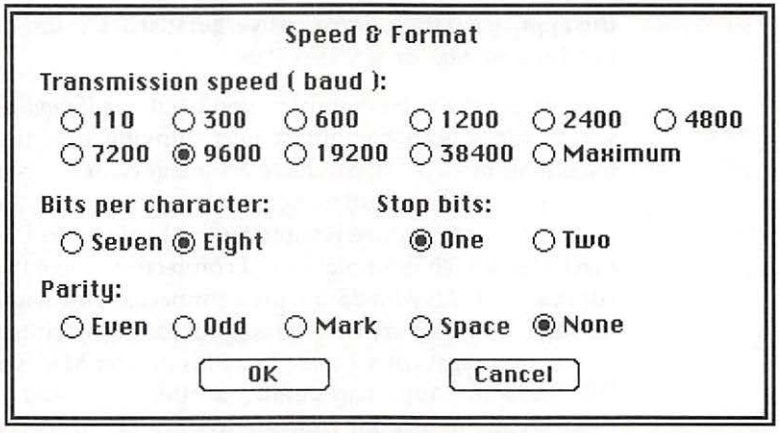


Figure 14.4: Serial communications settings in Smartcom II.

2. Some programs (including Smartcom II for the Mac) differentiate between a direct connection and a telephone line connection. If your programs are in this group, choose the appropriate commands to specify a direct connection. (With Hayes' Smartcom II, choose Direct Connect from the Connection menu.)

3. So that you can transfer files reliably, be sure both programs are configured to use the same *file-transfer protocol*. (A file-transfer protocol causes the two programs to proofread the data as it's being transferred to ensure that nothing is garbled.) The most widely supported transfer protocol is called *XMODEM*. Configure both programs to use the XMODEM protocol. If both programs support other protocols, such as *YMODEM* or *Kermit*, feel free to use them instead of XMODEM. The important thing is that both programs use the same protocol.

4. Be sure your Mac's communications program is configured to *not* use the *MacBinary* transfer option. This option enables the program to transfer Mac-specific file information, such as a file's icon. It also allows for the transfer of the file's resource fork and data fork. MS-DOS cannot use this extra information, so you don't want to transfer it.

5. On both sides, turn on the program's *local echo* option. This enables you to see what you're typing. The local echo option is usually within the program's terminal-adjustment settings.

After adjusting both programs' settings, try typing a few characters on both machines. If all is well, you will see them appear on the other computer's screen. If you don't, look everything over for problems, starting with the communications settings, and ending with the cable itself.

If you do see the characters you type on both machines, you're ready to transfer a file. Here's how:

1. On the receiving end, choose the command that will begin receiving a file using the XMODEM protocol.
2. On the transmitting end, choose the command that transmits a file using the XMODEM protocol.
3. During the transfer, each program displays status messages indicating how much data it has transmitted or received.

As you can see, the do-it-yourself approach requires more effort than using a product, such as MacLink Plus or LapLink Mac. Another drawback is that you don't have the benefits of those programs' file-conversion features. You must rely on the conversion features of the applications you use, or on a translation utility.

A Word About Mac-to-Mac Transfers

Although we're discussing Mac-and-PC file swapping here, most of the instructions in the previous section also apply to Mac-to-Mac file transfers. Following are the only exceptions:

- You need a different cable. Figure 14.5 contains a diagram for a Mac-to-Mac null modem cable.
- For Mac-to-Mac transfers, activate both programs' MacBinary file-transfer option. This will enable the programs to transfer all components of the files.



The Modem Approach

If the Mac and PC (or another Mac) aren't close to each other, you can still transfer files between them, provided that both computers are equipped with telephone modems. There are two ways to transfer files using modems: directly or through an online service.

Macintosh DIN-8	Macintosh DB-9		Macintosh DIN-8	Macintosh DB-9
4*	3	→	4	3
6	4	→	8	8
3*	5	→	5	9
8	8	→	6	4
5*	9	→	3	5
1	—	→	2	—
2	—	→	1	—

*If you use software handshaking and short cable lengths, you need connect only these three pins.

Figure 14.5: Diagram for a Mac-to-Mac null modem cable.

Direct-Modem Transfers

A direct-modem transfer is similar to the direct-cable transfer described in the previous section, except for the following differences:

- Rather than using a direct cable connection, both computers use a telephone modem and the phone lines to communicate.
- The sending computer must dial the receiving computer; therefore, you must configure the sending computer's program to dial the phone (usually by choosing a Dial command and then specifying the other modem's phone number), and the receiving computer's program to answer (generally, by choosing an Auto Answer command).
- Unless you have a state-of-the-art modem, you will have to use a transmission speed slower than 9600 baud; most modems have maximum speeds of 1200 or 2400 baud.

These differences aside, the steps are similar to those described in the previous section. After the receiving computer has answered the phone, the modems establish a connection and each user sees a message, such as *CONNECT 1200* on his or her screen. After that, you and your colleague should exchange brief typed messages to ensure that the connection is reliable and that both programs' communications settings match. If you both have a spare phone line, you may want to be talking to each other while the two computers converse. This will make it easier to troubleshoot problems because you will not need to break the computers' connection to call each other and ask, "What went wrong that time?"

Using a Communications Service

Transferring files using the direct-modem approach has some drawbacks: both computers must be on at the same time, and someone must be at each machine to choose the appropriate transfer commands and verify that the files transferred successfully. These drawbacks are especially significant if the two computers are located in different time zones. You may be ready to transmit a file at 9:00 a.m. in Boston, but your colleague in San Francisco may not feel like going into the office at 6:00 a.m. to receive it.

The solution is to use a communications service, such as *America Online*, as an intermediary. You transmit the file to your colleague's electronic mailbox on the communications service, and he or she retrieves it at a convenient time.



Using Transferred Files

We have seen how to move files from a Mac to a PC or a PC to a Mac; now let's look at the file format issues that surface after you transfer the files.

File Formats Revisited

As you may recall from Chapter 12, you can use three types of files when transferring data between Mac programs: *native* files, *interchange* files, and *text-only* (*ASCII*) files. These same three levels apply to Mac-and-PC file swapping.

Native Files

Following is a sampling of Mac-and-PC file exchange applications with which you can use native files.

Between word processing programs. Word processing programs that are available for both the Mac and PC generally can read each other's native formats. Microsoft Word 5 can read documents created by its PC cousins, Word 5 and Word for Windows, and it can save documents in DOS Word and Word for Windows formats. Word 5 for the Mac also can open documents created by Windows Write, the simple word processing program included with Microsoft Windows. Similarly, WordPerfect for the Macintosh can read and write documents created by WordPerfect on the PC.

Between Aldus PageMaker versions. The Mac and Microsoft Windows versions of Aldus PageMaker can access each other's documents easily.

After you transfer a Mac PageMaker document to the PC, rename the document so that it ends with the *file extension* .PM4. (In the DOS world, a file extension is that part of a file name that appears after a period character. MS-DOS file names can contain up to 11 characters: up to eight before the period, and up to three after it. File extensions are generally used to identify the type of file.) If the publications you're transferring contain large graphics, such as scanned images, you will need to take some special steps to transfer them. Consult your PageMaker manuals for details.

Between Aldus PageMaker and numerous word processing programs. The Mac version of PageMaker can read native files created by numerous PC word processing programs, including WordPerfect, WordStar, and XyWrite.

Between Adobe Illustrator or Aldus FreeHand versions. Adobe Illustrator and Aldus FreeHand are each available for the Mac and for Microsoft Windows; each version can open and save files created by its counterpart.

Between Microsoft Excel or Lotus 1-2-3 versions. Microsoft Excel and Lotus 1-2-3 are two popular programs that are available in both Macintosh and Microsoft Windows versions. Each program can open spreadsheets created by its counterpart; in many cases, macros are also compatible across versions.

Between different spreadsheets. Most popular Mac spreadsheet programs can open spreadsheets created by the DOS version of Lotus 1-2-3. Most Mac spreadsheets also can save worksheets in at least two 1-2-3 formats: WK1, the format used by version 2.x of 1-2-3, and WKS, the format used by 1-2-3 version 1A. (The Excel manual has details on how Excel treats 1-2-3 formulas and numeric formats.) Excel also can read and write dBASE II (DB2) and dBASE III (DB3) database files.

Between FoxBase versions managers. Microsoft's FoxBase series of database managers is available for the Mac and for PCs. Each supports the industry-standard dBASE file format. You also can run PC-based FoxBase applications on a Mac under FoxBase/Mac. By running unmodified PC dBASE applications on the Mac, you will forego the Mac's graphical user interface, but that may be a price you're willing to pay if you have a complex dBASE application that you rely on in your business.

Interchange Formats Revisited

The interchange file formats discussed in Chapter 12—DIF, RTF, EPS, TIFF, DCA, and SYLK—are widely supported in the DOS world. Many spreadsheets and database managers can create DIF and SYLK files, and most drawing and scanning programs support the EPS and TIFF formats. The DOS and Windows versions of Microsoft Word can save documents as RTF files, and the DOS version of Aldus PageMaker can import RTF files.

In addition to these formats, the DOS world has several popular file formats that are either directly supported by some Mac programs or are supported by Mac file-translation utilities. Technically speaking, some of the following formats are native formats, not interchange formats. But because they're supported by several Mac programs and by some file-translation utilities, they can serve as interchange formats.

BMP. Windows bitmap files. This bitmapped image file format can be used for monochrome or color (16, 256, or 16.8 million colors). You can generate Windows bitmap images using the Windows Paintbrush application or by taking screen snapshots in Microsoft Windows.

CGM. Short for *computer graphics metafile,* an object-oriented file format supported by several graphics applications, including Lotus Freelance Plus, Software Publishing's Harvard Graphics, and Micrografx Designer.

DRW. The object-oriented format used by Micrografx Designer.

DXF. The format used by the PC version of Autodesk's AutoCAD computer-aided design (CAD) program. Several developers of Mac CAD programs offer optional translation utilities for importing DXF files.

HPGL. Short for *Hewlett-Packard Graphics Language,* HPGL files contain commands that control a plotter or printer that uses HPGL. Many graphics and drafting programs can create HPGL files, and many file-translation utilities support HPGL. HPGL files often have the extension .PLT.

Lotus PIC. The format in which Lotus 1-2-3 and Symphony save charts.

PCX. This is the native file format for Zsoft's PC Paintbrush, PC Paintbrush IV Plus, and Publisher's Paintbrush. Many PC programs (including Windows Paintbrush) can use PCX files.

WKS, WK1. As mentioned earlier, two formats used by Lotus 1-2-3.

WMF. Short for *Windows metafile,* this is the Windows equivalent to the Macintosh PICT format. WMF files can store bitmaps or object-oriented graphics.

Using Transferred Text-Only Files

When you're crossing the PC-Mac barrier, text-only files can cause as many data-exchange headaches as formatted documents. The main problem occurs with lines that end with a hard carriage return, such as the last line of each paragraph in a word processing document. The PC signifies a hard return with two codes—a carriage-return code and a line-feed code. (When creating text-only files, some PC word processing programs also put a carriage return code at the end of every line.)

The Mac, however, doesn't need a line-feed code; it requires only a carriage-return code to signify a hard carriage return. Thus, when you open a PC text-only file using a Mac word processing program, you will see a hollow box at the beginning of each line that follows a hard carriage return (see figure 14.6). (On the Mac, a hollow box signifies an *unknown character*—one that isn't part of the Mac's built-in set of characters.)

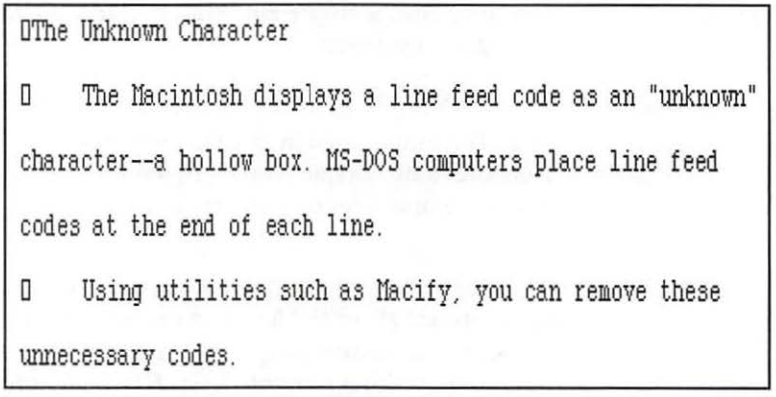


Figure 14.6: The Mac displays a line feed code as an unknown character.

The hard way around this problem is to use a Mac word processing program to edit the transferred text file, removing the line feed codes by hand. The easy way is to use a file-translation utility. Apple File Exchange is ideal for fixing PC text-only files; use its MS-DOS to Mac option and choose the check box labeled *Replace CR/LF with just CR* (see figure 14.7).

Another useful utility for massaging text files is Eric Celeste's *Macify* (shareware, $10). Macify not only enables you to fix carriage return/line feed problems, it also enables you to specify that single quotes be turned into true typographer's

quotes and that double hyphens be turned into an em dash (see figure 14.8). And you can specify up to three character translations—a useful feature for turning asterisks (*) into bullets (•).

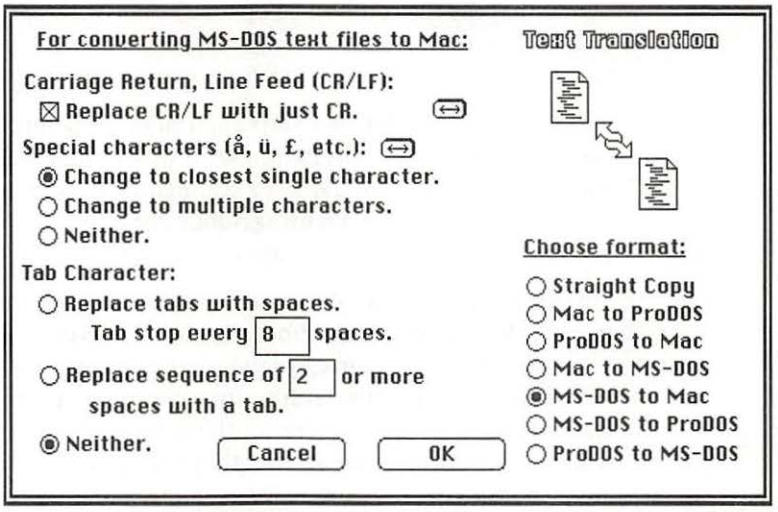


Figure 14.7: Using Apple File Exchange to remove line-feed codes.

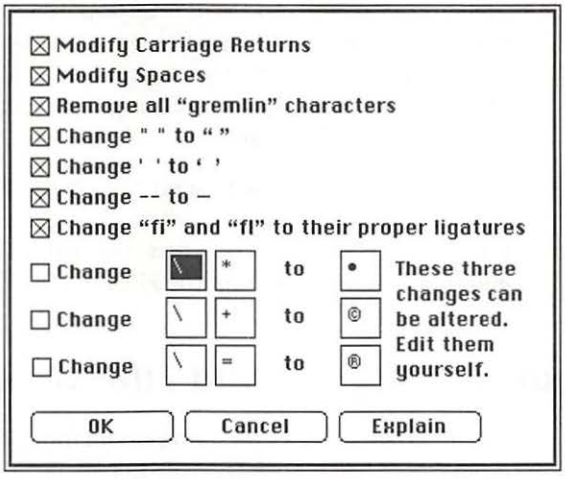


Figure 14.8: Eric Celeste's Macify utility.

A utility called *Evolutions* (by Kevin Hoctor; shareware, $10) also can fix carriage return/line feed problems.

Opening Transferred Files

When you want to open a file transferred to the Mac from a PC, you will be tempted to double-click it. If you try, you will probably receive a dialog box saying that the file couldn't be opened because the application that created it couldn't be found. This message appears because the Finder doesn't know which (if any) of your Macintosh programs can open the DOS file.

One solution is to first start your application program, and then use its Open command to open the file. But there are times when even this technique won't work. Suppose that you transfer a scanned TIFF image from the PC to the Mac because you want to alter it using Adobe Photoshop. When you try to open the document, its name may not appear in Photoshop's Open dialog box.

This problem occurs because of the unique structure of Macintosh files. As you may recall from the backgrounder "About File Types and Creators" in Chapter 5, Macintosh files contain a *signature* that specifies the file's *type* and *creator*. The Finder uses the signature to start the appropriate program when you double-click a document. Applications use the signature to display in their Open dialog boxes only those documents that they can open. The type and creator entries are each four-character codes; for example, a Microsoft Word document has a type of WDBN and a creator of MSWD.

Generally, a PC file that you transfer to the Mac has a type code of TEXT or BINA. And where Adobe Photoshop is concerned, therein lies the rub. Photoshop's standard Open dialog box shows files with a type of TIFF (among many others), but not files with a type of TEXT or BINA. Thus, even though the DOS TIFF file may be in the proper internal format, Photoshop will not recognize it as a TIFF file.

Fortunately, Photoshop makes it easy to get around this problem. Use the File menu's Open As command, whose dialog box lists every file, regardless of its type. In the Open As dialog box, select the TIFF-masquerading-as-TEXT file, and then choose TIFF from the File Format pop-up menu.

How to Work Around File-Type Problems

Few programs are as forgiving about file types as Photoshop. With most programs, if you want a DOS file to behave like a Mac document at the Finder and show up in Open dialog boxes, you need to change the file's signature using ResEdit, a disk-editing utility, or a Desk Accessory, such as CE Software's DiskTop.

To change a file's type using ResEdit, start ResEdit, and then choose Get File/Folder Info from the File menu. In the Open dialog box that appears,

double-click the DOS file. In the Info dialog box, enter the new type code in the Type text box. For a TIFF file, the type code is, logically enough, TIFF (see figure 14.9).

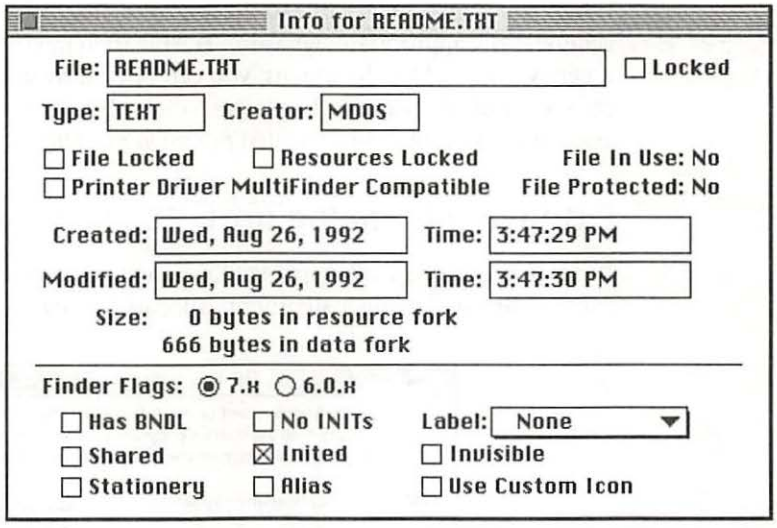


Figure 14.9: Changing a file's type code using ResEdit.

If you want to open the document by double-clicking it at the Finder, change its creator code, too. To open a PC PageMaker document by double-clicking it, for example, change its type to ALB4 and its creator to ALD4. You will find a list of type and creator codes used by popular Mac programs in Chapter 15.

File Extensions: Three Characters that Count

Depending on the Mac application you're using to open a PC file, you may need to add a specific file extension to the transferred file. The Mac version of PageMaker can open Windows PageMaker publications, for example, but their names must end with the extension PM4 (PM3 for PageMaker 3 documents). This doesn't apply if you change the publication's type and creator codes as just described.

Similarly, Mac PageMaker can import several types of PC WordPerfect, WordStar, XyWrite III, and DCA-format documents, but their names must end with the extensions WP, WS, XYW, and DCA, respectively.

Extension Mapping

Many file-translation products, including Apple's PC Exchange, enable you to associate certain DOS file extensions with certain Macintosh file signatures. When you transfer a DOS file to the Mac, the product reads the extension and generates the appropriate signature. The file then has the appropriate icon and it behaves like a Mac document: you can open it by double-clicking, and you can see the file in its application's Open dialog box. This extension-to-signature association scheme is often called *extension mapping*.

Extension Mapping with PC Exchange

To map extensions with Apple PC Exchange, open the PC Exchange Control Panel. A list of existing assignments appears (see figure 14.10).

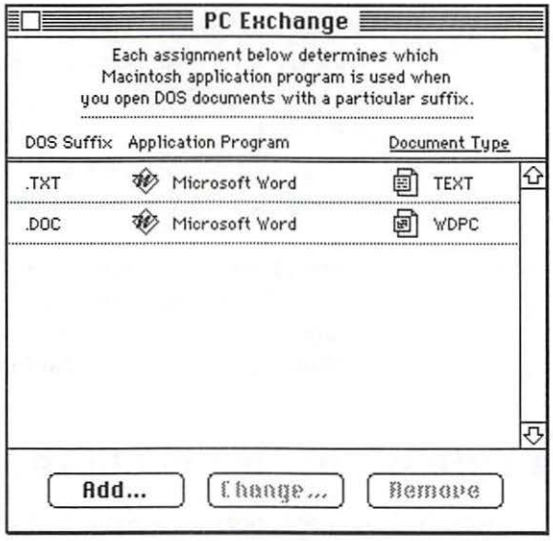


Figure 14.10: Extension assignments in PC Exchange.

To add a new extension-to-type assignment, click the Add button. In the dialog box that appears, type the DOS extension. Then locate and select the Macintosh program that is needed to open DOS files with that extension. The dialog box changes to reflect the types of documents that the Macintosh program can work with (see figure 14.11). Use the Document Type pop-up menu to choose the type of document you want to associate the extension with.

Click OK, and the new assignment appears in the PC Exchange Control Panel (see figure 14.12).

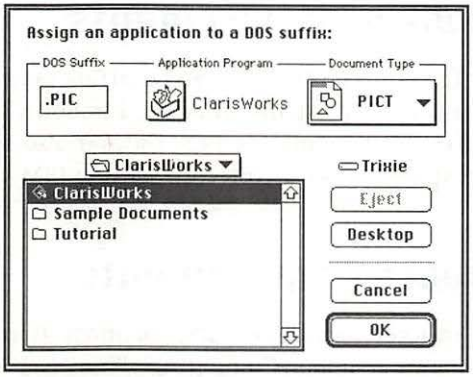


Figure 14.11: A complete extension assignment.

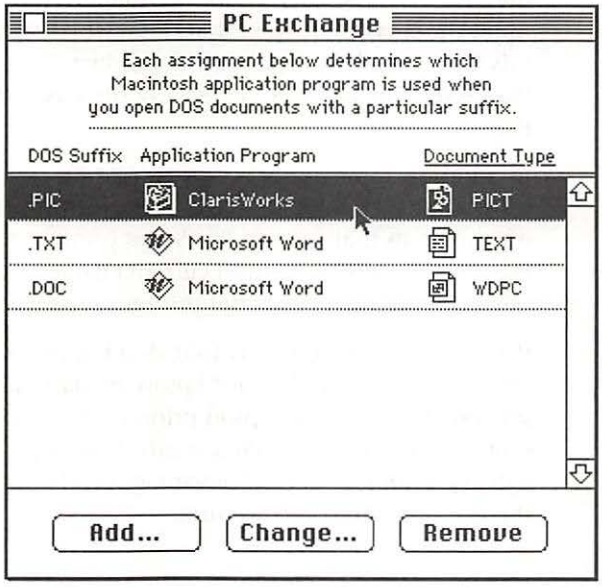


Figure 14.12: A new extension-to-signature assignment in PC Exchange.



Mac-to-PC Networking

Macs and DOS PCs can coexist on several types of networks. In this section, we concentrate on the simplest, least expensive method of dual-platform networking: attaching a DOS PC to a LocalTalk network and accessing Macintosh hard disks through AppleShare or System 7's file-sharing commands. We also show how you can set up a LocalTalk-equipped DOS PC to share a PostScript printer on the network, whether you use character-based or Windows programs.

Hardware Requirements

To connect a DOS PC to a LocalTalk network, you need to equip the PC with a LocalTalk expansion board. Farallon Computing and DayStar Digital offer LocalTalk boards for PCs; DayStar also sells a board for the MicroChannel expansion-slot architecture used in IBM's PS/2 computers.

Software Requirements

To access a server or PostScript printer from a LocalTalk-equipped DOS PC, you may use Farallon Computing's PhoneNet Talk, a software package that includes a variety of programs that enable you to access the server as well as drivers for all popular LocalTalk expansion boards. PhoneNet Talk also includes drivers for the IBM Token-Ring Network PC Adaptor. (PhoneNet Talk was originally an Apple product called AppleShare PC—which was covered in the first edition of this book. Farallon acquired the product from Apple and has enhanced it.) PhoneNet Talk lets a PC access any file server that uses the AppleTalk Filing Protocol (AFP).

In addition to enabling access to AFP file servers, PhoneNet Talk includes software that enables a PC to access a printer attached to the network. If you use programs that support PostScript printers directly—virtually all Windows programs do, and so do most current character-based programs—you can take full advantage of a PostScript printer's capabilities.

If you use older programs that don't support PostScript printers, you can configure PhoneNet Talk for Epson emulation. Then you configure your old software to print to an Epson printer. When you print, PhoneNet Talk intercepts the data and translates it into PostScript. PhoneNet Talk doesn't allow older programs to take full advantage of a PostScript printer, but at least it lets them access some of its features.

Using PhoneNet Talk

To enable you to connect to AFP file servers and network printers, PhoneNet Talk includes a network-access program that's loosely modeled after the Mac's Chooser desk accessory; it's even called the *Desk Accessory* in the PhoneNet Talk documentation. The PhoneNet Talk Desk Accessory enables you to select a file server, view and modify access privileges, and mount and unmount server volumes. When you mount a server volume, you assign a drive letter to it. After that, you can access it in the same way that you access local disks. The PhoneNet Talk desk accessory also enables you to set up extension mapping between DOS files and Macintosh documents.

You can specify that the PhoneNet Talk desk accessory remain resident in memory (as a terminate-and-stay-resident, or TSR, program), enabling you to open it from within any application by pressing Alt+A (or the key sequence of your choice). When the Desk Accessory is resident in memory, PhoneNet Talk uses between 190K and 215K of memory. When the Desk Accessory isn't memory resident, PhoneNet Talk uses about 130K. You can pare down its memory requirements further by installing only print services (you will not be able to access a file server) or only file services (you will not be able to access a networked printer).

Configuring DOS Software for Network Printing

After you set the stage for DOS LocalTalk printing by installing the required drivers, you need to configure your application programs to print using LocalTalk. We divided this step into separate categories for character-based DOS programs and for Windows programs.

Conventional DOS programs. The exact procedure depends on the programs you use, so we just outline the process. The PhoneNet Talk driver enables you to choose LPT1, LPT2, or LPT3 as the network printer's port. Configure your applications to print to a PostScript printer via the port you selected in the PhoneNet Talk Desk Accessory. If your software doesn't support PostScript printers, configure it for an Epson LQ-2500 printer.

Microsoft Windows programs. If you didn't install the PostScript printer driver when setting up Windows, do so now using the Print Manager program. After starting Print Manager, choose Printer Setup from the Options menu. Click the Add button, and then select the PostScript printer you want to install. Click the Install button, and Print Manager prompts you to insert the appropriate disk. If, when setting up the PhoneNet Talk software, you specified a port other than LPT1 as the network printer port, you also will need to use the Connect button to specify the appropriate port. Your Windows documentation contains more details on installing and choosing printers.

Macintosh Filenames in a DOS World

Because DOS filenames are limited to only 11 characters (including the extension), AppleShare creates a *short name* automatically for files or folders whose names exceed MS-DOS' length limits. Shortened names begin with an exclamation mark (!). A Mac file named *AppleShare Tips* appears as

"!APPLESH.ARE" on the DOS machines. If you plan to share certain Mac files with PCs, you may want to name those files with DOS' filename restrictions in mind to begin with. You can probably come up with more descriptive 11-character filenames than AppleShare can. Most other Mac–DOS network products use this or a similar renaming scheme.

Using Downloadable Fonts

Adobe offers MS-DOS versions of its downloadable PostScript fonts, but they're designed to be downloaded via a serial or parallel connection, not over LocalTalk. If you have downloadable fonts in Mac format, however, you *can* use them in documents created by Windows programs, such as PageMaker, Excel, and Word for Windows. All you need are the corresponding screen fonts in Windows format. If you have Adobe's Optima font in Macintosh format and you want to use it in PC PageMaker documents, for example, you need Adobe's Optima screen font for Windows. Adobe sells its screen fonts separately; you also can download them from the Adobe forum on CompuServe. Use Windows' Print Manager to install the fonts.

To print a document containing a downloadable font, first use a utility, such as Apple's LaserWriter Font Utility, to download the font manually from the Mac (see Chapter 6). Then print the document from your Windows application.



The Fully Windowed Office

If your office uses both Macs and PCs running Microsoft Windows, consider standardizing on application programs that are available for both camps. Dual-platform programs generally share similar if not identical file formats, so you can move files between Macs and PCs with a minimum of file-transfer headaches.

Another benefit of standardization is that most Mac-and-Windows programs have similar operating styles. This also can cut training costs because people will not need to learn entirely new ways of working when switching between Macs and Windows machines. (They will have to adjust to the two camps' other differences; for example, the Macintosh Finder has little in common with Windows' program and file managers, and Windows runs under the MS-DOS operating system, which limits filenames and has other complexities that can make DOS PCs harder to learn.)

Problems in Paradise

Macs and PCs don't always coexist peacefully. As you may recall from Chapter 12, all personal computers use the same ASCII codes for representing the alphabet, numerals, and common punctuation symbols. But characters, such as copyright symbols, bullets, typographer's quotes and dashes, and accented letters are not standardized. Their ASCII assignments differ between the Mac and PC. (Even within the PC world, their ASCII assignments can differ between Microsoft Windows and MS-DOS itself.) When you open a transferred file and find its special characters have changed, you have fallen victim to *high-bit* ASCII incompatibilities—differences in those ASCII codes numbered 128 and up.

The printers you use with your Macs and PCs also can influence your file-transfer results. Suppose that you format a Macintosh document for a PostScript printer and then transfer it to a PC connected to a non-PostScript printer. The other printer may not have the same fonts and font sizes as its PostScript counterpart, and even if it does, their character widths may differ. You may need to reformat the document after transferring it to the PC, altering its fonts to match those available on the PC's printer. When creating a document, it's best to use only those fonts and sizes available on the printer that will produce the final copy.

A Dual-Platform Application Sampler

Table 14.1 is a partial list of the programs that are available for both the Macintosh and for Microsoft Windows.

Running PC Software on the Mac

Although Mac zealots cringe at the thought of it, you can run PC software—including Microsoft Windows—on a Mac. You can see PC software on the Mac screen the three following ways:

A software emulator. Insignia Solutions' *Soft PC* and *Soft AT* programs imitate a PC using only software. They're adequate for text-oriented applications, but too slow to deliver acceptable performance with graphical environments, such as Microsoft Windows.

A hardware emulator. Orange Micro's *Orange386* contains a 16MHz Intel 386SX processor, 1MB of RAM (expandable to 16MB), and two expansion slots—it's essentially a PC crammed onto a NuBus board that plugs into a NuBus-equipped Mac. Because it doesn't rely on the Mac's processor to imitate yet another processor, it's considerably faster than a software emulator. With prices starting at about $2,000, it's also several times more expensive.

A PC remote-control program. Several programs are available that enable you to control a PC using the Mac. With this approach, you're still running the software on the PC; you're simply using the Mac's keyboard, mouse, and monitor. (Conceptually, this isn't too different from using a program, such as Timbuktu, which we looked at in the previous chapter.) PC remote-control programs include Argosy Software's *Run PC/Remote* and *Run PC/Network* (for modem or network connections, respectively) and Vano Associates' *MacChuck*, which works with modems or networks.

Table 14.1: A sampling of programs that are available for the Mac and for Microsoft Windows.

Company	Product	Type of Program
Aldus	PageMaker	Publishing
Aldus	FreeHand	Illustration
Adobe	Illustrator	Illustration
America Online	America Online	Graphical online communications service
Aldus	Persuasion	Presentation graphics
Claris	FileMaker Pro	Database management
Caere	OmniPage	Optical-character recognition
Intuit	Quicken	Personal finance management
Microsoft	Excel	Spreadsheet
Microsoft	Word	Word processing program
Microsoft	Project	Project-management
Microsoft	PowerPoint	Presentation graphics
Microsoft	Works	Integrated
Computer Associates	CA Cricket Graph	Graphing
Frame Technology	FrameMaker	Publishing
Quark	QuarkXpress	Publishing
Passport Designs	Master Tracks Pro	Music (MIDI) sequencer
Lotus	1-2-3	spreadsheet
WordPerfect	WordPerfect	Word processing program
Software Ventures	MicroPhone II	Telecommunications

CHAPTER

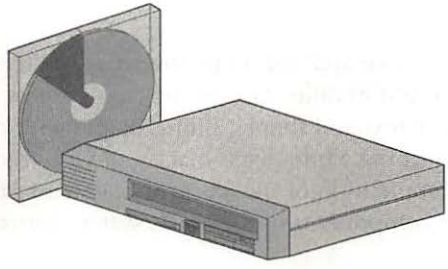
15

TECHNICAL DETAILS

WHAT'S INSIDE

- How the Mac's video circuitry works
- How to enhance your Mac's video capabilities
- A tour of the key components inside a Macintosh: what they do and how they work
- How the Mac's RAM and ROM chips operate
- How to upgrade your Mac's memory
- A closer look at NuBus expansion slots
- The 68000 family of microprocessors and the key differences between each member
- What happens when you switch on your Mac?

A dizzying array of events takes place within the Mac. Data travels between the central processor, memory, and disk drives at the speed of light. Another circuit constantly updates the contents of the Mac's RAM chips while painting an image on the video screen. And through it all, the Mac is on the alert for keystrokes and mouse movements.



This is the precisely choreographed dance between hardware and software we mentioned back in Chapter 1. And it must go off without a hitch. If one member of the team steps on another's toes, the result is usually a system crash—and lost work.

In this chapter, we peer under the hood for a look at the Mac's hardware. If you're worried about slogging through a course in electronics theory, rest easy. This chapter does get a bit technical, but we concentrate less on theory and more on the basic concepts that will help you understand how the Mac works—concepts that will help you choose hardware add-ons and memory upgrades, diagnose difficulties, and give you a greater appreciation for the Mac's design.



Video Details

The Mac has many unique features, but the one you notice first is its razor-sharp screen display. Because graphics play such a large role in the Macintosh world, it helps to understand how the Mac creates screen displays. This section summarizes the video-related information we have touched on in previous chapters, and describes in more detail how the Mac creates screen images.

Video Recap

First, let's review the three key points about Mac video that we have mentioned already.

- Unlike many computers, which have separate display modes for creating text and graphics, the Mac's display circuitry has only one display mode: graphics. It's this trait that allows the Mac to display its vast variety of type fonts and sizes.
- The Mac uses a bitmapped display. In a monochrome (black and white) Mac, each screen dot, or pixel, corresponds to—or is *mapped to*—one bit in a reserved area of the Mac's memory called the *screen buffer*. In compact, monochrome Macs, such as the Classic, the screen buffer uses about 22K of RAM. As you see shortly, creating displays with color or shades of gray requires the Mac to assign more than one bit to each pixel.
- To create screen displays, application programs use a library of system software graphics routines called QuickDraw. QuickDraw provides routines for drawing text and shapes, filling shapes with patterns, inverting shapes (turning white pixels black and vice versa), and more. QuickDraw is the foundation of the Mac's display (and printing) capabilities. Other components of the Mac's system software, such as

the Menu Manager, Font Manager, and Window Manager, rely on QuickDraw routines as they work.

Painting with Light

Like all personal computers (not to mention television sets), the Mac uses a *raster display*—its screen images are comprised of hundreds of horizontal lines created by a beam of electrons on the inside surface of the video tube. This surface is coated with *phosphor,* a material that glows briefly when struck by electrons. The electron beam is guided by a magnetic field created by the video tube's *yoke,* a series of wire coils that encircles the neck of the video tube like a gaudy necklace. (*Raster* is a Latin word meaning *rake.* Imagine the electron beam raking a series of equally spaced lines across the video tube, and you can understand why pioneering television engineers of the 1930s coined the term.)

To rake an image into the phosphor, the electron beam begins at the upper left corner of the screen and scans across the screen from left to right. As it moves from left to right, the beam pulses off and on to create black and white pixels as needed. When the beam reaches the right edge of the display, the Mac's video circuitry shuts it off momentarily, and then returns it to the left edge of the screen, but down one pixel. The beam is then switched back on to paint another *scan line.* On a compact Mac, such as a Classic, this scanning scheme repeats until the beam has drawn 342 scanning lines. At that time, the video circuitry shuts the beam off again, aims it at the top-left corner, and repeats the entire process. Figure 15.1 summarizes this process.

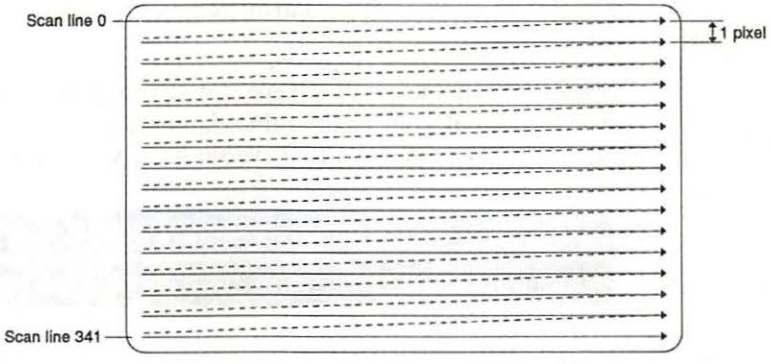


Figure 15.1: Creating a screen display.

This screen-painting process sounds time-consuming, but it's nearly instantaneous. On a compact Mac, the beam scans the entire screen in about 1/60 second. The speed with which a video system creates a complete screen is called

its *frame rate*. Compact Macs have a frame rate of 60.1 Hertz; that is, a compact Mac redraws, or *refreshes*, its entire display 60.1 times per second. The frame rate is also often called the *refresh rate*.

When we say the Mac refreshes its *entire* display 60 times per second, we mean it. Unlike television sets, the Mac repaints *every* scan line during each refresh cycle. Televisions use a screen-painting technique that involves drawing all the even-numbered scan lines during one pass, and then all the odd-numbered ones during the next pass. This scheme, called *interlacing*, can result in noticeable screen flicker. By combining *non-interlaced* video with a fast refresh rate, the Mac provides an image with much less flicker than a conventional television.

Resolution versus Pixel Count

The word *resolution* is often used to describe the number of pixels a computer's screen can display. Technically, resolution is the number of pixels *per inch* a video screen can display—just as printer resolution refers to how many dots per inch a printer can produce. The total number of horizontal or vertical pixels a screen can display determines its *pixel count*.

We have already mentioned that a compact Mac's screen contains 342 horizontal scan lines. Because a scan line is one pixel wide, the compact Mac's screen has a vertical pixel count of 342 pixels.

Compact Macs have a horizontal pixel count of 512 pixels. This value isn't determined by the number of scan lines on the screen, but by how quickly the electron beam can flick on and off as it moves from left to right to create a scan line.

Table 15.1 summarizes the pixel counts of the Apple's standard video hardware. The horizontal value is listed first, followed by the vertical. Most third-party monitors of comparable size have similar pixel counts.

Table 15.1: Pixel counts of Apple monitors.

Monitor	Pixel Count
12-inch Monochrome	640 by 480
12-inch RGB Display	512 by 384
AppleColor RGB Monitor	640 by 480
16-inch Color Display	832 by 624
21-inch Color Display	1152 by 870
2-page Monochrome Monitor	1152 by 870

Monitor	Pixel Count
Portrait Display	640 by 870
Compact Mac (SE, Classic)	512 by 342

Simulating Shades of Gray

Monochrome Macs can display any color pixel you want, as long as it's black or white. Because each pixel in a monochrome Mac is mapped to one bit, and because a bit can have only one of two values (zero or one—white or black), monochrome Macs cannot display color or shades of gray.

They can, however, simulate gray shades by using patterns of white and black pixels, a process called *dithering*. Two common examples of dithering in the Mac interface are the Mac's gray Desktop pattern and the gray pattern you see inside scroll bars.

Figure 15.2 shows how a dithered gray compares to a true shade of gray. It shows an image created by a scanner and displayed by the Adobe Photoshop image-processing program. The right screen shows how the image appears on a monochrome Mac. The left screen shows how the same image appears on a grayscale display. Which would you prefer for electronic retouching?

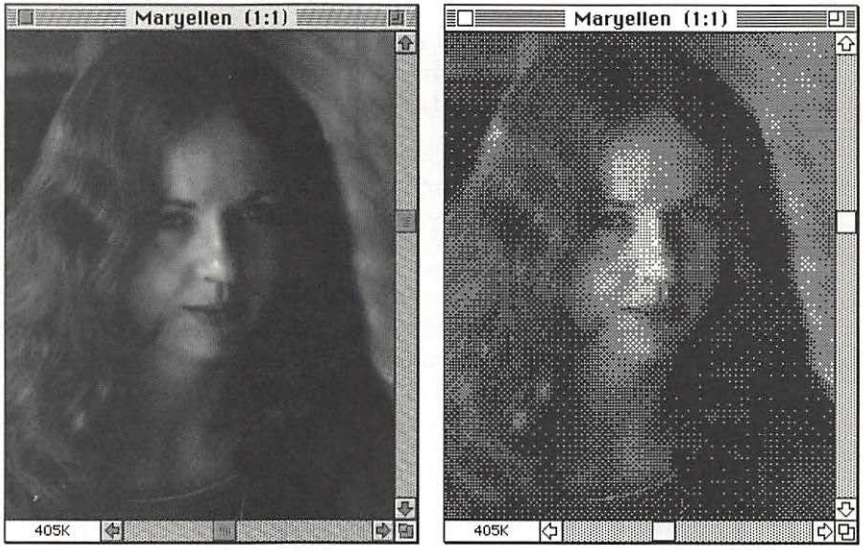


Figure 15.2: Dithered gray (right) versus true gray (left).

As you may recall from Chapter 4, the phrase *grayscale* is often used to describe hardware or software that can work with true shades of gray.



Color and Grayscale Video

Like monochrome Macs, color Macs use non-interlaced, bitmapped displays driven by QuickDraw. Beyond this are some significant video-related differences that we look at in this section.

When you look closely at a color Mac's monitor, you can see that each color pixel is actually comprised of three much smaller patches of red, green, and blue light. These three colors are *primary colors,* the basic building blocks of white light. Because these *triads* of colored light are too small to see individually, the eyes merge them into a single, colored pixel.

Each pixel's triads of red, green, and blue light are created by three electron guns (one for each color) in the video tube's neck. The tube's inside surface is coated with red, green, and blue phosphor dots. The Mac's video circuitry determines each pixel's color by controlling the stream of electrons as the guns create each pixel. (Some video tubes, such as Sony's Trinitrons, use just one electron gun that fires at all three types of phosphors.)

Video Circuitry: Built-in or Plugged-in?

When we wrote the first edition of this book, only monochrome Macs included built-in video circuitry—the Mac II family machines of that era required plug-in NuBus video cards.

Beginning with the Mac IIci, Apple began building color and grayscale video circuitry into Mac logic boards. Since the Mac IIci appeared late in 1989, Apple has introduced only one Mac II-family machine that lacked built-in video circuitry: the IIfx.

All current color Macs include on-board video circuitry and monitor connectors. You can still add to or replace a Mac's video circuitry using plug-in NuBus or direct slot video cards. We will describe a few of the ways in which you can enhance your Mac's video features later in this chapter.

Storing Color: Video Memory

In the world of bitmapped video, the key to storing color or grayscale information is to assign more than one bit to each pixel. These additional bits convey information about the pixel's color or shade of gray. By assigning two bits to each pixel, color Macs can display four colors. Four bits can represent 16 colors, and eight bits can represent 256. When you use the Monitors Control Panel to choose how many colors or gray shades you want to see, you're actually telling the Mac how many bits to assign to each pixel.

It's obvious that color and grayscale video require more video memory than monochrome video. All those extra bits you're assigning to each pixel have to come from somewhere. In color Macs, that somewhere is *video RAM*, often abbreviated *VRAM* and pronounced *VEE-ram*. Video RAM cannot be used to store system software and programs; it's reserved for the bits that correspond to the pixels on your screen.

In most Macs containing built-in color video circuitry, the VRAM is a separate set of RAM chips. The Mac LC II contains 256K of VRAM, for example. (Yes, the LC II provides twice as much RAM for video alone as the original Macintosh provided for video *and* everything else.)

Two Mac models—the IIci and IIsi—don't provide dedicated VRAM chips, but instead steal some of their main memory for use as VRAM. This means that these Macs provide somewhat less free memory than do models that use separate VRAM chips. With some IIsi and IIci memory configurations, it also has an effect on performance, since the CPU must sometimes wait to access memory because the video circuitry will be accessing the same bank of memory.

Expanding Your Video RAM

Many Macs containing built-in color video can accept VRAM expansion boards that allow for the display of more colors on certain monitors. Expanding your Mac's video RAM is an inexpensive way to enhance its display capabilities.

To expand video RAM, you simply plug SIMM boards into the slots provided on your Mac's logic board. (Before you start, see the section "Should You Install RAM Yourself?" later in this chapter.) Here's how many SIMMs you will need.

- LC or LC II—one 256K SIMM
- Quadra 700—you can expand a Quadra 700's VRAM in two ways: by adding two 256K SIMMs or by adding six
- Quadra 900 or 950—four 256K SIMMs
- Mac IIvx, IIvi, Performa 600—two 256K SIMMs
- PowerBook Duo Dock—one 512K SIMM

How many colors will you get from your expansion? Table 15.2 lists the standard and expanded video display capabilities of various Mac models when used with the most common monitor sizes.

Table 15.2: Color and grayscale capabilities with small monitors

	Grays Displayed	Colors Displayed	
	12" Monochrome	12" RGB Monitor	AppleColor 13" and 14" Color
LC, LC II, Performa 400			
Standard	16	256	16
Expanded	256	32,768	256
IIsi, IIci			
Standard	256	256	256
IIvx, IIvi, Performa 600			
Standard	256	256	256
Expanded	256	32,768	32,768
Quadra 700			
Standard	256	256	256
1 VRAM expansion	256	16.7 million	16.7 million
2 VRAM expansion	256	16.7 million	16.7 million
Quadra 900			
Standard	256	16.7 million	256
Expanded	256	16.7 million	16.7 million
Quadra 950			
Standard	256	16.7 million	32,768
Expanded	256	16.7 million	16.7 million

	Grays Displayed	Colors Displayed	
	12" Monochrome	12" RGB Monitor	AppleColor 13" and 14" Color
Duo Dock			
Standard	256	256	256
Expanded	32,768	32,768	32,768
IIcx, II, IIx, IIfx	card required	card required	card required

Many Macs containing built-in video circuitry also can drive larger monitors. Table 15.3 lists the standard and expanded video display capabilities of various Mac models when used with larger monitor sizes.

Table 15.3: Color and grayscale capabilities with large Apple monitors.

	Colors Displayed		Grays Displayed	
	16" Color Display	21" Color Display	2-page Monochrome	Portrait Display
LC, LC II, Performa 400	not supported	not supported	not supported	not supported
IIsi, IIci				
Standard	not supported	not supported	not supported	16
IIvx, IIvi, Performa 600				
Standard	not supported	not supported	not supported	*
Expanded	not supported	not supported	not supported	*
Quadra 700				
Standard	256	16	16	16
1 VRAM exp.	256	256	256	256
2 VRAM exp.	16.7 million	256	256	256
Quadra 900				
Standard	32,768	256	256	256
Expanded	16.7 million	256	256	256

continues

Table 15.3 Continued

	Colors Displayed		Grays Displayed	
	16" Color Display	21" Color Display	2-page Monochrome	Portrait Display
Quadra 950				
Standard	32,768	256	256	256
Expanded	16.7 million	32,768	256	256
Duo Dock				
Standard	256	*	*	*
Expanded	*	*	*	*
IIcx, II, IIx, IIfx	card required	card required	card required	card required

Controlling Multiple Monitors

As mentioned in previous chapters, you can connect more than one monitor to a modular Mac by adding additional video cards. In a Mac that's connected to multiple monitors, each monitor has its own video circuitry, which includes VRAM for the bits that correspond to that screen's image.

When you have monitors connected, the Mac keeps track of each monitor's color or grayscale capabilities. This enables you to mix and match different types of video hardware and displays. If you want one color monitor, one two-page grayscale display, and one full-page monochrome display, you can have them—and you can drag windows between them, or even position a window so that it spans them. Because the Mac keeps track of each monitor's capabilities, it can adjust the way it displays the window on each monitor.

24-Bit Video: When 256 Colors Aren't Enough

We have already said that most Macs' built-in video circuitry supports up to 256 colors. While 256 colors are more than adequate for color charts and graphs, artists or desktop publishers striving for photographic realism require a larger rainbow of hues. The eye can discern between thousands of different colors; 256 aren't enough for photographic realism. A color Mac can simulate more than 256 colors through dithering (combining patterns of colored pixels), but even this technique isn't adequate for rendering color images with photographic realism.

For such applications, the answer may be a *24-bit color* or *true color board*. By assigning 24 bits to each pixel, such boards give you direct access to over 16 million colors.

The Quadra family contains built-in 24-bit video circuitry. You can add 24-bit color boards to other NuBus-equipped Macs; Apple, SuperMac, Radius, and RasterOps are just a few of the firms selling 24-bit color boards. These boards use Apple's 32-bit QuickDraw, which is built into System 7 and available as an extension for System 6. What about the 8-bit difference between 24-bit boards and 32-bit QuickDraw? Those extra eight bits, sometimes called an *alpha channel*, can be used by application developers for specialized purposes, such as assigning transparency information to images. Programs like Adobe Photoshop let you use the alpha channel to create *masks* that protect parts of an image from accidental alteration.

Accelerated Video

When you're assigning 24 bits—three bytes—to every pixel on the screen, you're forcing the Mac's CPU to move megabytes of data around just to create a screen display. Ordinary tasks like scrolling through a window can become frustratingly slow, especially if you have a large monitor.

If you're serious about true color, you will probably want a 24-bit video card that also provides *graphics acceleration*. Cards, such as SuperMac's Spectrum/24 PDQ or Thunder, Apple's 8•24GC, and Radius' PrecisionColor 24X and 24Xp contain their own microprocessors that handle the dirty work of manipulating the data in video RAM, thus lightening the load on the Mac's CPU. Apple's 8•24GC card, for example, contains an American Micro Devices 29000 RISC processor—the same RISC chip used in many high-performance PostScript printers, including Apple's Personal LaserWriter NTR.

NTSC Video

In this era of QuickTime and multimedia, it's becoming more and more common to see Macs connected to video recorders. You can videotape Mac screen images by using a video card that can generate *NTSC video*. (NTSC is short for National Television Standards Committee; NTSC video is the standard video signal used in North America.) Many of Apple's video cards and built-in video circuits can generate monochrome NTSC video when equipped with an appropriate cable. Some 24-bit video boards support color NTSC output, although boards capable of generating broadcast-quality video are costly.

PowerBook Video

If you have a PowerBook 160 or 180—or a PowerBook Duo outfitted with a Duo Mini Dock—you can connect a color monitor. As mentioned in Chapter 5, you can use the PowerBook Display Control Panel to specify that the external monitor be used as an extension of the PowerBook's Desktop or that it duplicate the contents of the PowerBook's screen.

If you have a different PowerBook model, you can add a color or grayscale monitor using a variety of third-party products. Several firms offer monitors that connect to the SCSI port on a PowerBook. Some firms also offer adaptor boxes that attach between the PowerBook's SCSI port and a conventional monitor. The primary advantage of a SCSI-based monitor is that it requires no additional circuitry in the PowerBook. The disadvantage is that scrolling and other screen-updating tasks are on the slow side.

You also can buy third-party video expansion boards that squeeze into the PowerBook's case. The pros: you can attach to nearly any monitor, and you will enjoy fast performance. The cons: there isn't a lot of vacant real estate inside a PowerBook, and you (or a technician) can damage a PowerBook by installing a video board carelessly. Also, the video board's circuitry will add heat to the case.

The good news for PowerBook 140, 145, and 170 owners is that these machines' ROM chips already contain the software required to drive a color display. Once you add the necessary hardware, your PowerBook will have color capabilities comparable to the latest models.



Hardware Concepts

Now let's step back for the big picture. In this section, we take a closer look at how the Mac works. If some of the following material seems a little too technical, feel free to skim or skip over it.

The Internal Clock

We have said before that the Mac's operation is an expertly choreographed dance between hardware and software. In order to have a dance—even one between hardware and software—you need a beat. In the Mac, the beat is provided by a quartz crystal that vibrates millions of times per second when stimulated by electric current. This crystal and the circuitry that supports it form the Mac's *internal clock*. (Don't confuse the internal clock with the clock that keeps track of the time and date. They're separate beasts. To avoid confusion, the Mac's time-and-date clock is often called the *real-time clock*.)

Many of the Mac's circuits use the internal clock. The circuitry that controls the Mac's RAM uses it to periodically refresh the contents of each RAM chip. The video display circuitry uses clock ticks to time the painting of the video screen. The CPU uses the clock as a metronome to time its accesses to RAM, ROM, and peripherals.

After reading that last point, you may think that the speed of a computer's internal clock plays a big part in determining the computer's overall performance. You're right. The more times per second a computer's metronome ticks, the faster the pace of its internal dance.

The speed of a computer's internal clock is called its *clock rate*. As we saw in Chapter 4, the original Macs, the Mac Plus, the SE, and the Classic share the same clock rate: roughly eight million cycles per second. Cycles per second are measured in Hertz, so eight million cycles per second equals eight megahertz, or 8MHz for short. Other Macs have 16MHz, 20MHz, 25MHz, or even 40MHz clocks. Their faster clock rates allow them to access memory and peripherals more quickly, and to load and execute program instructions faster.

Interrupts

Even when it's just sitting idle, the Mac is hard at work, painting the image on its video screen, keeping the contents of its RAM chips fresh, and remaining alert for mouse movements or keystrokes. When you start a program, open a document, or access a disk in some other way, the Mac works even harder, performing all those jobs even as it accesses the disk.

It may seem that the Mac is performing all these tasks at the same instant. It isn't. In reality, it's switching from one task to the next under the control of *interrupts*. Interrupts are signals sent to the CPU by a device or component that needs the CPU's attention. When you press a key or move the mouse, the keyboard or mouse generates an interrupt, in effect saying to the CPU, "Listen up! I have some data for you."

The CPU acknowledges the interrupt, and then turns control over to an *interrupt handler*—a software routine whose job is to respond to, or *service*, that particular kind of interrupt. The interrupt handler then does its job. In the case of a keystroke, that means determining which key was pressed and storing its corresponding character. The interrupt handler then returns control of the CPU to the program you're running.

The whole process works much like a phone conversation: the device generates an interrupt (the phone rings), the CPU acknowledges it (you answer the phone), and the interrupt handler services the interrupt (the conversation takes place). Afterwards, the CPU resumes what it was doing beforehand (you resume watching TV).

Interrupt Priorities

Anyone who watches TV knows that some interruptions are more important than others. The Mac also has its own priorities where interrupts are concerned. Some kinds of interrupts must be serviced before others. The interrupt the mouse generates has a lower priority than the interrupt a disk drive generates, for example, because the disk drive transmits far more data in the same amount of time than the mouse. The Mac can temporarily ignore mouse movements in order to respond to the disk drive without losing any important data or impairing performance. If it were to ignore data being sent from the disk drive in order to respond to the mouse, however, information would be lost—or disk performance would slow to a crawl—each time you moved the mouse during a disk access.

You can see the results of this priority scheme by moving the mouse while the Mac is accessing a floppy disk: you will see the mouse's pointer movement become jerky as the CPU divides its attention between the higher-priority disk interrupts and the lower-priority mouse ones.

Catching the Bus

The roadways upon which data and program code travel are called *buses*. Buses are the link between the CPU and the components that serve it—and ultimately, between the CPU and the Mac's keyboard, mouse, printer, hard disk, and other add-ons.

All Macs have two primary buses: the *address bus* and the *data bus*. The address bus carries memory addresses from the CPU; these signals specify the location in memory where data is to be stored or retrieved. The data bus carries the data itself. The two buses work together like a taxi dispatcher and a taxi: the dispatcher specifies where data is to be delivered or picked up, and the data bus carries the data itself. These buses are often called *external buses* because they're outside of the Mac's CPU chip, which contains its own address and data buses, called *internal buses*. Unless otherwise noted, the following descriptions refer to the external buses.

With both the address and the data bus, speed is of the essence. Thus, both transfer their data in parallel—with the bits that form each byte traveling alongside each other, instead of in single-file, serial form.

A computer bus is often described in terms of its *width*. Bus width refers to how many bits of data a bus can carry at once. Just as some freeways have more lanes than others, some buses are wider than others, and therefore, can carry more data in the same amount of time.

Generally, the wider a bus, the better. But the specific advantage of a wider bus width depends on the type of bus you're dealing with. Let's look at the impact bus width has on an address bus and a data bus.

Address Bus Width: The Wider the Bus, the More Memory

With an address bus, greater width means the computer can access a larger amount of memory. Why? Think back on Chapter 1's discussion of bits and binary: the more bits you lump together, the greater the range of values you can represent. Also consider the taxi analogy we just used: having a wider address bus is like having a more powerful dispatcher's radio that can reach a wider area of addresses.

The 68000 chip in the Mac Plus and SE has a 24-bit address bus, which, in theory, would allow these machines to access a maximum of 16MB of RAM. However, because of the way the Plus' and SE's address lines are used, these machines are limited to accessing a maximum of 4MB of RAM.

Macs containing 68020, 68030, and 68040 processors have 32-bit address buses. In theory, a 32-bit address bus allows access to up to four *gigabytes* (GB) of memory—4096 megabytes. In practice, however, System 6 and earlier versions of the Mac's system software are unable to access more than 8MB. System 7, however, supports *32-bit addressing,* opening the memory frontiers well beyond 8MB.

MODE32: Cleaning Up Dirty ROMs

System 7 enables the Mac to access more than 8MB of memory, but whether you can actually add more than 8MB of RAM to your Mac depends on the model you have. The ROM chips in some Macs—the II, IIx, IIcx, and SE/30—are not what Apple calls *32-bit clean;* that is, they don't follow all the rules necessary to operate under 32-bit addressing.

This problem sounds serious, but fortunately, the fix is easy: simply use the MODE32 Control Panel (see figure 15.3).

MODE32 was developed by Connectix Corporation, and has since been licensed by Apple. MODE32 is included with many memory upgrades and is also available free through user groups and online services.

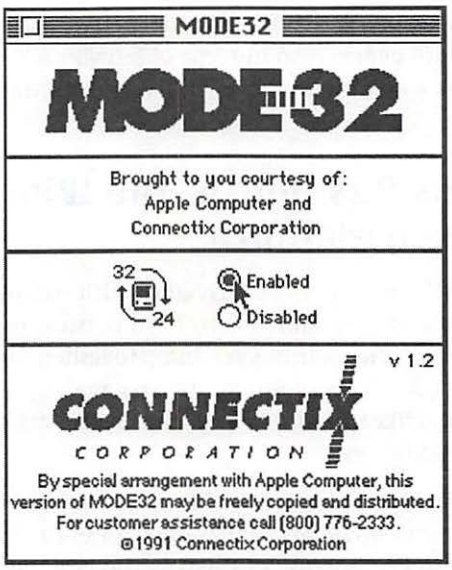


Figure 15.3: Activating 32-bit addressing with MODE32.

Data Bus Width: The Wider the Bus, the Faster

Because an address bus carries addresses, a wider bus width allows a computer to access a greater range of memory addresses. But a data bus carries data, so a wider data bus has no effect on how much memory a CPU can address. With a data bus, greater width means greater speed, because more data can be transferred across the data bus in the same amount of time—just as an eight-lane freeway can move more cars per hour than a four-lane one.

68000-based Macs have 16-bit data buses. The 68020-based Mac LC and LC II also have 16-bit data buses, even though these machines' 68020 processor supports 32-bit buses. (Indeed, the original Mac II, another 68020-based machine, does have 32-bit data buses.) This was a design trade-off that Apple made in order to keep the cost of the machines down. A 32-bit data bus would have cost more to implement because it would have required two 16-bit memory-management chips instead of one.

All 68030- and 68040-based Macs have 32-bit data buses, allowing these Macs to internally move twice as much data at a time. Their wider bus and their faster clock rates are two of the factors that make these high-powered Macs so much faster than their predecessors. (Another reason is that the 68030 and 68040 microprocessors are faster and more efficient than the 68000 and 68020; more about that later.)

It's important to realize that a computer's overall speed is determined by many other factors, including the speed of its disk drives, the software it's running, and the internal structure, or *architecture,* of its microprocessor. The width of a computer's data bus is only one factor that influences performance.



Memory Details

We have discussed the Mac's RAM and ROM chips in general terms; now let's get into specifics. If you plan to expand your Mac's memory, read this section for an introduction to memory concepts and for some advice about whether or not you should tackle the job yourself.

We concentrate on RAM in this section, but most of the concepts also apply to ROM.

RAM Basics

Like most computers, the Mac uses *dynamic RAM* chips, or *DRAMs* (pronounced *DEE-RAM).* In order to retain their contents, DRAMs require a periodic *refresh signal,* an electronic prodding that keeps the RAM chip's electronic switches in position. The other primary category of RAM, *static RAM,* doesn't require this constant prodding. Static RAM tends to be more expensive and electrically complex than dynamic RAM, and plays a relatively small role in personal computers.

In classic Macs, the DRAMs are refreshed 60 times per second by the video display circuitry. As we said in previous chapters, the Mac uses a bit-mapped display in which each dot on the screen corresponds to a bit in memory. The area of memory that holds this screen data is the *screen buffer.* The Mac's video circuitry must scan the screen buffer at regular intervals as it labors to keep the contents of the screen current.

Because the screen buffer requires regular scanning and because DRAMs require regular refreshing, Apple's engineers devised a kill-two-birds-with-one-stone technique in which the video circuitry refreshes the RAM chips *and* updates the screen display. This scheme simplifies the compact Mac's hardware. But it also slows memory-access performance, since the CPU must often wait for the video circuitry to finish painting a line on the screen before it can access RAM.

Modular Macs work differently. As we mentioned earlier in this chapter, the screen buffer in most modular Macs isn't part of the Mac's main RAM, but is located on separate VRAM chips or even a separate video card. In these Macs, a separate chip refreshes the DRAMs every 15 milliseconds or so. Except for these fleeting interruptions, the CPU has uninterrupted access to RAM.

DRAM Density

The amount of information a DRAM chip can hold is determined by the chip's *density*, which is measured in kilobits. One kilobit, or *Kbit* for short, equals 1024 bits. (Notice that we're talking about *bits* here, not *bytes*.)

These days, the most common DRAM sizes are 256-Kbit, 1-megabit, and 4-megabit. You can determine how many bits a chip can store by multiplying its density by 1024. By multiplying 1024 by 256, for example, we learn that one 1-Mbit DRAM chip contains a total of 1,048,576 electronic switches—each of which can be on or off, storing a value of one or zero.

Cramming over a million bits on a single chip is impressive, but remember that bits are combined into larger, more versatile units—bytes. To get one megabyte of RAM, you must tie together 8 1-Mbit DRAMs. That's exactly what a 1MB SIMM does—it puts 8 1-Mbit DRAMS together on a plug-in circuit board (see figure 15.4).

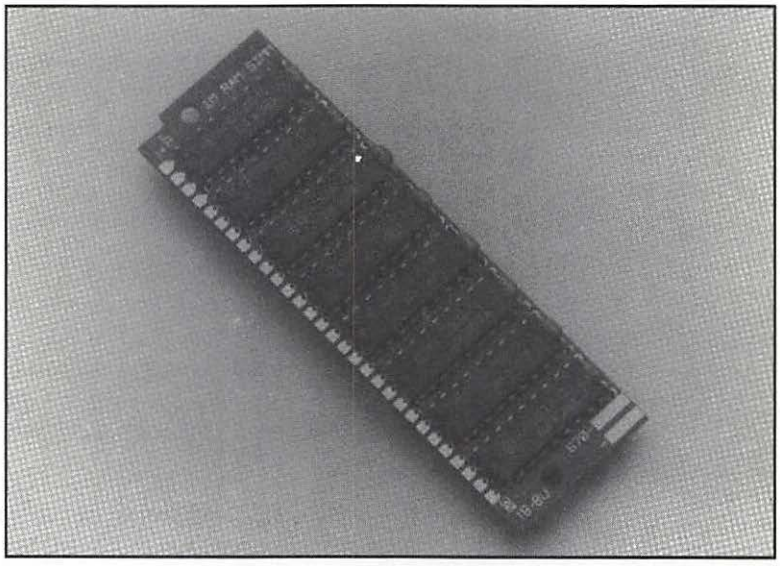


Figure 15.4: A Single In-line Memory Module (SIMM).

It is important to remember the following key concepts:

- Individual RAM chips store *bits*, not *bytes*.
- The density of individual chips is measured in kilobits (Kbits) or megabits (Mbits).

- Because the byte is the workhorse when it comes to representing programs and data, and because there are eight bits to a byte, the Mac uses RAM chips in groups of eight.

How Big a SIMM?

When upgrading RAM, you may need to take into account the physical size of the SIMMs. *Low-profile* SIMMs are the thinnest, and are able to fit within the cramped confines of, say, a Quadra 700. (Some of the SIMM banks in the Quadra 900 and 950 are also a tight squeeze.) *Composite SIMMs* are fatter and may not fit in some Macs. At this writing, the 16MB SIMMs that are being sold are of the composite variety: instead of using eight 16M-bit DRAM chips, a composite 16MB SIMM uses 32 4M-bit chips.

DRAM Access Time

Memory chips store and supply data quickly, but even within their microscopic world, things take time. The time required for the Mac to successfully read from or write to a DRAM chip is called its *access time*. The Mac Classic, for example, requires DRAMs with an access time of 120 nanoseconds (ns—one billionth of a second)—pretty slow as RAM chips go. The faster Mac LC II requires 100-ns DRAMs, while the Quadra 950 needs 80-ns DRAMs. Here's a list of Mac-family DRAM speed requirements:

- Plus, SE—150 ns
- Classic, SE/30, II, IIx, IIcx—120 ns
- IIsi, LC, LC II, Classic II, Performa 200, Performa 400—100 ns
- IIci, IIfx, IIvx, Quadra 700, Quadra 900, Quadra 950, Performa 600—80 ns

When shopping for Mac memory upgrades, look for chips whose access time equals or is faster than that required for your Mac.

You can use DRAMs with a faster access time than your Mac requires. 80-ns DRAMs work fine in a Mac IIsi, for example, but they do not improve performance because the Mac IIsi's circuitry is designed for the timing of 100-ns DRAMs. Macs assume a specific access time for their DRAM chips, and cannot take advantage of faster ones.

Still, there is one good reason to buy faster DRAMs than your Mac requires: if you upgrade to a faster model, you will be able to use your old SIMMs.

Should You Install RAM Yourself?

Installing SIMMs isn't difficult work, but it is delicate work. The SIMM slots in many Macs use plastic retaining clips that are easily broken. (The SIMM slots in most newer Macs use metal clips that are much easier to work with and much more durable.) A slot with a broken clip will not hold the SIMM tightly enough for reliable operation; you will probably have to replace the Mac's entire logic board at a cost of at least several hundred dollars (much more for costlier Macs).

Most companies that sell RAM upgrades include informative booklets or even videos that show how to tackle the job. Read the instructions (or watch the video) a couple of times to make sure you have the routine down. And if you doubt your abilities, have a technician do the job. It will not cost much, especially compared to buying a new logic board.

Mac Plus and SE DRAM Configurations

A one-megabyte Mac Plus or SE contains four SIMMs, with each SIMM containing eight 256-Kbit DRAM chips. You can expand the Plus' and SE's memory to 2, 2.5, or 4 megabytes. Here's how the SIMMs are configured for each upgrade:

- The 2MB configuration uses two 1MB SIMMs. In this configuration, two of the logic board's SIMM slots are vacant.
- The 2.5MB configuration uses two 1MB SIMMs and two 256-Kbit SIMMs.
- The 4MB configuration uses four 1MB SIMMs.

The Plus and SE require additional components called *RAM size resistors* to be installed in various combinations, depending on how much RAM the machine contains. Adding a RAM upgrade to a Plus or SE requires installing or removing certain RAM size resistors and making minor adjustments in the Mac's power supply to accommodate the new DRAM chips. (On later SE models, the RAM size resistors were replaced with a three-pin *jumper* that you remove when upgrading to 2.5MB or 4MB.) This is another reason we recommend you have a classic Mac upgraded by a qualified technician.

Mac Classic Configurations

The Mac Classic accepts an optional memory expansion board that contains 1MB of RAM as well as two SIMM slots. Table 15.4 lists possible RAM configurations for the Mac Classic.

Table 15.4: Mac Classic RAM configurations.

Total RAM	SIMMs Needed
2MB	Expansion Board
2.5MB	Two 256K and Expansion Board
4MB	Two 1MB and Expansion Board

Mac Classic II Configurations

The Classic II's logic board contains 2MB of RAM and two SIMM slots. Both SIMMs must be of the same capacity. Table 15.5 lists possible RAM configurations for the Mac Classic.

Table 15.5: Mac Classic II RAM configurations.

Total RAM	SIMMs Needed
4MB	Two 1MB
10MB	Two 4MB

Mac LC Configurations

The Mac LC's logic board contains 2MB of RAM and two SIMM slots. Both SIMMs must be of the same capacity, and you must add two at a time. Table 15.6 lists possible RAM configurations for the Mac LC.

Table 15.6: LC RAM configurations.

Total RAM	SIMMs Needed
4MB	Two 1MB
10MB	Two 4MB

LC II Configurations

The Mac LC II logic board sports 4MB of RAM and two SIMM slots. Table 15.7 lists possible RAM configurations for the Mac LC II.

Table 15.7: LC II RAM configurations.

Total RAM	SIMMs Needed
6MB	Two 1MB
10MB	Two 4MB

Mac II, IIx, IIcx, IIci, and SE/30 Configurations

Each of these machines provides eight SIMM slots. Each set of four slots is called a *bank;* the two banks are named *bank A* and *bank B*. Table 15.8 lists the SIMM configurations for these machines.

Table 15.8: SIMM configurations for the Mac II, IIx, IIcx, IIci, and SE/30.

Total RAM	SIMMs Needed
1MB	Four 256K
2MB	Eight 256K
4MB	Four 1MB
5MB	Four 256K, Four 1MB
8MB	Eight 1MB

In addition to the above configurations, the SE/30, IIcx, and IIci can accommodate greater amounts of RAM (see Table 15.9.)

Table 15.9: Mondo memory configurations for the SE/30, IIcx, and IIci.

Total RAM	SIMMs Needed
16MB	Four 4MB
17MB	Four 256K, Four 4MB
20MB	Four 1MB, Four 4MB
32MB	Eight 4MB
64MB	Four 16MB

Total RAM	SIMMs Needed
65MB	Four 256K, Four 16MB
68MB	Four 1MB, Four 16MB
80MB	Four 4MB, Four 16MB
128MB	Eight 16MB

Mac IIsi Configurations

The IIsi's logic board contains 1MB of RAM and four SIMM slots. When upgrading RAM, you must add four SIMMs at a time, and all must have the same capacity. Table 15.10 lists the SIMM configurations for the IIsi.

Table 15.10: SIMM configurations for the Mac IIsi.

Total RAM	SIMMs Needed
2MB	Four 256K
5MB	Four 1MB
17MB	Four 4MB
65MB	Four 16MB

Mac IIvx, Performa 600 Configurations

These Macs contain 4MB of RAM soldered to their logic boards. They also provide four SIMM slots. Table 15.11 lists the SIMM configurations for the IIsi.

Table 15.11: SIMM configurations for the Mac IIvx and Performa 600.

Total RAM	SIMMs Needed
8MB	Four 1MB
20MB	Four 4MB
68MB	Four 16MB

Mac IIfx Configurations

The IIfx contains eight SIMM slots, and requires special 64-pin SIMMs designed for the IIfx. If you use both 1MB and 4MB SIMMs, the 4MB SIMMs must be installed in Bank A. Table 15.12 lists the SIMM configurations for the IIfx.

Table 15.12: SIMM configurations for the Mac IIfx.

Total RAM	SIMMs Needed
4MB	Four 1MB
5MB	Four 1MB, Four 256K
8MB	Eight 1MB
16MB	Four 4MB
17MB	Four 4MB, Four 256K
20MB	Four 4MB, Four 1MB
32MB	Eight 4MB
64MB	Four 16MB
65MB	Four 16MB, Four 256K
68MB	Four 16MB, Four 1MB
80MB	Four 16MB, Four 4MB
128MB	Eight 16MB

Macintosh Quadra 700

The Quadra 700's logic board sports 4MB of RAM and four SIMM slots. SIMMs used in the Quadra 700 must be 1MB or larger, and all four must have the same capacity. Table 15.13 lists the SIMM configurations for the Quadra 700.

Table 15.13: SIMM configurations for the Mac Quadra 700.

Total RAM	SIMMs Needed
8MB	Four 1MB
20MB	Four 4MB
68MB	Four 16MB

Macintosh Quadra 900 and 950

The Quadra 900 and 950 provide a slew of SIMM slots: 16 to be exact, organized in four banks of four. Each bank must contain SIMMs of the same capacity, and larger-capacity SIMMs must fill out the lowest banks first. Table 15.14 lists the SIMM configurations for the Quadra 900 and 950.

Table 15.14: Quadra 950 SIMM configurations.

Total RAM	SIMMs Needed
4MB	Four 1MB
8MB	Eight 1MB
12MB	Twelve 1MB
16MB	Sixteen 1MB or Four 4MB
20MB	Four 4MB, Four 1MB
24MB	Four 4MB, Eight 1MB
28MB	Four 4MB, Twelve 1MB
32MB	Eight 4MB
36MB	Eight 4MB, Four 1MB
40MB	Eight 4MB, Eight 1MB
48MB	Twelve 4MB
52MB	Twelve 4MB, Four 1MB
64MB	Eight 4MB

Using 4MB SIMMs on the Original Mac II

The original Mac II cannot use standard 4MB SIMMs. Instead, you need special 9-chip SIMMs that contain a programmable-array logic (PAL) chip. If you want to use 4MB SIMMs on an original II, be sure to specify that you're buying them for this machine.

This restriction doesn't apply if you get Apple's SuperDrive upgrade kit for the original II. This upgrade kit also includes new ROM chips that eliminate the need for special 4MB SIMMs.

Where are the DIP Switches?

If you have ever installed memory in an IBM PC or compatible computer, you may have struggled with *DIP switches*—those infuriatingly small switches on the PC's motherboard that you set to tell the computer how much memory you have installed. If you upgrade your Mac's memory, you will be spared that chore. When you switch the Mac on, ROM-based diagnostic software tests the RAM and determines how much is installed. This diagnostic routine stores a value in RAM that corresponds to the amount of memory your Mac contains. The Finder and other parts of the Mac's system software can access this value to find out how much memory your Mac contains.

A Word About ROM

Although this section concentrates on RAM, some of the concepts we have discussed also apply to ROM. ROM density—the capacity of a ROM chip—is described in the same way: in kilobits or megabits. And as with RAM chips, multiple ROM chips are electrically tied together.

One DRAM concept that doesn't apply to ROMs is that of a regular refresh cycle. Because a ROM's contents are electrically frozen at the factory, a ROM chip doesn't require a refresh signal at regular intervals. Simply put, ROM chips don't forget.



NuBus Details

The expansion slots that most Macs provide give plug-in cards direct access to these machines' data and address buses. If the bus is a freeway, then a slot is a set of on-ramps and off-ramps. When you plug an expansion board into a slot, you connect its circuitry directly to the Mac's main freeways. Because an expansion board is connected directly to the internal bus, it has fast, direct access to the CPU and other components. Put another way, when performance counts, ride the bus.

We spotlighted the key categories of expansion boards in Chapter 4, and we looked at the processor-direct slots (PDS) that many Macs provide. In this section, we take a closer look at the primary method of expansion in the Macintosh family: NuBus.

NuBus Background

NuBus is a bus standard developed in the 1970s at the Massachusetts Institute of Technology and refined in 1985 by a standards committee comprising engineers and representatives from MIT, AT&T, Texas Instruments, Apple, and other firms. Like many computer- and electronics-related standards, NuBus was born under the auspices of the Institute of Electrical and Electronic Engineers (IEEE, usually pronounced *eye-triple-e*).

Two primary factors contribute to the sophistication of NuBus.

- NuBus supports multiple processors. NuBus slots are designed to coordinate the workings of numerous processors, including the CPU on the main logic board. If your work involves specialized tasks, such as real-time animation or sound processing, you can equip your Mac with the appropriate coprocessor boards to perform those tasks more quickly.
- NuBus boards configure themselves. In the IBM PC world, installing an expansion board often means the DIP switch dance—fussing with the settings of DIP switches in an attempt to get all your expansion boards to coexist. All NuBus boards are self-configuring: you plug them in, switch on your Mac II, and go.

Let's take a closer look at the technicalities that make these strengths possible.

Sharing the Bus

NuBus provides a scheme that allows an expansion board to become a *bus master*. As its name implies, the bus master is a board that has control of the bus. Under normal operation, the Mac's logic board is the bus master; however, thanks to special NuBus control signals, a NuBus board can say, "I'm the boss now," and take over the bus to become the new bus master. Accelerator boards, such as the Radius Rocket, use this feature to disable the Mac II's CPU. More significant, coprocessor boards can use this feature to work *with* the CPU—taking over when a specialized task arises, and then returning control to the CPU when their work is done.

NuBus provides a *fair arbitration* scheme of bus arbitration. That simply means that each card installed in the machine has the same chance of becoming a bus master as the card next to it—no slot has a higher priority than another; all slots are considered peers.

Automatic Configuration

The self-configuring nature of NuBus boards allows you to fill a Mac with boards without worrying about them conflicting with each other. Each NuBus board contains a *configuration ROM,* a ROM chip that tells the Mac what the board can do: control a video monitor, perform graphics calculations, provide additional memory, and so on.

A configuration ROM also may contain other items, including (but not limited to):

- Driver software the board can load into the Mac's memory upon startup to activate the board's features
- Text information about the board, such as its name and version number, that may appear in a Control Panel or application program
- A serial number to thwart software pirates (a company selling a combination hardware-and-software product may use this feature to write software that runs only when its matching board is installed)

Two components of the Mac's system software, the *Slot Manager* and the *Start Manager,* work together with a NuBus board's configuration ROM. As its name implies, the Start Manager orchestrates the Mac's start-up process. Part of that job involves using the Slot Manager to check for NuBus cards and to load any special software from their configuration ROMs into the Mac's memory. The Start Manager performs this check-and-load routine just prior to loading any INIT resources that may be in your startup disk's System Folder.

Variations from the NuBus Standard

In the computer world, standards aren't always standard. That's the case with Apple's implementation of NuBus in the Macintosh. NuBus wasn't designed with personal computers in mind; for that reason, Apple adapted the original draft of the standard in several areas. These changes eventually became part of a revised NuBus standard. A few of the more significant adaptations include the following:

- *Different physical dimensions for boards.* The NuBus standard calls for boards to measure approximately 11-by-14 inches. Obviously, accommodating such large boards would require a huge case. Moreover, few computer expansion boards need that much real estate to hold their circuitry. Apple created an alternate board size of approximately 4 by 13 inches. The Quadra 900 and 950 can accommodate a board that's up to 6 inches tall.
- *An additional signal line for interrupts.* The NuBus standard provides no provision for simple interrupts. Instead, a board that needs the CPU's

attention must become a bus master. And that means equipping the board with the circuitry necessary to handle NuBus' bus-arbitration techniques. That kind of sophisticated circuitry is overkill for relatively simple cards, such as internal modems or cards, that provide additional serial ports. To allow a board to get the CPU's attention without becoming a bus master, Apple added a new signal line named NMRQ, short for *non-master request.*

- *An enhanced power-fail warning signal.* The NuBus standard specifies a signal line named PFW, short for *power fail warning.* The original NuBus standard intended the PFW line to be used as a way of warning a board that power to the system was about to be removed. Apple enhanced the workings of the PFW line so that it can not only warn of an impending shutdown, but also actively turn the power off or on. Thus, a NuBus board can use the PFW line to control the Mac's power. A modem board and communications program may use this feature to turn the Mac on at a specified time, sign on to an electronic mail service to retrieve waiting mail, and then turn the Mac off.

Quadra NuBus Differences

We just mentioned that the Quadra 900 and 950 can accommodate a slightly larger NuBus board than other Macs. The Quadra family (including the 700) has other differences where NuBus is concerned. The Quadras support some of the features of a new version of the NuBus specification, called *NuBus 90,* which allows for faster data transfers between NuBus boards and between a NuBus board and the CPU, main memory, and video memory.



The Mac's Microprocessors

A computer's hardware is like a football team: every team member is needed, but one member is especially important. In football, it's the quarterback; in a computer, it's the CPU. This section is an introduction to the CPUs used in the Mac family. We will provide an overview of how a microprocessor operates, and we spotlight the key characteristics of each Mac's CPU chip.

What's in a Number?

Most introductions begin with an exchange of names, so let's start there. The Mac family uses the MC68000 series of microprocessors designed and manufactured by Motorola. The matriarch of the family is the MC68000, introduced in 1979.

The Mac wasn't the first computer to use the 68000, but it was the Macintosh that gave the 68000 the prominence it enjoys today. The Mac 128K, 512K, 512K Enhanced, Plus, SE, Classic, and PowerBook 100 all use the 68000.

Just as computer companies compete by introducing ever-faster machines, microprocessor makers are always at work creating faster, more efficient versions of their best-selling chips. Indeed, computer companies and chip makers have a symbiotic relationship: computer makers' constant desire to create faster machines drives the progress of the microprocessor industry. Or perhaps the progress of the microprocessor industry inspires computer makers to take advantage of faster chips. In either case, when a computer company wants to create a faster machine, it turns to the newest generation of microprocessors.

In 1984, Motorola introduced the 68020, the CPU used in the original Mac II and in the original LC. The 68020 offered faster performance while remaining compatible with the 68000.

In 1987, Motorola unveiled the 68030. This chip doesn't provide the leap in performance that the 68020 provided over the 68000, but as you will see shortly, it is slightly faster and, more important, it offers the built-in PMMU circuitry needed for System 7's virtual memory. The Mac IIx, IIcx, IIci, IIvi, IIvx, Performa 400 and 600, and SE/30 use the 68030, as do all PowerBooks except the 100. Accelerator boards that use the 68030 are available for many compact Mac models.

The Motorola 68040 is currently the flagship of the 68000 family. Combining a built-in math coprocessor with numerous performance-enhancing features, it's the fastest and most sophisticated 68000-family processor yet. Accelerator boards that use the 68040 are available for most Macs, too.

In the interest of brevity, the 68020 and 68030 are often referred to as the 020 and 030, respectively. If you're concerned about pronunciation, here's the way to name drop:

- 68000—sixty-eight-thousand
- 68020—sixty-eight-oh-twenty, or oh-twenty for short
- 68030—sixty-eight-oh-thirty, or oh-thirty for short
- 68040-sixty-eight-oh-forty, or oh-forty for short

Common Denominators

While there are some significant differences between the 68000 and its successors, all four chips—and, for that matter, all microprocessors—share a great deal of common ground. The primary components of the 68000 and its successors include:

Registers. Registers are similar to memory, in that they can store data and program instructions. Unlike a computer's main memory, however, registers are built into the CPU chip itself, and they provide a very limited amount of storage space. Some registers serve as small scratchpads where the CPU can store the results of calculations or a set of numbers to be calculated or compared. Other registers perform behind-the-scenes tasks, such as storing the currently executing instruction and keeping track of which instruction is to be executed next.

Arithmetic and logic unit, or *ALU.* The ALU is the part of a microprocessor that performs arithmetic and decision-making operations. The ALU swings into action when a calculation needs to be performed or when two values need to be compared to determine which is greater.

Instruction decoder. When a program instruction has been transferred from memory into the CPU's *instruction register,* the instruction decoder deciphers the instruction and causes the chip's internal timing circuits to produce the sequential signals necessary to perform the events that the instruction specifies.

Internal address and data buses. Don't confuse these buses with the address and data buses that traverse the Mac's logic board. A microprocessor's address and data buses exist within the processor's subminiature world, and connect to the computer's address and data buses.

The 68020 Difference

The 68020 provides several distinct advantages over the 68000.

- It's a true 32-bit microprocessor. The 68000 provides a 32-bit internal bus, but a 16-bit external bus: the chip can manipulate data in 32-bit chunks, but transfers data to and from the Mac's data bus in 16-bit chunks. By discarding this hybrid approach, the 68020 can move twice the data in the same amount of time.
- It contains a 256-byte *instruction cache,* a small area of high-speed, on-chip memory that stores the most recently used instructions and supplies them to the CPU if they're needed again. According to Motorola, the instruction cache boosts performance by 40 percent by allowing near-instantaneous access to recently used instructions.
- It can accommodate faster clock rates. The 68000 can accommodate clock rates of up to 16.67MHz. The 68020 can run at up to 33MHz.

The 68030: In the Mainstream

The 68030 represents the further evolution of the 68000 family. The 68030's primary improvement is its built-in *paged memory-management unit,* or *PMMU.* The PMMU in the 68030 allows 030-based Macs to take advantage of System 7's virtual memory feature. By swapping chunks, or *pages,* of memory between the hard disk and RAM chips, the Mac can run larger programs as well as run more programs at the same time.

The 68030's other improvements include the following:

- A 256-byte *data cache,* which holds 256 bytes of the most recently used data, and supplies the data to the CPU if it's needed again, eliminating the need for the CPU to retrieve it from main memory or from disk. The 68030 also retains the 256-byte instruction cache found in the 68020. (These caches aren't related to the Mac's RAM cache, which we looked at in Chapter 10.)
- Two internal 32-bit address and data buses. These buses operate in parallel, allowing the CPU to perform multiple tasks simultaneously, thus boosting performance. The 68030 can access its instruction cache, data cache, and external memory simultaneously, for example. The 68030 was the first microprocessor to have two internal address and data buses. This parallel bus design first appeared in some mainframe computer CPUs, and is called the *Harvard-style bus architecture.*

The 68040: Moving Toward Tomorrow

The 68040 is the top of the line processor in the current Macintosh family. It contains 1.2 million transistors—four times the number found on the 68030, and six times the number on the 68020. Like the 030, the 68040 contains a built-in PMMU. The 040 also contains a subset of the 68882 math coprocessor. This enables the 040 to handle some (but not all) of the math calculations that would normally be shuttled to a math chip.

Other improvements in the 68040 include the following:

- Two built-in, 4K caches—one for data and one for instructions. (The 68030 also contains data and instruction caches, but each holds only 256 bytes.) The caches can operate in a faster mode called *copy-back* mode; it's this mode that causes problems with application programs that violate Apple's guidelines.
- A six-stage *pipeline* design. *Pipelining* is the process of decoding and executing several program instructions at the same time. An

instruction pipeline works much like an assembly line: each stage works on its own portion of a given program instruction.

The 68040 also uses the Harvard-style architecture found in the 68030.



Math Coprocessors

The 68020 and 030 also have the ability to *off-load* instructions to a different microprocessor; that is, they can turn certain instructions over to a different processor instead of executing them themselves. Most Macs take advantage of this feature by including or supporting optional *math coprocessors,* specialized microprocessors designed to calculate and store *floating point* values—numbers with decimal portions—faster and more accurately than a general-purpose microprocessor. Because math coprocessors specialize in floating-point calculations, they're often called *floating-point coprocessors.*

The CPU and a math coprocessor work together: when the CPU encounters a complex calculation, it says to the math chip, "This is your job; I have other things to do." The coprocessor performs the calculation and transfers the result to the CPU, which, by then, is ready to perform the next program instruction. The result of this joint effort is that a coprocessor-equipped Mac can perform calculations roughly 200 times faster than other Macs.

The Mac II used Motorola's 68881 math chip. Other Macs use (or support) the faster and newer 68882. According to Motorola, the 68882 is two to four times faster than the 68881. Two primary factors combine to give these chips their number-crunching skills.

- Both contain special circuits that can store and process information in 80-bit (10-byte) chunks. This allows the processor to accurately calculate values with up to 18 digits after the decimal point. Without a coprocessor, the Mac's calculations are accurate to a maximum of 14 digits.
- Both contain many built-in *constants* (values that don't change, such as 0, 1, and pi) as well as transcendental and non-transcendental functions for performing trigonometric and logarithmic calculations. These constants and functions are part of the coprocessor's hardware; without a coprocessor, the CPU must tie up memory and time by using software routines to perform the calculations.

The 68000 doesn't have a built-in coprocessor interface; however, it does provide bus-arbitration signal lines that allow a math coprocessor to gain control of the internal bus in order to do its work. Accelerator boards containing math coprocessors are available for the Mac Plus, SE, and Classic.

Do You Need a Math Coprocessor?

A *math coprocessor* does not improve your Mac's overall performance. It does not, for example, enable programs to start up faster or windows to scroll more quickly. A math chip is just that—a chip that speeds up math calculations. Starting programs and scrolling windows don't require extensive calculations; they simply involve moving lots of data from Point A to Point B.

So when does a math chip help? It will dramatically improve recalculation times with spreadsheets, such as Microsoft Excel and with engineering and math applications, such as Mathematica.

A math chip also improves the performance of 3-D rendering packages, such as Strata's StrataVision 3d, Ray Dream's Ray Dream Designer, and Pixar's MacRenderMan, Showplace, and Typistry. In order to create their photorealistic images, these programs must perform millions of complex floating-point calculations.



The Start-Up Process

Sometimes it seems like the Mac takes a long time to start up. Like the Concorde supersonic jet, the Mac works pretty quickly, but it takes a while to get off the ground.

The fact is, quite a few things happen between the time you switch on the Mac and the time the Finder's Desktop appears. When you switch the Mac on, it appears that the machine simply beeps and asks for a disk. Behind the scenes, however, the Mac's ROM-based Start Manager performs a series of tests and tasks before the beep is sounded.

Phase 1: Initialization

The first part of the Mac's start-up process is the *initialization process*. The initialization process sets the Mac's hardware and software components to known states. The process occurs when you switch the power on or restart the Mac by pressing the programmer's switch or choosing the Finder's Restart command.

The following list describes what happens:

1. A set of diagnostic routines tests various chips. If no problems are detected, the Mac's startup tone is sounded and the hardware components are initialized.

2. Memory is tested. If you've just switched the machine on, the Mac performs a complete memory test; if you're restarting, a faster, less-extensive test is performed.
3. The Start Manager determines which CPU is installed and the clock rate at which it's running. The results of these tests are stored in memory where the operating system and application programs can access them to find out about your hardware.
4. Key memory values used by the operating system and its various managers are initialized; that is, set to specific values and known states.
5. A small amount of memory, called the *system heap,* is set aside for the operating system's use.
6. Several ROM-based managers are initialized.
7. On NuBus-equipped Macs, the Slot Manager is initialized and the configuration ROM of each installed NuBus card is read. If the configuration ROMs contain any initialization code for their boards, the code is executed.
8. The ADB Manager, which controls the Apple Desktop Bus, is initialized.
9. The Start Manager looks for a video board or video circuitry to use for the primary video display. During this process, QuickDraw is initialized and the gray Desktop is drawn.
10. The SCSI Manager, Disk Manager, and Sound Manager are initialized.
11. The arrow pointer appears.

Phase 2: System Startup

A great deal has happened, but so far, all we have is a gray Desktop with an arrow pointer on it. Phase 2 of the startup process involves starting the Macintosh from a disk and turning control over to the Finder. The following list describes what happens:

1. The drive number of the internal SCSI hard disk (if one is installed) is obtained from the Mac's battery-powered parameter RAM. The Start Manager pauses for up to 30 seconds to allow the hard disk to spin up to speed.
2. The Start Manager looks for a start-up device. First, it checks the floppy disk drives for a disk. If no disk is found, the Start Manager uses the drive you specified as the start-up device (using the Startup Disk

Control Panel). If you never specified a start-up drive, or if that drive is disconnected or otherwise unavailable, the Start Manager looks for drives attached to the SCSI port.

3. After the Start Manager has located a start-up drive, it reads the system-startup information from that drive. On a Mac equipped with NuBus slots, a NuBus board can intercept the start-up process at this point and take over the system.
4. The System file on the current start-up drive is opened and the Mac's Resource Manager, System Error Handler, and Font Manager are initialized.
5. The `Welcome to Macintosh` message appears.
6. If it's present on the disk, the system *debugger,* a software utility used by programmers to ferret out bugs, is loaded. Unless you have configured your system to load a debugger, this step will not occur on your system.
7. ROM patches are loaded from the System file into memory.
8. On Macs equipped with the Apple Desktop Bus, all ADB-related routines are loaded from disk and executed.
9. The Mac begins to track mouse movement.
10. Driver software corresponding to installed NuBus boards may be loaded and executed, depending on the nature of the boards.
11. The RAM cache specified in the Memory Control Panel is created, and an area of memory for holding applications, the *application heap,* is set aside and initialized.
12. All extensions and Control Panels containing INIT resources are loaded.
13. The size of the system heap (created in step 5 of the initialization process) is adjusted as needed.
14. The Finder starts.

Finally—the Macintosh is up and running.

CHAPTER

16

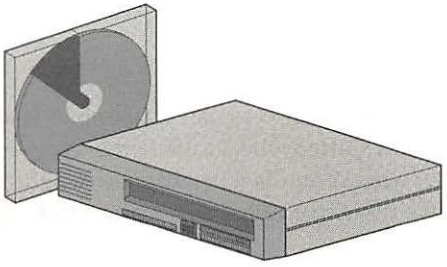
INPUT AND OUTPUT

WHAT'S INSIDE

- How the Mac's keyboard and mouse operate
- How the Mac produces sound
- How the Mac's SCSI bus operates
- Connecting SCSI devices—and living to tell about it
- Serial data transmission terms and concepts

As essential as the Mac's buses, RAM and ROM chips, slots, and CPU are, they're worthless unless you can get information into and out of the computer. That's where the keyboard, mouse, video screen, and external ports come in.

We looked at Macintosh video, font, and printing concepts in earlier chapters. In this chapter, we examine the rest of the Mac's input and output features.



The Keyboard and Mouse

You may recall from the previous chapter that the Mac uses interrupts to maintain a constant vigil for keystrokes and mouse movements. Let's take a closer look at how the keyboard and mouse operate.

The Mac Plus and earlier Macs use a different keyboard and mouse than the SE, the II family, and other Macs equipped with the Apple Desktop Bus, or ADB. For that reason, we discuss the keyboards and mice for non-ADB Macs separately from those used by ADB-equipped Macs.

The Non-ADB Keyboards

Keyboards for the pioneering Macs come in two flavors—the original keyboard, which lacks cursor keys and a built-in numeric keypad (a detached keypad was optional); and the Mac Plus keyboard, which offers a keypad and cursor keys. Internally, all non-ADB Mac keyboards operate in the same way. The keyboard contains its own microprocessor, which receives power from one of the four wires that connects the keyboard to the Mac. The microprocessor contains a small amount of RAM and ROM dedicated to watching for keystrokes and communicating with the Mac.

As for the other three wires, one carries data between the keyboard and Mac. The keyboard's *data line* is a serial line; data travels from the keyboard to the Mac (and vice-versa) in serial fashion. Another wire carries a clock signal that times the transmission of data from the keyboard to the Mac. The fourth wire is connected to *ground*. (In any electrical circuit, ground is a common point of connection.)

When a key has been pressed or released, the keyboard transmits a code corresponding to the key's position to a chip in the Mac. That chip generates an interrupt to the CPU, and the CPU uses the Mac's data bus to retrieve the key code from the chip. If you press a key before releasing a different key, the keyboard interprets both keystrokes in their proper sequence. This feature is called *two-key rollover*.

The Mac Plus Mouse

The Mac Plus' mouse contains a rubber-coated steel ball that touches two *capstans*, each connected to a slotted wheel called an *interrupter wheel* (see figure 16.1). Each interrupter wheel is sandwiched between a light-emitting diode (LED) and a light-sensitive transistor called a *phototransistor*.

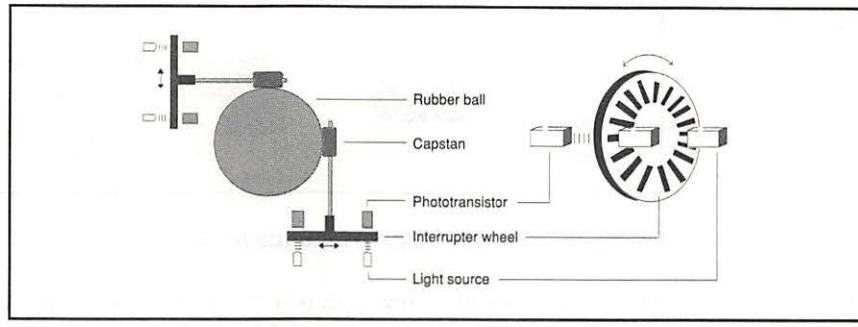


Figure 16.1: Inside a Mac Plus mouse.

When you move the mouse, the ball rolls and turns the interrupter wheels. Horizontal motion turns one of the wheels, while vertical motion turns the other. Each slot in each interrupter wheel enables light from the LED to reach the phototransistor. The phototransistors respond to the pulses of light by generating signals corresponding to the wheel's movement. A mouse that combines a mechanical roller ball with optical measuring techniques often is called an *opto-mechanical* mouse.

The signals from the mouse's phototransistors travel through the mouse cable to the Mac. One signal simply tells the Mac that the mouse has moved; others indicate the direction of movement. A chip generates an interrupt for the CPU, and the Mac's mouse driver software consults the chip to determine what direction the mouse is moving.

What about the mouse button? Beneath the button is a small switch (a *microswitch)* that, when pressed, completes a circuit. The Mac checks the state of the mouse button each time the video circuitry finishes painting a complete screen image. That occurs roughly 60 times per second—fast enough to catch the most fleeting press of the mouse button.



The Apple Desktop Bus

As you saw in Chapter 4, Apple created ADB in order to have a standard interface for input devices on all of its computers, thus eliminating the need to manufacture several different types of mice and keyboards. But the bus also has an advantage for you: it can accommodate multiple input devices. You can attach several input devices to your Mac by *daisy-chaining* them—connecting one device's output to another device's input (see figure 16.2).

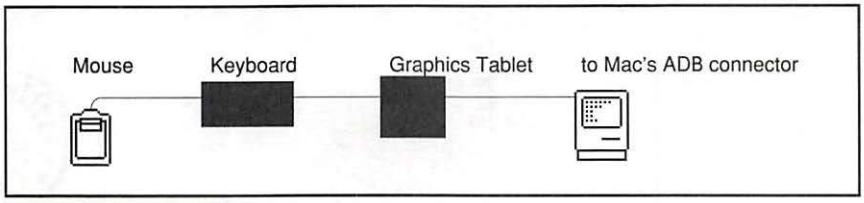


Figure 16.2: Daisy-chaining input devices.

ADB's capability to accommodate daisy-chained devices enables you to attach more than two input devices to a Mac. An architect or illustrator may want to use a graphics tablet in addition to the keyboard and mouse. A foreign-language translator may want to use a foreign-language keyboard along with the English-language keyboard. Technically, ADB can accommodate up to 16 devices, but Apple recommends against daisy-chaining more than three because ADB signals can weaken as they travel through the devices' wiring.

How ADB Works

ADB is a *single-master, multi-slave serial bus*. That's a mouthful, but it translates into a few simple concepts.

Single-master. The Mac is always in control of the Apple Desktop Bus. When a device needs to send data to the computer, it transmits a *service request* signal to the Mac, which acknowledges the request and then reads the data.

Multi-slave. We have touched on this point already; ADB can accommodate up to 16 devices. When the Mac starts up, it assigns each device its own address. The Mac uses these addresses to identify each device on the bus.

Serial. ADB transmits the bits that comprise each byte in serial fashion (with one bit following the next). ADB is limited to a maximum data-transmission speed of about 4,500 bits per second (bps). That's slow for a computer interface; but remember, ADB was designed for input devices; 4,500 bps is fast enough to keep up with the fastest typists and mouse movers.

Every ADB device contains an *ADB transceiver chip,* a microprocessor that transmits and receives *(transceives)* data to and from the Mac. Communications between the Mac and an ADB device is a joint effort between these chips.

The ADB Keyboards

Apple offers two ADB keyboards—the *Apple Keyboard II* and the *Apple Extended Keyboard II*—for use in English-speaking countries. (A number of foreign-language keyboards are also available.) Both ADB keyboards work similarly. When you press a key, its corresponding code is stored in the keyboard's ADB transceiver, and then transmitted to the Mac's ADB transceiver. The ADB transceiver forwards the data to another chip, and the ADB Manager transfers control to the Mac's keyboard driver software, which interprets the code and makes it available to applications.

Like the original Mac keyboards, both ADB keyboards provide two-key rollover.

Keyboard Mapping

Every key transmits a unique code, or number. Within the Mac's keyboard driver software, every key code is assigned, or *mapped,* to a given character. When the driver software receives a key code, it consults a resource in the System file called KCHR to learn the character that corresponds to that code. The driver then passes the appropriate character to the active application.

This may seem like technical trivia, but you can use it to your advantage. By editing KCHR resource with Apple's ResEdit, you can *remap* the keyboard—change the workings of some or all of the keys on the keyboard. You may want to remap only a few keys—to more conveniently access opening and closing quotes, for example, or you may want to create an entirely different keyboard layout, such as the Dvorak Simplified Layout, a more efficient layout developed by August Dvorak in the 1940s. Many keyboard layout variations are available through user groups and online services.

Incidentally, the KCHR resource is also the key to the Mac's multilingual keyboard capabilities. When you use the Keyboard Control Panel to switch between, the U.S. and French keyboard layouts, for example you're actually switching KCHR resources.

The ADB Mouse

The ADB mouse sports a sleek design that fits the hand more comfortably than the original Mac mouse. Underneath, the ADB has large Teflon feet that help the mouse move smoothly. The original Mac mouse, by contrast, has molded plastic feet that can wear after extensive use, hampering the mouse's movement. (For some tips for making the original Mac mouse roll more smoothly—and for cleaning all Mac mice—see Chapter 8.)

Internally, the ADB mouse works in much the same way as the original Mac mouse. The signals generated by the ADB mouse's interrupter wheels travel to the mouse's ADB transceiver chip, which communicates with the ADB transceiver in the Mac. The Mac's ADB transceiver forwards the mouse information to the Mac, and ROM routines translate the information into on-screen pointer movement.

Two Fine Points about the Mouse

Before leaving the Mac's input devices to discuss its sound features, let's look at two mouse-related details:

- The difference between relative and absolute motion pointing devices
- Mouse tracking, how it affects pointer movement, and which tracking settings you may want to use.

The following points apply to all Mac mice.

Relative versus Absolute Motion

The Mac's mouse is a *relative-motion* pointing device. That is, the mouse doesn't report where it is—for example, two inches from the edge of your desk, or at the upper-left corner of the screen. Instead, the mouse reports only how far it has moved and in which direction.

For most applications, that's all you need. It can be a drawback for some graphics-oriented applications, however, particularly for drafting or illustration jobs that involve tracing artwork. For such applications, you may prefer an *absolute-motion* pointing device, such as a graphics tablet, which does report the location of its stylus relative to the tablet's surface area.

Controlling the Pointer Speed

You may remember from Chapter 5 that the Mouse Control Panel enables you to specify how the mouse's physical speed relates to the speed of the on-screen pointer. This ratio of mouse speed to pointer speed is called *mouse tracking* or *mouse scaling.*

The Mac's designers knew that users would sometimes need a great deal of pointer precision (when using a drawing or desktop publishing program, for example), but that they would also want to be able to zip the pointer from one end of the screen to the other in a hurry; to move to a scroll bar or up to the menu bar, for example. To accommodate both requirements, they gave the Mac

a mouse tracking feature. With the slowest tracking settings, the mouse needs more desk space to move the pointer. With faster tracking settings, the Mac senses when you're moving the mouse quickly, and zips the pointer across the screen.

To illustrate the difference, we created a mouse dragstrip by clamping a ruler to the edge of a desk. Next, we made sure that the mouse pointer was at one end of the screen, and then we butted the flat edge of the mouse against the ruler. Finally, we moved the mouse as quickly as possible and measured how much desk space was required to move the pointer from one end of a 13-inch monitor to the other. In the slowest setting, the mouse required nine inches of desk space to move the pointer across the screen. In the fastest setting, the mouse required less than two inches.

So which tracking settings should you use? That depends on several factors:

Whether you're using a mouse or PowerBook trackball. As we mentioned in Chapter 8, a PowerBook's trackball often feels more precise when used with slower tracking settings.

Your mouse or trackball proficiency. If you're new to the Mac and haven't quite gotten the hang of pointing and clicking, you may prefer the slower tracking settings at first.

The size of your monitor. If you have a 13-inch or larger monitor, you will probably prefer the faster tracking setting for general-purpose navigation tasks: scrolling, choosing menu commands, and dragging.

What you're using the mouse for. If you're using a publishing or drawing program, and you want extra pointer precision, consider using the slower tracking settings. Slower settings won't actually increase the mouse's precision (it registers roughly 200 units of movement per inch regardless of the tracking setting), but they will make it easier to move objects in single-pixel increments.



Sound Details

We examined how sound fits into the Macintosh world, how to attach your Mac to an audio amplifier, and how to customize your Mac's alert sounds. In this section, we explore the technicalities behind the Mac's audio capabilities. If you're unfamiliar with such sound-related terms as *waveform*, and *frequency*, you will find some background in the backgrounder sidebar, "Sound Basics."

Backgrounder: Sound Basics

Sound is formed by variations in air pressure. When you speak, your vocal cords vibrate, causing "ripples" in the air around them, just as a stone plopping into a pond causes ripples in the water. When these atmospheric ripples, or *sound waves,* reach your ears, they cause your eardrums to vibrate accordingly. The eardrums generate minute electrical pulses that the brain receives and interprets as sound. Loudspeakers and microphones mimic the workings of the vocal chords and ear, respectively: a speaker uses a vibrating paper cone to recreate variations in air pressure, while a microphone uses a small, eardrum-like *diaphragm* to sense variations in air pressure and generate corresponding electrical pulses.

Sound waves generally follow a repeating pattern that can be displayed visually (see figure 16.3). In these *waveform* displays, the vertical axis represents the sound's loudness, or *amplitude,* while the horizontal axis represents time. The peaks in a waveform display correspond to regions of higher air pressure; the valleys, or *troughs,* represent lower air pressure; the center line represents normal air pressure. The more vibrations that occur per second, the more often a soundwave completes a cycle, and the higher the sound's pitch, or *frequency.* A soprano singer's vocal cords vibrate more times per second than those of a baritone, for example.

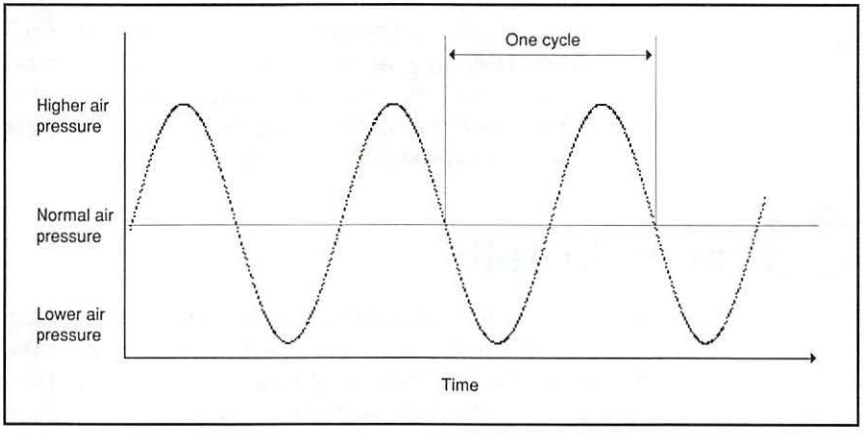


Figure 16.3: A simple waveform display.

Digital Sound Concepts

Between QuickTime, multimedia, built-in microphones, and funny error beeps, digital sound has become common in the Macintosh world. In this section, we take a closer look at how the Mac stores and plays back digitally recorded sound. But first, let's lay the foundation for our discussion by examining two concepts that play a vital role in digital audio: analog-to-digital and digital-to-analog conversion.

Analog versus Digital

Webster's dictionary defines *analog* as "being or relating to a mechanism in which data is represented by continuously variable physical quantities." We live in an analog world. The Earth rotates smoothly; it doesn't pause for a minute, then move, then pause again. Sound is also an analog phenomenon—the variations in air pressure that make up a sound are continuous.

But computers are digital devices. To recreate an analog phenomenon such as sound, a Mac must first convert the analog data into digital data. This process is performed by a circuit called an *analog-to-digital converter*, or *ADC*. Almost all current Macs contain an ADC, which is connected to the microphone jack. If your Mac included a microphone, it has all the circuitry you need to record sound with fidelity roughly equal to that of a decent table radio (especially if you use external speakers as described in Chapter 8.)

If your Mac didn't include a microphone, you will need additional hardware, such as MacroMedia's MacRecorder, which includes SoundEdit Professional, a program that enables you to alter sounds and save them as resources in your System file or in HyperCard stacks. Another popular sound editing program is OpCode Systems' Audioshop.

When digitally recorded sound is played back, another circuit, a *digital-to-analog converter (DAC)*, turns the digital data back into analog data. All digital audio circuitry—whether in a compact disc player or a Macintosh—performs a digital-to-analog conversion in order to play back recorded sound.

Sampling: Snapshots of Sound

As a digital device, the Mac cannot store the continuous variations in air pressure that comprise a sound. But by using a digital-to-analog converter to examine, or *sample*, the sound at periodic intervals, the Mac can create a reasonably accurate digital version of the sound (see figure 16.4).

Another form of sampling is the motion picture—a movie camera samples its subject 24 times per second. When those samples are played back, the illusion of smooth, analog motion is created.

But the ears are less forgiving than the eyes. To accurately represent sound, digital recording equipment must take thousands of samples each second. Each sample represents the state of the sound at the moment the sample was taken, just as each frame of a movie represents the action at the moment the frame was photographed.

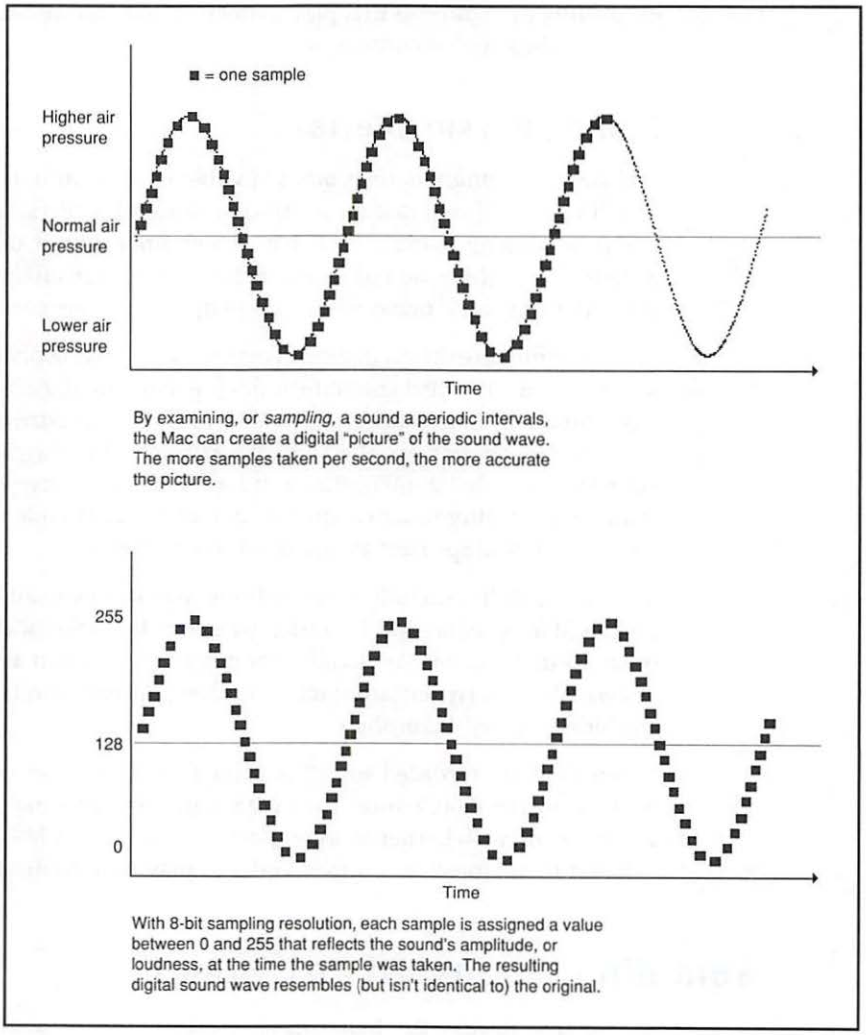


Figure 16.4: Sampling enables the Mac to store a digital representation of sound.

Sound Quality Issues

Three primary factors influence the sound quality of digital audio:

- The number of samples taken each second—the *sampling rate*. Faster sampling rates provide a more accurate snapshot of the original sound.
- The number of bits used for each sample—the *sampling resolution*. A higher sampling resolution makes each sample a more accurate representation of the original sound at the moment the sample was taken.
- The design and quality of the audio circuitry used to filter and amplify the sound.

This isn't an audio book, so we won't discuss the third factor here. Instead, let's concentrate on the first two.

Professional digital recording equipment takes over 44,100 samples per second; that's a *sampling rate* of 44.1 *kilohertz* (thousands of cycles per second, abbreviated KHz). The sampling talents of the Mac Plus and SE fall short of that; their maximum sampling rate is approximately 22.255KHz (usually just stated as 22KHz). Faster Macs can sample at 44.1KHz.

The sampling rate also affects sound quality because it determines the highest frequency that can be accurately recorded. To accurately record a given frequency, the sampling rate must be twice that frequency. To accurately record sounds up to 10KHz, for example, the sampling rate must be at least 20KHz. This upper frequency limit (in the preceding example, 10KHz) is called the *Nyquist frequency,* after the scientist who discovered this phenomenon.

The sampling resolution affects sound quality because it determines how accurately the computer can detect dynamic variations—changes in loudness—in the sound being sampled. The more bits you assign to each sample, the more accurately you can measure the sound. Professional digital audio equipment uses 16-bit sampling resolution, enabling it to recognize and reproduce thousands of different loudness levels.

All Macs use 8-bit sampling resolution, and thus can discern 255 dynamic levels. When the dynamic level of a given sample lies between two points, it's rounded to the nearest point. This rounding process, also called *quantization,* results in sampling errors that you hear in the form of noise.

If you have a NuBus-equipped Mac, you can boost your Mac's sampling rate and sampling resolution to professional levels by adding a board, such as Digidesign's Audiomedia, which contains a Motorola 56001 *digital signal-processing* (*DSP*) chip.

Incidentally, if you would like to hear examples of various sampling rates and digital audio effects, you can do so with a HyperCard stack called Jim Heid's Sound Stack. It's available in the U.S. and Canada for $17.95 postpaid from Navarro Software, P.O. Box 743, Albion, CA 95410. It also includes Jim Heid's Sound Disk, a library of original music and sound effects you can use for error beeps, alarm clock extensions, and presentations.

Audio Compression and Expansion

One drawback of sampled sound is that it uses disk space with a vengeance. Just one second of sound sampled at 22KHz uses 22K disk space, for example. Storing 45 seconds of sound requires a megabyte of disk space. System 7 lessens the amount of memory and disk space required to accommodate sounds by enabling sound to be *compressed*—encoded to use less disk space—by either a 3-to-1 or 6-to-1 ratio. At playback time, the Mac *expands* the sound as it's being played. Apple calls this compression-and-expansion feature *Macintosh Audio Compression/Expansion*, or *MACE*.

You can experiment with various compression ratios and learn more about digital sound by playing with the Audio Help stack that accompanies the version of HyperCard that Apple includes with the Mac.



SCSI Details

In this section, we take a detailed look at how the Mac's SCSI bus operates. We provide some tips and guidelines for setting up SCSI devices, and we describe some commercial, free, or shareware programs that let you tinker with and learn about the SCSI bus and the devices attached to it.

Review the following SCSI basics:

- The SCSI bus provides high-speed parallel data transmission, and is typically used to connect to hard disks, CD-ROM drives, scanners, tape-backup drives, and certain printers.
- The Mac Plus and all PowerBook models, except the Duo series, provide a single SCSI connector. (The Duo models require a docking station.) In the Mac Plus, the SCSI connector is a DB-25 located at the back of the case; the PowerBooks use a smaller HDI-30 connector. Other Macs provide two SCSI connectors: a rear-panel DB-25, and a 50-pin connector inside the case for internal hard disks.

- The SCSI bus enables you to daisy-chain up to seven devices to the Mac. Each device has its own *address* that the Mac uses to differentiate between devices. You can change a SCSI device's address—usually by setting switches on the device, but sometimes by running a utility program included with the device.
- A SCSI device's address also specifies its priority on the bus. When two devices vie for the Mac's attention at the same time, the device with the higher priority wins.
- The Mac always has a SCSI address of 7 (the highest possible address, and the one with the highest priority). When a Mac has an internal hard disk, the hard disk's address is always 0.

SCSI Cables

As you set up your SCSI devices, you may work with three types of cables:

SCSI System Cable. This cable attaches between the Mac's SCSI port and the first SCSI device; it has a male DB-25 connector on one end, and a 50-pin connector on the other.

Peripheral Interface Cable. This cable enables you to daisy-chain one SCSI device to the next. Apple's Peripheral Interface Cable (part number M0207) is one meter (about three feet) long.

Cable Extender. This cable, also about three feet long, is a SCSI extension cord that gives you more flexibility in positioning your SCSI devices. (It's great for getting a noisy hard disk out of earshot.) The part number of Apple's Cable Extender is M0208.

Figure 16.5 shows one way you may use these three cables. Notice that you can attach several Cable Extenders together, as long as the total length of all the SCSI cabling in your system doesn't exceed 20 feet. Beyond that distance, SCSI signals deteriorate, causing unreliable operation. And be sure to use the cables' metal clamps and thumbscrews to establish a tight, reliable connection.

SCSI cables vary in quality. Don't trust cheap ones—they become unreliable as the length of your SCSI bus grows.

Look for cables that are *double-shielded.* Avoid stepping on, kinking, or otherwise molesting a SCSI cable—you could break the cable's shielding or one of the wires inside it.

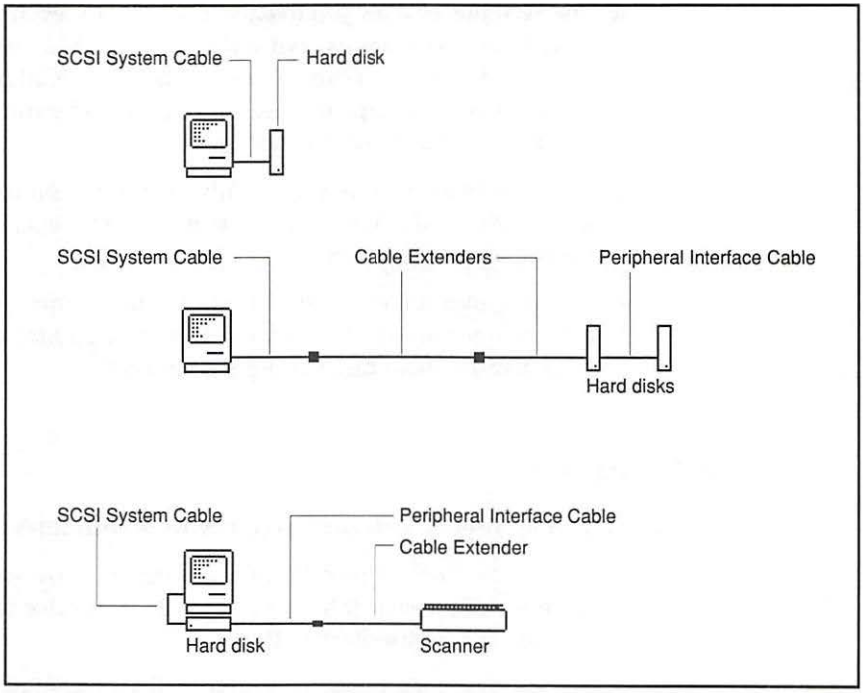


Figure 16.5: Some typical SCSI cabling setups.

PowerBook SCSI

As mentioned earlier, the PowerBook Duo models (and the Duo Dock) use a smaller HDI-30 SCSI connector. To connect a PowerBook to a SCSI device, use Apple's Apple HDI-30 SCSI System Cable (part number M2538LL/A). If you need a longer cable—and you may, because the HDI SCSI System Cable is only 18 inches long—use a Peripheral Interface Cable.

Several PowerBook models, including the 100, 160, and 180, support the SCSI disk mode—you can connect them to another Mac and then access the PowerBook's hard disk as though it were a standard external drive.

To connect a PowerBook to another Mac via SCSI, you need a HDI-30 SCSI Disk Adapter Cable (Apple part number M2539LL/A). Connect the Disk Adapter Cable to a SCSI System Cable. Depending on the Mac you're connecting to, you also may need one or more SCSI terminators; check your PowerBook's manual for details.

SCSI Termination

When attaching a SCSI device to the Mac, you may need to contend with one of the trickier aspects of SCSI: *termination*. In order for the Mac to know where the SCSI bus begins and ends, the bus needs special components called *terminators*, which absorb the SCSI signals at the end of the bus. Terminators absorb electrical noise that could cause data-transmission errors and other problems.

Terminators come in two varieties: internal and external. An internal terminator is located within a SCSI device's case. An external terminator is located outside the case, and clamps between the SCSI cable and the device's connector (see figure 16.6).

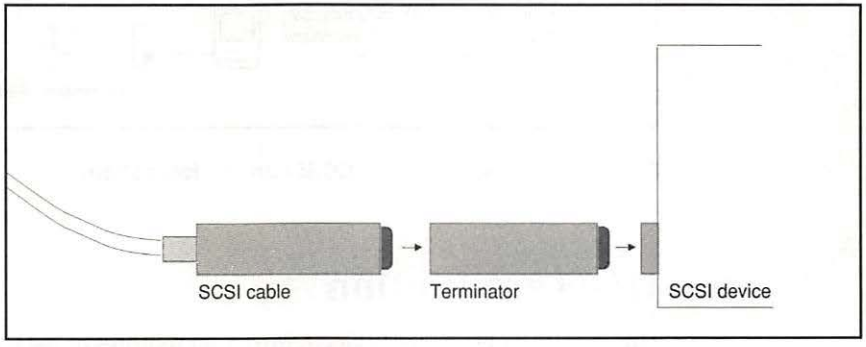


Figure 16.6: An external terminator attaches between a SCSI cable and a SCSI device's connector.

Some SCSI devices contain internal terminators, while others use external ones. Unfortunately, there isn't a great deal of consistency in the industry. Internal hard disks use internal terminators, but so do some external drives. Similarly, some SCSI scanners use internal terminators, but others don't. You will need to check your devices' manuals to determine which kind of terminators they use. If you're shopping for SCSI hardware, you may want to seek out devices that use external termination rather than internal termination. External terminators are much more convenient to work with.

As a general rule, your SCSI bus should have two terminators, one at each end of the SCSI bus. But there are exceptions to this rule. Figure 16.7 shows several SCSI connection and termination schemes that Apple recommends. You will find more examples in your Mac's manual and in the manual, *Apple SCSI Cable System*, that comes with Apple's SCSI System Cable.

Finally, remember the first rule of SCSI installation: Turn off your Mac and everything attached to it before connecting or disconnecting a device.

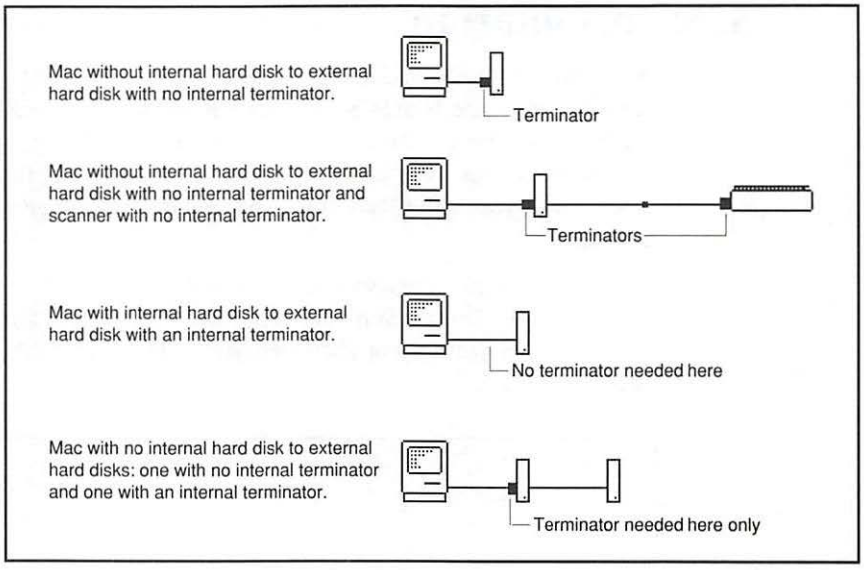


Figure 16.7: A sampling of SCSI connection schemes.

Mac IIfx Termination

The Mac IIfx uses special SCSI circuitry that requires nonstandard terminators, which usually have black plastic cases rather than the common gray ones. If you have a IIfx, be sure to use the black, IIfx-style terminators.

Setting SCSI Addresses

As mentioned earlier, the Mac uses addresses to differentiate between each SCSI device on the bus. Generally, you want to assign the higher-priority addresses (those closer to 7) to high-priority devices such as hard disks. Use lower-numbered addresses for lower-priority add-ons such as tape-backup drives or scanners.

You don't need to number devices sequentially. You can, for example, use addresses 6, 3, and 1, and skip over 5, 4, and 2. What *is* important is that you don't give two devices the same address. That causes an *address conflict,* which often results in data errors or the Mac not being able to recognize either device. If you have just added a SCSI device to your system and you have found that you cannot start up your Mac, there may be an address conflict between the newcomer and the old-timers on your SCSI bus. If that's the case, turn everything off, adjust the SCSI switches to give each device its own address, and

then power up again. (If your device requires that you run a utility program to change the address, you may need to disconnect the first SCSI device in order to enable the Mac to recognize the new one. This illustrates one drawback of SCSI devices that require software to set their addresses.)

Incidentally, if your SCSI devices use thumb switches or push-button switches to set addresses, be careful where you position the devices in your work area. Take care to not place the devices where you may accidentally change their addresses by bumping them.

Tinkering with SCSI

Several commercial, free, or shareware programs are available that can help you work with and learn more about SCSI devices. Some examples include the following:

- SCSI Probe (by Robert Polic; free). SCSI Probe is a Control Panel that enables you to determine which addresses your SCSI devices are using (see figure 16.8). It also enables you to access a SCSI drive that wasn't turned on or inserted when you started up your Mac. The latter feature can be especially handy if you use removable SCSI media such as Bernoulli or SyQuest cartridges.

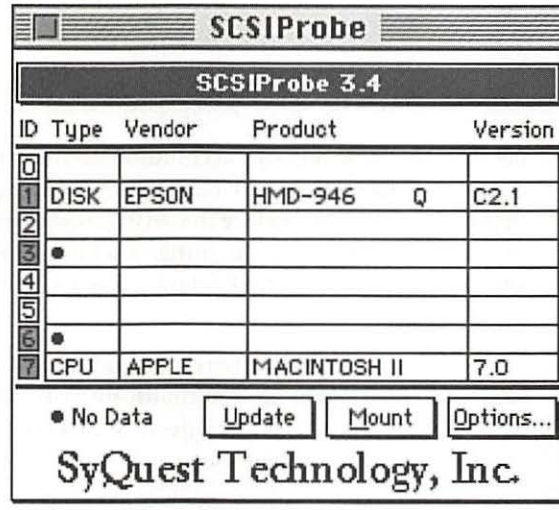


Figure 16.8: Robert Polic's SCSI Probe Control Panel.

- SCSI Identifier (by Laurie Gill of Dantz Development; free). This simple application scans your SCSI bus and displays information about each device it finds. It's especially useful to find out who

manufactured your hard disk. (Only a handful of companies actually manufacture hard disk drives; most hard disk companies buy drives from these firms and package them with their own power supplies and cases.)

- MacEKG. This commercial utility from Micromat Computer Systems is a diagnostic package that tests many of the Mac's components and reports on their condition. MacEKG can test your Mac's SCSI controller chips as well as test and report on the performance of your hard drive.
- InUse. This simple Control Panel displays a SCSI ID number in the Mac's menu bar when data is moving across the SCSI bus. If you're not sure if a SCSI-based scanner is transmitting data, InUse can tell you.



SCSI Technicalities

For the technically curious, we have included some details on how the SCSI bus operates. In this section, we describe how the Mac communicates with SCSI devices, and we look at how different SCSI communication techniques affect how quickly the Mac can exchange data with a SCSI device.

You don't need to know this information to connect and use SCSI devices. If you aren't interested in SCSI technicalities, feel free to skip this section.

SCSI Communications

Because the SCSI bus can accommodate numerous peripherals, it requires a communication scheme that enables the Mac to address the correct peripheral. In the SCSI world, the device that instigates communication on the bus is called the *initiator*. The device the initiator addresses is called the *target*. In the Mac world, the Mac itself usually plays the role of initiator, while a hard disk is the most common target.

The SCSI bus uses seven different operating modes called *phases*, which enable initiator and targets to communicate with each other. As the following descriptions of each phase show, SCSI communications compares to the process of making a telephone call.

Bus-free phase. When no SCSI device is using the bus, the bus is in bus-free phase. The phones are hung up, and the lines are ready for a call.

Arbitration phase. Before an initiator can begin a communications session with a target, it must gain control of the bus. This process compares to picking up the phone and hoping no one else in the

house is already on the line. After a initiator has "picked up the phone," no other device—regardless of its priority—can interrupt it.

Selection phase. After the initiator picks up the phone, it dials the number—that is, it selects the target device. This phase ends with an acknowledgment from the target device—it "answers the phone."

Command phase. At this point, the initiator and the target are talking to each other. In the command phase, the target receives instructions from the initiator—it's the SCSI equivalent of a phone caller saying, "I'd like to order a pizza."

Data phase. In the data phase, the transfer of data occurs between the initiator and the target. The initiator says, "I'd like a large with everything except anchovies." (SCSI devices hate anchovies.)

Status and message phases. In these final two phases, the target sends two bytes of status and message information to complete the data transfer. If the transfer was successful, it may say, "OK, thanks for your order." If a communications error occurred, it may say, "Sorry, could you repeat that?"

SCSI Data Transmission

As mentioned previously, the SCSI bus uses parallel, rather than serial, data transmission. The Mac's SCSI chip can operate in two modes: *normal mode* and *pseudo-DMA mode.* (DMA stands for *direct-memory access,* an efficient data-transmission technique by which data is transferred between a peripheral and memory without requiring the CPU to be involved in every step of the process.)

In the SCSI chip's normal mode, the Mac's SCSI driver software manages the communication process between the Mac and the SCSI device. Because normal mode uses software to manage this handshaking process, it slows the Mac's performance. In the pseudo-DMA mode, the internal logic circuits within the SCSI chip handle the handshaking process, freeing the Mac's CPU for other tasks.

The Mac uses both operating modes to transfer data. First, the CPU uses the normal mode to initiate the data transfer, then it uses the pseudo-DMA mode for the actual transfer itself. In conversational terms, the CPU says to the SCSI chip, "I'll get things started, then you take over." After the transfer is underway, the SCSI chip uses one of its internal registers (the Bus and Status register) to indicate when it has received a byte of data from, or sent a byte to, the peripheral.

But the CPU cannot completely remove itself from the process. It must still supervise the transfer, and it does—by checking the SCSI chip's Bus and Status register to verify that data went through.

The CPU can check the Bus and Status register in either of two ways. With the *polling* method, the CPU checks it before each byte is read or written. With the *blind transfer* method, the CPU checks it just once, before a block of bytes is read or written. To put things in conversational terms, the polling method involves the CPU saying to the device, "I want to know each time you're ready to receive or send a byte." With the blind transfer method, the CPU says, "I want to know when you're ready to receive or send this chunk of data. After that, you can deal with my assistant, the SCSI chip."

As you may expect, the polling method requires more effort on the part of the CPU; thus, using it means slower performance. 68000-based Macs, such as Classics, have a maximum sustained data transfer rate of less than a megabyte per second; 68030 Macs such as the IIci can transfer a maximum of about 1.5MB per second. A Quadra can handle 3MB to 5MB per second. As you see in the next chapter, not all hard drives can supply or accept data this quickly.

SCSI-2: SCSI in the Fast Lane

A newer version of the SCSI standard, called *SCSI-2*, has the potential to boost data transfer rates to 20MB per second and more. There are two aspects of the SCSI-2 specification that allow for faster performance: *fast* mode and *wide* mode. Fast mode enables speedier data transfers; wide mode enables transfers in 16- or 32-bit chunks, versus the standard SCSI's 8 bit chunks.

So how do you take advantage of SCSI-2? For one thing, you need a hard drive that supports the fast and wide aspects of the SCSI-2 specification. Numerous hard drive manufacturers now offer such drives—most are high-capacity drives that store 300MB or more. Note that it isn't enough for the drive to *support* SCSI-2; it must also support the fast and wide modes.

Second, you need a SCSI-2 adapter card. Many leading hard drive vendors, including FWB, MicroNet, Storage Dimensions, and PLI, offer SCSI-2 adapters that install in a NuBus slot. Some firms also offer SCSI-2 adapters that install in the processor-direct slot of a Quadra.

In theory, a SCSI-2 adapter that supports fast and wide SCSI-2 allows data transfer rates of up to 20MB per second when the accelerator is paired with a drive mechanism that also supports fast and wide SCSI-2.

A SCSI accelerator won't speed up every drive; it simply enables the Mac to keep up with the fastest drives. Another drawback: with most SCSI accelerators, you need to journey into the Mac's case to change a SCSI accelerator's SCSI ID or termination settings. And most SCSI accelerators work with hard drives only; they will not improve the performance of SCSI add-ons such as scanners.

Still, a SCSI accelerator may be a worthwhile purchase for someone who demands top drive performance. If you have spent several thousand dollars on a high-performance drive and you routinely work with huge color-scanned images, QuickTime movies, or other colossal files, it may not be a bad idea to spend a bit more to see what your drive is really capable of.



The Serial Ports

We wrap up our look at the Mac's input and output features by examining its modem and printer ports. This section describes the following:

- Serial communications terminology
- How the Mac's modem and printer ports operate
- Differences between the modem port and printer port

Serial Jargon

In this section, we define the serial-communications terms you're most likely to encounter as you work with communications software and telephone modems.

Start, Stop, and Parity Bits

As you may recall from Chapter 1, with serial transmission, the bits that form each byte travel in single-file, with one bit behind another. In many cases, some additional bits travel along with each byte. Two such specialized bits—*start bits* and *stop bits*—mark the beginning and end of each byte.

Figure 16.9 illustrates how start and stop bits serve to frame each byte. (This figure shows just one stop bit; however, two often are used.) To return to our automotive analogy, if you imagine each byte as a presidential motorcade, the start and stop bits compare to the police escorts at the beginning and end of the motorcade.

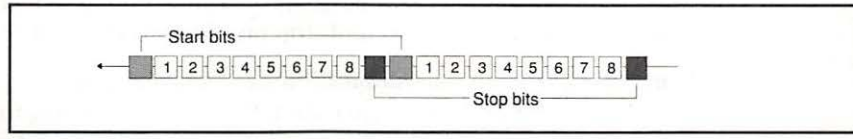


Figure 16.9: Start and stop bits frame each byte.

Another specialized bit in serial communications is the *parity bit.* A parity bit serves as a data proofreading device: it enables the receiving device to verify that it has accurately received a given byte. With parity checking, the transmitting device processes the bits in a given byte according to a formula, and then sets the parity bit accordingly. When the receiving device receives a given byte, it processes its bits according to the same formula, and then verifies that it comes up with the same result. If it doesn't, it can tell the transmitting device to send the byte again.

In working with communications software, you encounter three possible parity settings:

Odd. With odd parity, the transmitting computer always sends an odd number of 1 bits (bits with a value of 1). When a given byte contains an even number of 1 bits, the sending device adds an additional bit. The receiving device then verifies that it received an odd number of bits.

Even. With even parity, the transmitting computer always sends an even number of 1 bits. When a given byte contains an odd number of 1 bits, the sending device adds an additional bit. The receiving device then verifies that it received an even number of bits.

None. With this setting, no parity bit is transmitted or expected on the receiving end. This is the most common setting in microcomputer communications.

When a parity bit is used, it's positioned before the stop bit that marks the end of a given byte.

Asynchronous versus Synchronous

Start and stop bits make possible a form of communications called *asynchronous* communications. The word *asynchronous* means *without synchronization.* In the computer world, it means that two devices are not communicating under the control of rigid timing signals. Instead, they use start and stop bits to denote the beginning and end of each byte. Asynchronous communication is a very flexible method of data transmission; the transmitting device can send data as it's ready, and as long as the two devices are set up to send and recognize the right combination of start and stop bits, the message will get through.

But asynchronous communication has a drawback, too: it's inefficient. Start and stop bits don't carry actual data; they simply go along for the ride, telling the receiving device when to expect the data. This excess baggage effectively reduces the overall transmission speed—time that could be used exchanging data is wasted sending and receiving start and stop bits. Think about how much roadway those presidential motorcades require.

Synchronous communication solves this inefficiency by using a timing clock to regulate the transmission of data. With synchronous communications, data is transmitted in chunks (typically containing 256 bytes) called *frames* or *packets*. Each frame is preceded by timing information that tells the receiving device how many characters to expect in a given amount of time. The receiving device then uses this timing information to count off incoming characters. Start and stop bits aren't required, and as a result, the two communicating devices can exchange more data in the same amount of time.

In the personal computer world, asynchronous communication is far more common than its synchronized counterpart. Synchronous communication is generally used in mainframe computers and in local-area networks (including LocalTalk).

Most low- to medium-speed modems (those providing speeds up to and including 2400 bits per second) use asynchronous communication. Many of today's high-speed modems also support synchronous communication.

Full Duplex versus Half Duplex

Another consideration in serial communication involves whether both devices can transmit and receive simultaneously, or whether only one device can transmit at a time. The former is called *full-duplex* operation; the latter is *half duplex*.

Both types of communication have parallels in the non-computer world. Full-duplex operation compares to telephone calls: both people on the line can speak and listen at the same time. Half-duplex operation compares to two-way radio: only one person can talk at a time, and must signal the other person when it's his or her turn to speak. Personal computer communication almost always uses full-duplex mode.

Handshaking

When two serial devices are communicating, the receiving device may occasionally need to tell the transmitting device to pause momentarily. When you're printing to an ImageWriter, for example, the printer's internal memory may fill periodically, and the printer must tell the Mac to stop sending more data, lest some characters get lost. When the printer is ready to resume receiving data, it needs a way to tell the Mac to continue. Similarly, if you're connected to an information service and you're saving incoming data on disk, the Mac must periodically tell the transmitting computer to pause while it accesses the disk.

This wait-and-resume is called *handshaking,* or *flow control.* Following are two forms of handshaking:

> *Software handshaking.* The receiving device transmits a software code to the sender. The most common form of software handshaking is called *X-on/X-off.* When the receiving device requires a pause in data transmission, it sends an X-off code. When it's ready to resume receiving, it sends an X-on code. When using a communications program, you often can send X-off code by pressing Ctrl+S, and an X-on code by pressing Ctrl+Q. (Some programs may use the Command key rather than the Control key.)
>
> *Hardware handshaking.* The receiving device changes a voltage on a signal line in order to pause transmission.

Software handshaking is generally used in remote communications applications, such as when you're connected via modem to an information or electronic mail service. Hardware handshaking is common in links between a computer and a serial add-on, such as a printer (although software handshaking can be used here, too).

The Mac's Serial Ports

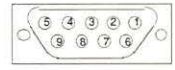
As we have mentioned previously, most Macs provide two serial ports, called the modem and printer ports, labeled on the Mac's case by telephone handset and printer icons. In some technical documentation, the ports are referred to as ports *A* and *B.* Port A is the modem port; port B is the printer port.

Figure 16.10 shows the pin configuration and signal assignments for the Mac family's serial ports.

At startup, the Mac's serial ports are configured to communicate automatically at 9600 bits per second (bps), with eight data bits, no parity bit, and two stop bits. The Mac uses these settings when communicating with an ImageWriter printer.

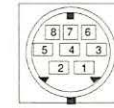
While the ports are initially configured for 9600-bps communications, they can operate at speeds of up to approximately 256K bps using the internal clock. (LocalTalk operates at this speed.) When driven by an external clock signal, the ports can operate at speeds of up to 1M bps. Both ports support both hardware handshaking and X-on/X-off software handshaking.

Female DB-9
(Mac 512K Enhanced and earlier)



1 Chassis ground
2 +5 volts
3 Signal ground
4 Transmit data +
5 Transmit data –
6 +12 volts
7 Input handshake or external clock
8 Receive data +
9 Receive data –

Female DIN-8
(Mac Plus and later)



1 Output handshake
2 Input handshake or external clock
3 Transmit data –
4 Signal ground
5 Receive data –
6 Transmit data +
7 Clock input (see note below)
8 Receive data +

Note: Pin 7 clock input available on modem port only of SE, II, and later machines. On the Mac Plus, this pin is not connected.

Figure 16.10: Serial port pin-outs and signal assignments.

Serial Port Differences

The modem port and printer ports have several important differences:

- The modem port has a higher interrupt priority within the Mac, making it the preferred port for high-speed communication.
- The modem port provides a second incoming line for handshaking. This line enables these Macs to support the external timing clocks used by synchronous modems.
- If you use a LocalTalk network, you must connect the LocalTalk connector to the printer port—not because the printer port has special LocalTalk-oriented hardware, but simply because the Mac's AppleTalk Manager is configured to use the printer port.

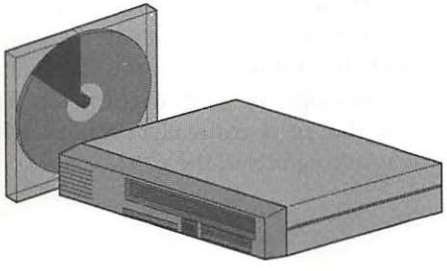
CHAPTER

17

DISK DETAILS

WHAT'S INSIDE

- How floppy and hard disks operate
- Storage alternatives: Bernoulli and SyQuest cartridges
- High-capacity storage: CD-ROM and optical drives
- Factors to consider when shopping for storage devices
- How to interpret hard disk performance specifications
- How the Mac keeps track of what's on a disk
- How to diagnose and fix disk problems
- Programs that enable you to explore the contents of disks



Fast processors and megabytes of memory are great, but ultimately, your Mac's capabilities are determined by the capacity, speed, and reliability of its mass-storage devices. Storage capacity is important if you have a large software library or you're working with sounds, QuickTime movies, or scanned images. Speed is significant because it determines how quickly the Mac can start up, load programs, and open and save documents. And reliability is important for obvious reasons.



Disk Basics

In Chapter 2, we said that breakthroughs in user interface design enabled computers to become more interactive. These software breakthroughs couldn't have occurred without advances in hardware. The video screen was one such advance. Another was in the mass-storage department. Punched paper cards—the kind you couldn't fold, spindle, or mutilate—surrendered to a faster, more reliable storage medium: magnetic tapes. You have probably seen these spinning back and forth in science-fiction movies. Soon, magnetic tapes gave way to magnetic disks.

Disks offer a significant advantage over tapes and cards: they're a *random-access* medium. A computer can quickly access any portion of a disk without having to read through the entire disk's contents. It's similar to the difference between phonograph records and cassette tapes: you can access a specific song on a record in a fraction of the time it would take to locate it on tape.

Inside a Floppy Disk

How do disks provide their random-access benefits? Within the plastic shell of a 3 1/2-inch disk is a circle of flexible plastic (see figure 17.1). This flexible—or floppy—plastic disk is coated with invisible particles of iron oxide—a material not too different from everyday rust. When it's being read from or written to, the disk spins at a rate of between roughly 390 and 600 revolutions per minute.

When the Mac is writing to the disk, a pair of *read/write heads*, one for each side of the disk, moves across the surface of the disk (see figure 17.2). Each head generates magnetic fields that rearrange the disk's iron oxide particles into patterns representing the bits being written. When the Mac is reading from the disk, the particles recreate those magnetic fields in the heads. The heads then send electrical impulses to the Mac's disk-controller circuitry, which interprets the impulses and sends the resulting bits to the CPU.

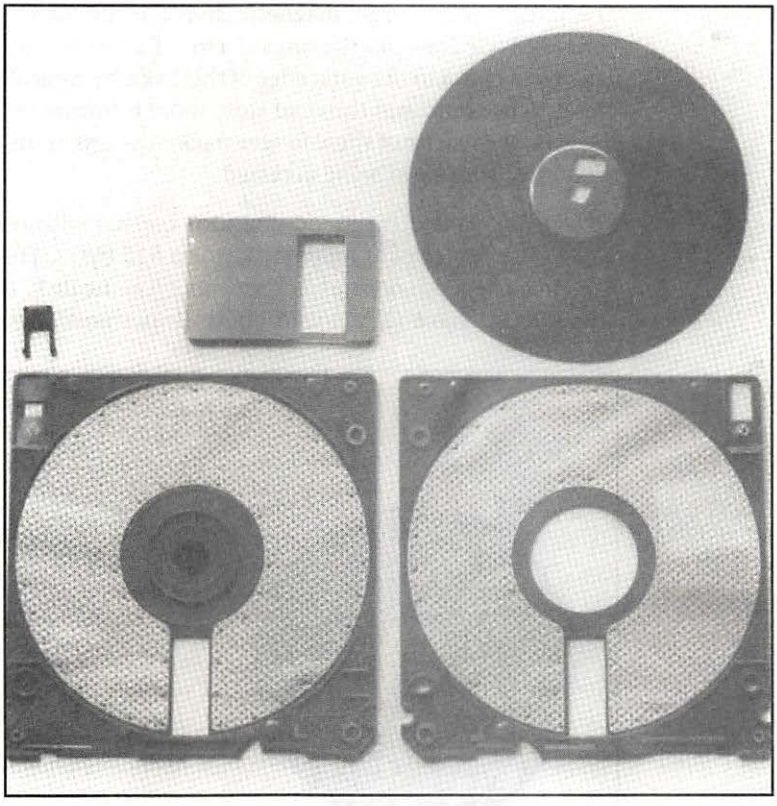


Figure 17.1: A disassembled floppy disk.

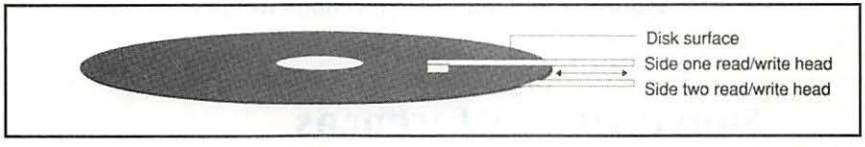


Figure 17.2: Inside a floppy disk drive.

What Initializing Does

Any storage system requires some structure and organization, and a brand new disk doesn't provide either. Its surface is simply an array of randomly arranged microscopic magnets. When you insert a new disk, the Mac tells you it's unreadable and asks if you want to *initialize* it. During the initialization process, the Mac uses the disk drive's read/write heads to create magnetic divisions that will provide the structure needed to store files.

The most basic of these magnetic divisions are *tracks* and *sectors*. Tracks are concentric circles—like the rings of a tree. Each side of a disk contains 80 tracks. The tracks closer to the outer edge of the disk are physically longer than the ones closer to the hub, and thus can store more information. To take advantage of the greater capacity of these longer tracks, the disk spins more slowly when the outermost tracks are being accessed.

Sectors are smaller magnetic divisions created within each track (see figure 17.3). Each sector of a floppy disk stores 512 bytes. The number of sectors in each track depends on the track's location on the disk. The outermost tracks of an 800K disk have 12 sectors each; the innermost ones have 8 sectors each.

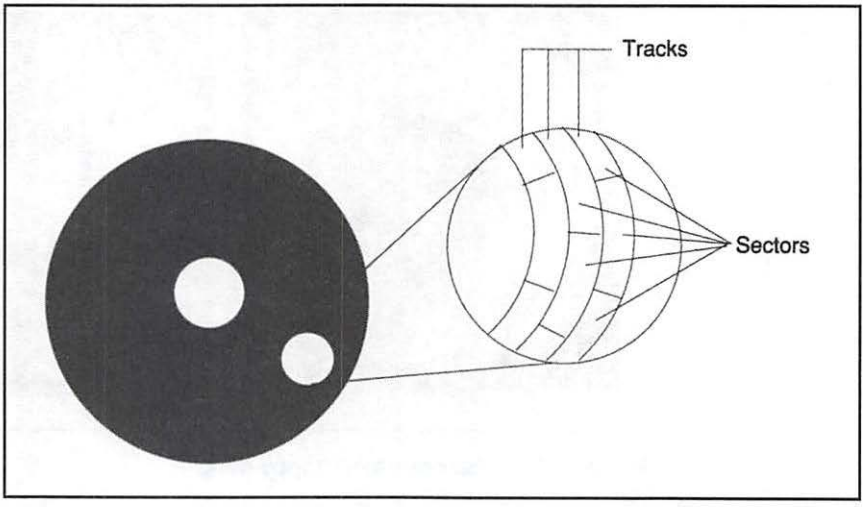


Figure 17.3: Sectors are divisions within each track.

SuperDrive Differences

The 1.4MB high-density disks used by the SuperDrive work slightly differently. Each side of a high-density disk still contains 80 tracks, but each track—regardless of its location on the disk—contains 18 sectors. Also, high-density disks always spin at 300 revolutions per minute when they're being accessed. Table 17.1 summarizes the differences between 800K and 1.4MB disks.

The 400K disks used by the 128K and 512K Macs have the same basic specifications as 800K disks, except that they record information on one side of the disk only. If you click the Single Sided button when asked if you want to initialize a disk, the Mac formats the disk on one side only. (One reason you may want to do this is to create a disk that can be accessed by a Mac that has only 400K drives.)

Incidentally, the *capacity per disk* entries in Table 17.1 reflect the disk's *total* capacity. That entire amount isn't available for storing applications or documents. As you see later in this chapter, the Mac requires some space for storing information about the disk's contents.

Table 17.1: Differences between disks.

	800K Disks	High-Density Disks
Bytes per sector	512	512
Sectors per track	8-12	18
Tracks per side	80	80
Capacity per side (bytes)	409,600	737,280
Capacity per disk (bytes)	819,200	1,474,560
Rotation speeds (rpm)		
Tracks 0-15	394	300
Tracks 16-31	429	300
Tracks 32-47	472	300
Tracks 48-63	525	300
Tracks 64-79	590	300

Tips for Floppy Disks

Floppy disks are an extremely reliable storage medium, provided that you follow some common-sense shopping and storage guidelines.

- *For 800K drives, buy disks tested for double-sided operation.* Disk manufacturers don't have separate factories or assembly lines for single-sided and double-sided disks. Instead, all new disks are tested on each side, and those that fail the test on side two are packaged and sold as single-sided disks. But these disks often can be initialized as double-sided disks; thus, some people try to economize by buying single-sided disks and initializing them for double-sided use. It's false economy. The second side of the disk may initialize properly, but quickly develop problems that can cause lost data. Disks are inexpensive, especially compared to recreating lost work. Always buy high-quality disks that are certified for double-sided use.
- *For SuperDrives drives, buy certified high-density disks.* High-density disks have a hole in the upper-left corner of their housing that identifies them as high-density (see figure 17.4). An FDHD drive will not create a 1.4MB disk unless the disk contains this hole. This contrasts sharply

with many high-density drives in the DOS PC world, which allow you to initialize an ordinary double-sided 3 1/2-inch disk to store 1.4MB. Some people save money—but risk data—by doing just that. (We take a closer look at high-density disk issues shortly.)

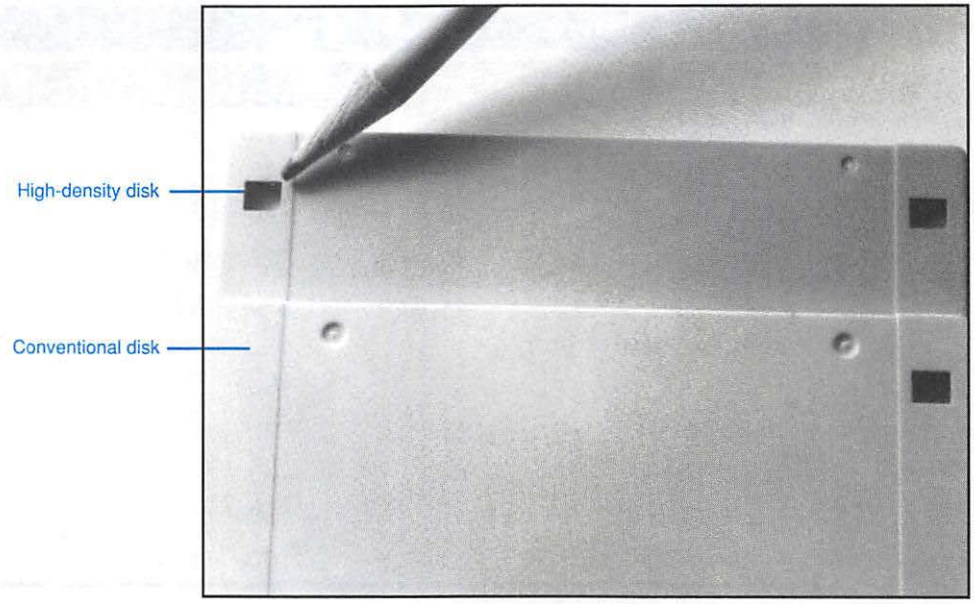


Figure 17.4: A high-density disk has a hole in its upper-left corner; a conventional disk does not.

- *Always eject disks properly.* Drag a disk's icon to the Trash when you're done using it (or select the icon and choose Put Away from the Finder's File menu). If you have a Classic, SE, Plus, LC, or LC II, choose the Finder's Shut Down command before shutting the power off. (On other Macs, choosing Shut Down turns off the power automatically.) Ejecting a disk properly enables the Mac to update the disk's invisible DeskTop file and perform any other necessary tidying tasks.
- *Don't open a disk's metal shutter by hand and touch the disk surface inside.* Of course *you* wouldn't do that, but an inexperienced colleague or child may.
- *Don't use a cold or hot disk (or disk drive).* If you have just brought a new box of disks or your Mac in from a car on a hot summer or cold winter day, wait until the disk or drive has reached room temperature before using it.
- *Watch out for loose labels.* If a disk's label becomes loose, it may hang up in the drive, preventing you from ejecting the disk. Be sure labels are securely attached to the disk, with no large air bubbles or lifting

edges that could catch on the drive's mechanism. When you're peeling an old label off a disk, be sure it doesn't tear and create dusty paper fragments. Instead of struggling to remove an old label, consider simply applying a new one directly over the old.

- *Erase a disk you want to recycle.* Don't simply throw its files in the Trash. When you use the Erase Disk command, the Mac checks the disk to verify that it's in good working order. If an `Initialization failed!` message appears, consider throwing the disk away. You may be able to successfully initialize it on the second or third try, but chances are it's near the end of its useful life.
- *Use the drive spacers when you ship your Mac.* To keep your disk drives in proper alignment, insert the plastic drive spacers when you ship your Mac or carry it in a car. If you threw the spacers out, use unneeded disks instead.
- *Store and ship disks carefully.* Keep them in a cool, dry place. Don't leave them locked in a hot car or in the sun, and don't set them on your desk, where they may get soaked by spilled coffee. Don't set them near devices that generate magnetic fields, such as loudspeakers, high-intensity or halogen desk lamps, and appliances containing electric motors. And as mentioned in Chapter 8, avoid setting up an external floppy disk drive to the left of a Classic Mac.

Because the edges of the disk's case aren't sealed against dirt, keep them in a covered box when you are not using them, and don't mail them without extra protection against dust and bending. For mailing disks, use a cardboard disk mailer, such as Dennison's Mini Floppy Disk Mailer (order number 18-275), available at most office- and computer-supply stores.

As for airport X-ray machines, the X-rays themselves don't pose a threat to a disk's contents, but the machines can contain transformers that generate magnetic fields. Generally, airport security equipment isn't a threat to disks, but to be on the safe side, you may want to request that your disks be inspected by hand.

Mixing High-Density and 800K Disks

After the SuperDrive was released, some people complained about problems occurring when high-density disks were used in 800K drives. The problems trace back to the fact that high-density disks are physically different than 800K, double-sided disks. In addition to the extra hole mentioned earlier, a high-density disk has a thinner magnetic coating and smaller magnetic particles. The thinner coating means that the magnetic force needed to alter the particles doesn't have to be as strong as it does in an 800K drive. The smaller

particles enable data to be packed more tightly on the disk—they help make it possible for a high-density disk to have 18 sectors per track.

If you use an 800K drive to initialize a high-density disk, the drive will create an 800K disk that will appear to work properly—until you insert the disk into an FDHD drive. At that time, the drive will notice the extra hole and attempt to read the disk as a high-density disk. Because the disk isn't in high-density format, a dialog box will appear asking if you want to initialize the disk.

So, if you need to exchange files between 800K and SuperDrive disk drives, don't use high-density disks to do it. Instead, format an 800K disk and use it to exchange the files.

Hard Disks

Conceptually, hard disks are similar to floppies. They use read/write heads to change the patterns of the magnetic particles representing bits and bytes, and their surfaces are magnetically divided into tracks and sectors.

Physically, however, hard disks are quite different. Instead of using a flexible circle of plastic to hold magnetic particles, they use one or more rigid disk surfaces called *platters*. Each platter in a hard disk has its own set of read/write heads (see figure 17.5).

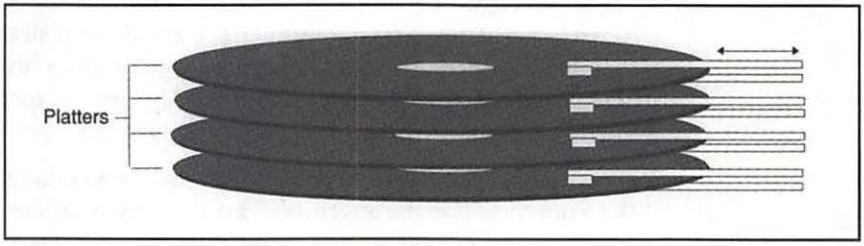


Figure 17.5: Inside a hard disk drive.

These platters are manufactured to precise tolerances, enabling their magnetic particles to be packed more closely together, thus providing more storage capacity. Most floppy disks can accommodate a maximum of 135 tracks per inch, but hard disks can have several hundred or more tracks per inch.

Unlike the heads of a floppy disk, a hard disk's heads don't touch the disk surface, but ride a hair's width above it. If a speck of dust lands on a spinning disk platter and hits the head, it can cause the head to bounce up and down on the platter. That is called a *head crash.* In the early days of hard disks, a head crash could damage the disk's fragile magnetic coating permanently. Today's hard disk platters are much more durable; a head crash can cause a momentary loss of data—a *soft error*—but it's less likely to permanently damage the platter.

In any event, because dust is a significant threat to a hard disk, its platters are sealed in a dust-free chamber.

Hard disks also spin much faster than floppies—generally at about 3600 revolutions per minute, or about ten times faster than floppies. What's more, hard disks spin continuously; floppies spin only when they're being accessed. A hard disk's faster rotation speed and tighter data packing are two of the factors that help hard disks transfer data so much faster than floppies. (We examine other speed issues shortly.)

Removable-Media Drives

Several drives are available that combine the warehouse-like capacity of a hard disk with the removable convenience of floppies. In a *removable-media* drive, often simply called a *removable drive* for short, the magnetic medium is enclosed in a cartridge that slips into and out of the drive—much like a floppy disk. In this day of color graphics, digital sound, QuickTime movies, and programs that come on ten floppy disks, removable-media drives are becoming increasingly popular (see figure 17.6).

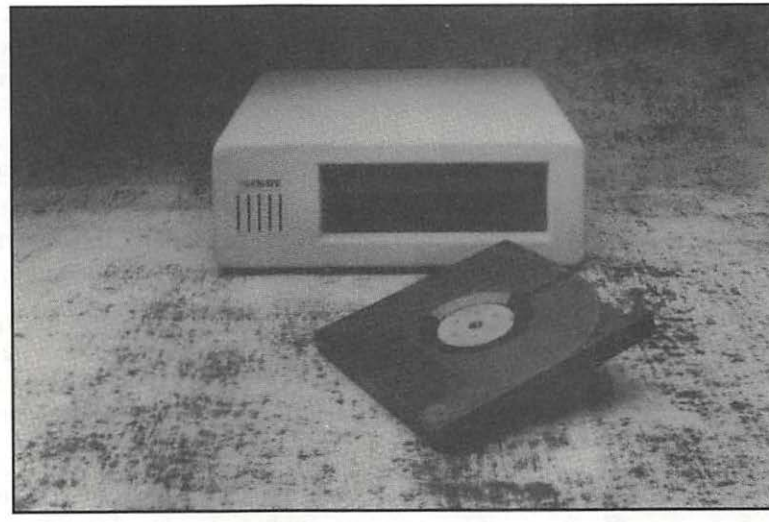


Figure 17.6: A removable-media drive and cartridge.

Removable-media drives have several advantages over conventional hard disks:

Convenience. If you frequently need to move megabytes of data from one machine to another, you can buy two drives and swap cartridges between them as needed.

Security. You can store a removable cartridge in a safe at the end of the day or pop it into your briefcase and carry it home.

Capacity. No matter how large a hard disk you buy, chances are that you will fill it someday and need to throw away old files to make room for new ones. With a removable-media drive, when you fill one cartridge, you can replace it with another.

Flexibility. A removable-media drive not only works well for day-to-day storage, it makes a wonderful backup device for a hard disk because you don't have to feed it floppy after floppy to back up your work.

A Removable Drive Sampler

The following are two popular removable-media technologies available for the Mac.

Iomega Bernoulli series. Iomega Corporation's pioneering Bernoulli Box was the first practical, reliable removable media. Original Bernoulli cartridges were bulky affairs that held a mere 10MB; capacities have improved steadily, and today's Bernoulli drives store 90MB on compact (5 1/4-inch) cartridges. Inside the cartridge, a flexible disk spins within a cushion of filtered air that draws the disk toward the drive's read/write head—just as a shower curtain is drawn inward by the difference in air pressure between the shower and the rest of the room. (These principles of fluid dynamics were discovered by an eighteenth-century mathematician named Daniel Bernoulli.) In a Bernoulli cartridge, if a dust particle works its way between the disk and head, the disk simply flexes to make room for it, while the filtered air blows it away. Thus, Bernoulli drives are virtually immune to head crashes.

SyQuest removable hard disk. SyQuest's removable hard disk drives are the most popular removable-media drive. Most hard drive vendors also offer SyQuest-based drives. Original SyQuest cartridges contain a single hard disk platter that holds 44MB; today, 90MB drives are also available.

Finally, it's worth stressing that the same care-and-storage guidelines we presented for floppies also apply to removable-media cartridges—in spades. Losing the contents of a floppy disk is bad enough; losing 40MB or 90MB can be traumatic enough to send you over the edge. Don't carry a cartridge for long distances without backing up its contents first.

Tomorrow's Removable Media—Today

The Bernoulli and SyQuest drives are the three most popular removable-media drives currently available for the Mac. These drives are being joined by *optical* storage media that use lasers and compact-disc technology to store hundreds of megabytes.

Two primary types of optical drives are already available: *WORM* drives and *erasable optical* drives. WORM is an unflattering acronym for *write-once, read many times*. In a WORM drive, a laser creates pits in the surface of the disk that represent binary ones and zeros. As the name implies, after you save something on a WORM drive, you cannot delete it. With between 400 and 800MB available, however, that may not be a real drawback.

An *erasable optical* (EO) drive, also called a *magneto-optical* drive, offers the cavernous capacity of a WORM drive, but with the erase-and-reuse flexibility of magnetic media. Indeed, EO disks use minute magnetic particles embedded in an alloy that coats the surface of the disk. A laser and electromagnet orient these magnetic particles to create the binary ones and zeros that represent what you're storing. The laser uses a high-powered beam when writing to the disk, heating the alloy so that the magnetic particles can be reoriented. When reading the disk, the drive uses a low-power laser that reflects off the magnetic particles.

Many hard drive vendors also sell EO drives. Two types of drive are available. One uses 3 1/2-inch media and holds 128MB. Another uses 5 1/4-inch media and mechanisms made by Sony, Ricoh, or Maxtor. The larger drives store between 290 to 325MB per side, depending on how they are formatted. To access the second side of one of these disks, you must flip it over—just as you flip a cassette tape to play its second side.



Shopping for Storage

The Mac's system software is growing larger, as are commercial programs. Grayscale or color graphics, QuickTime movies, and digital sound devour disk space. Unless you use a Mac for extremely simple tasks, you will probably need to buy a high-capacity storage device someday.

But what kind of device should you buy? In this section, we provide some guidelines to help you decide.

What Do You Need and Want?

Before you shop for storage, you need to assess your needs and your preferences:

- How much storage do you want? These days, the smallest-capacity hard disks you can buy store 40MB or 50MB. That used to be more than enough for almost anyone, but today, it's barely adequate. You may want to consider a 100MB unit instead; they don't cost much more, but they do store much more.
- Do you want an internal or external drive? Internal drives are convenient if you frequently carry your Mac with you, and they don't require you to clutter your work area with SCSI cables and power cords. But if an internal drive breaks, your Mac must go to the shop along with it. Internal drives also add heat to the inside of the Mac. For these reasons, many users prefer external drives. Another benefit of an external drive is that it's easy to move it to another Mac. They tend to cost more than internal drives, however, since they require their own cases and power supplies.
- Should you buy a conventional hard disk or a removable-media drive? Conventional hard disks almost always cost less than removable drives, but keep in mind that their storage capacities are finite. After you fill a hard disk, you will need to throw away old files to free up space. With a removable drive, you can simply add new cartridges. On the other hand, shuffling removable cartridges isn't as convenient as having all your files and applications in one place.
- How important is speed? Any high-capacity drive is delightfully fast compared to floppy disks, but there can be significant differences in performance between drives. Bernoulli and SyQuest removable cartridges are slower than conventional hard disks, as are optical drives. And some hard disks are faster than others. In the next section, we provide more guidelines for assessing drive speed, and we unscramble some of the technical terms you will encounter when shopping for storage.

But whether speed is critical depends on how you will use your drive. If you tend to spend a lot of time in one program before starting another, differences in drive speeds aren't very important. On the other hand, if you routinely switch between programs under System 7 or System 6 MultiFinder, or if you will be using a drive with a file server, a drive's speed becomes critical. A fast hard disk is also preferable if you work with huge images or QuickTime movies, and if you rely on System 7's virtual memory feature, described in previous chapters.

Technical Factors to Consider

Shopping for storage is like shopping for a stereo; you encounter a lot of technical specifications, many of which were born in a laboratory or marketing department and don't really relate to the real world. You can, however, learn something about a drive by evaluating its technical specifications, so we take a brief look at the most common—and most important—specs you're likely to encounter.

Data transfer rate. A drive's *data transfer rate* specifies how quickly the drive can send data to the Mac. The higher the value, the better—to a point. As we saw in the last chapter, slower Macs, such as the Classic, cannot accept data over the SCSI bus as quickly as a Mac II- or Quadra-family machine.

Average access time. The average amount of time it takes for the drive's heads to reach a given track is called the *average access time.* The lower the value, the faster the drive's heads can locate a given track. Most fast drives use *voice coil actuators* to move the drive's heads. In addition to providing faster access times, voice coil actuators are quieter and often more reliable than the old-fashioned head-positioning mechanism (and the one used in floppy drives), the *stepper motor.*

Spindle speed. In many fast drives, the platters spin not at 3600 rpm, but at 5400 rpm. This enables the drives to transfer data more quickly because more bits pass beneath the read/write heads in a given amount of time.

Mean time between failure. Drive manufacturers often rate the reliability of their products by assigning a *mean time between failure (MTBF)* rating to them. Like laser printer engine-life ratings, MTBF ratings don't relate very well to the real world. Still, they can be useful, especially if you're purchasing a drive that will be used by a file server. Such a drive will see more constant use than a workstation drive. With MTBF ratings, the higher the value, the better.

A Word About Interleave Ratios

Another technical phrase you will hear tossed around is the *interleave ratio.* The interleave ratio describes how the sectors in each track are organized (see figure 17.7). A one-to-one (1:1) interleave means that the sectors are numbered sequentially and that the Mac can read each one in turn. With a 2:1 interleave, the Mac must read every second sector, so it takes two revolutions of the disk to read an entire track. With a 3:1 interleave, the Mac reads every third sector.

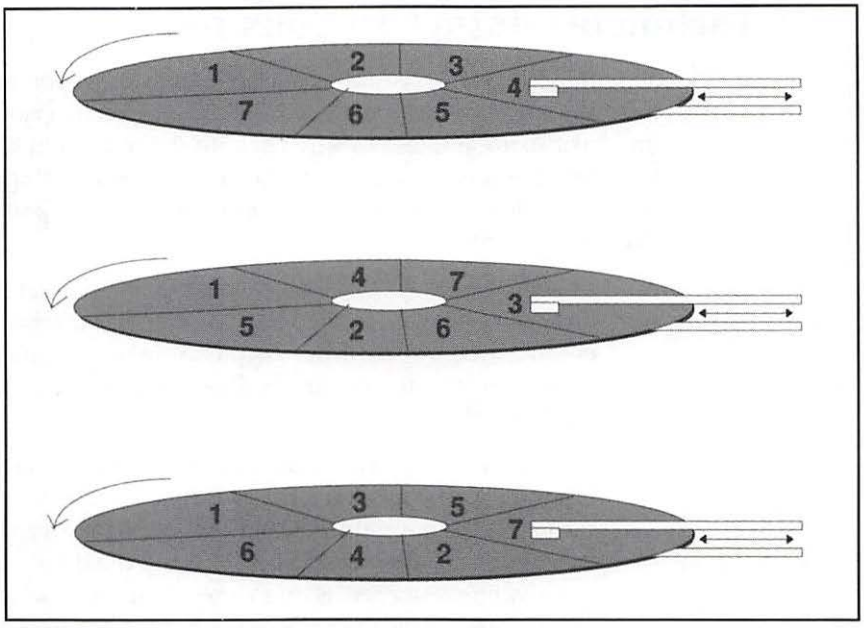


Figure 17.7: How sectors are organized with a 1:1 interleave (top), a 2:1 interleave (middle), and a 3:1 interleave (bottom).

Generally, a 1:1 interleave is best—provided that your Mac can accept the data that quickly. The SE/30 and II family can, but the SE requires a 2:1 interleave, and the Plus, a 3:1 interleave. Use a drive formatted for a 1:1 interleave on one of these Macs, and performance will actually be slower.

Some drive manufacturers, however, supply their own SCSI drivers that enable a slower Mac to use a 1:1 interleave. Other drives include built-in *track caches*, which store an entire track in a small amount of memory contained in the drive. Should the Mac need subsequent sectors from a given track, the drive supplies them from its cache, thus boosting performance.

A drive's interleave ratio isn't a fixed value like its access time or MTBF ratings. Many drives include utility software that enables you to change the interleave ratio. (Note that doing so requires you to reinitialize the drive.)

The ins and outs of interleave ratios can be summarized in one sentence: when you buy a drive, be sure that its interleave ratio either matches that required by your Mac, or that you can change the ratio if it doesn't.

Other Factors to Consider

As you may recall from Chapter 7, many laser printers are available for the Mac, but most use engines made by only a few manufacturers. There's a parallel in

the mass-storage world: a couple of dozen companies offer hard disks and removable drives for the Mac, but only a few firms actually manufacture drives.

Still, there are factors that differentiate one drive from the next. Most premium-priced drives, for example, have heavier-duty power supplies and other internal components that should make them more reliable in the long haul—in theory, at least. Also, many mass-storage vendors include utility software that adds extra value to their products. You may find utilities for backing up the drive, locating files, testing and formatting the drive, encrypting files so they cannot be read, partitioning the drive into numerous logical volumes, and *parking* the drive's heads—moving them to a safe, unused portion of the disk so they cannot damage its surface if the drive is jostled while being moved. (Many drives park their heads automatically when you turn their power off.) When you're shopping, determine which types of utilities a company includes with its drives.

It's also important to evaluate a company's warranty and customer-support policy. How long is the drive guaranteed? Does the company have a customer-support hotline? You also may want to talk with members of a user's group to determine if they've had good or bad experiences with the company. Have they been able to get through to the technical support department, or have they left messages that are never returned? If they've had to return a drive, does a replacement arrive promptly? These issues are especially important if you plan to buy a drive through the mail rather than at a local dealer.

If you will be using a drive in a quiet office, you also will want to determine how loud it is. All drives make some noise, but some are louder and more grating than others. If you plan to move a drive around with you, you will want to assess its portability and ruggedness. Many manufacturers provide *g-force* ratings that measure how well their drives stand up to physical abuse, such as being dropped. With g-force ratings, the higher the value, the better.

Hard Disk Tips

Following are several tips for keeping your hard disk healthy. Although these tips apply specifically to hard disks, many of them also apply to removable-media drives.

- Don't move it when it's turned on. Doing so is an invitation to a head crash. Always turn the power off and wait a minute for the disk platters to stop spinning. If the drive includes a head-parking utility, run it before moving the drive.
- Avoid drastic temperature changes. If you have just brought a hard disk (or removable cartridge) in from a hot or cold car, give it a couple of hours to adjust to its new surroundings before using it.

- Keep its files contiguous. As you may recall from Chapter 9, you can defragment a hard disk's contents by using a utility program or by backing up the disk, erasing it, and then restoring its contents. Keeping a disk's files contiguous does more than just optimize its performance; it prolongs the life of the drive's head actuator mechanism by reducing the need to constantly move the heads from one track to another in order to piece together fragmented files.
- Let it breathe. Be sure to give the hard disk plenty of ventilation space. If you're using SCSI cable extenders to move a noisy drive out of earshot, be sure the location you choose for the drive is well ventilated and clean. Don't banish it to the dusty floor of a hot closet—it will get its revenge sooner or later (probably sooner).

Mixing Disks Between System 6 and System 7

Floppy and hard disks that you have used with earlier system versions work with System 7. When you insert a disk that you have used with an earlier system version, the Finder displays a message saying *Updating disk for new system software.* The Finder is creating a desktop database file that enables it to locate the disk's contents. For high-capacity disks, the desktop database file replaces the DeskTop file. The DeskTop file is still used for disks whose capacity is less than 2MB—in other words, for floppies.

If you use a hard disk or removable high-capacity cartridge with System 7 and then move it to a Mac running System 6.x, you notice two new folders: Desktop and Trash. These are folders that Finder 7 creates to store any icons you move to the Desktop, and store the contents of the Trash. (Under System 7, the Trash is actually a folder—which is why it isn't emptied until you explicitly choose Empty Trash.) You can delete these folders, but the Finder creates them again the next time you use that hard disk or cartridge with System 7.



How the Mac Saves Files

We looked at the physical characteristics of various storage media, and presented some guidelines for taking care of floppies and shopping for high-capacity drives. Now let's journey into the world of tracks and sectors to examine how the Mac stores data on disks. Some technical background on how the Mac accesses disks can help you diagnose disk difficulties—a subject we look at next.

Reserved Disk Areas

The key to understanding how the Mac accesses disks is to understand that not all of a disk's tracks and sectors are available to hold files. During the initialization process, the Mac sets aside certain areas of the disk to hold information that enables it to keep track of the disk's contents. These reserved sections of a disk are extremely important; if something happens to them, you can lose files.

In this section, we look at these "reserved seating" sections. We do not explore every nook and cranny of each reserved area; instead, we provide an overview of the jobs each area performs. These descriptions apply specifically to disks that use the *Hierarchical File System* (HFS)—that includes 800K and 1.4MB floppies, and all hard disks. At the end of each section, we note any differences in the structure of 400K disks that use the original Macintosh File System (MFS). (If you want a refresher on the differences between HFS and MFS, refer to Chapter 3.)

The Directory: A Table of Contents

Tracks and *sectors* are like the page numbers of a book: they provide the underlying structure needed to locate something quickly. But a book's page numbers aren't very useful without a table of contents. Similarly, a disk needs a table of contents to enable it to keep track of where files are located.

A disk's table of contents is called the *directory*. When the Mac needs to read a file, it consults the directory to determine which tracks and sectors contain that file, then it moves the disk's read/write heads accordingly. When you save a file for the first time, the Mac adds an entry to the directory for that file, then it saves the file using sectors that aren't in use by other files.

On HFS disks, the directory actually comprises two separate files: the *Catalog B-Tree* file and the *Extents B-Tree* file. Both files can grow or shrink as you add or remove data from a disk.

The Catalog B-Tree file contains an entry for each file and contains information that describes the hierarchical filing structure you have set up for that disk. Each file's entry contains the file's four-character type and creator codes, the file's name, its attributes, and information specifying where the file is located on the disk. (We examine these entries again later in this chapter.) Unless a file grows particularly large, all the information for it can be stored in the Catalog B-Tree file.

When a file grows large and becomes fragmented across physically non-contiguous files on the disk, the Extents B-Tree file comes into play. This file

contains information about where each file fragment is located on the disk. Figure 17.8 shows what a fragmented file may look like if you were able to see it by looking at a disk.

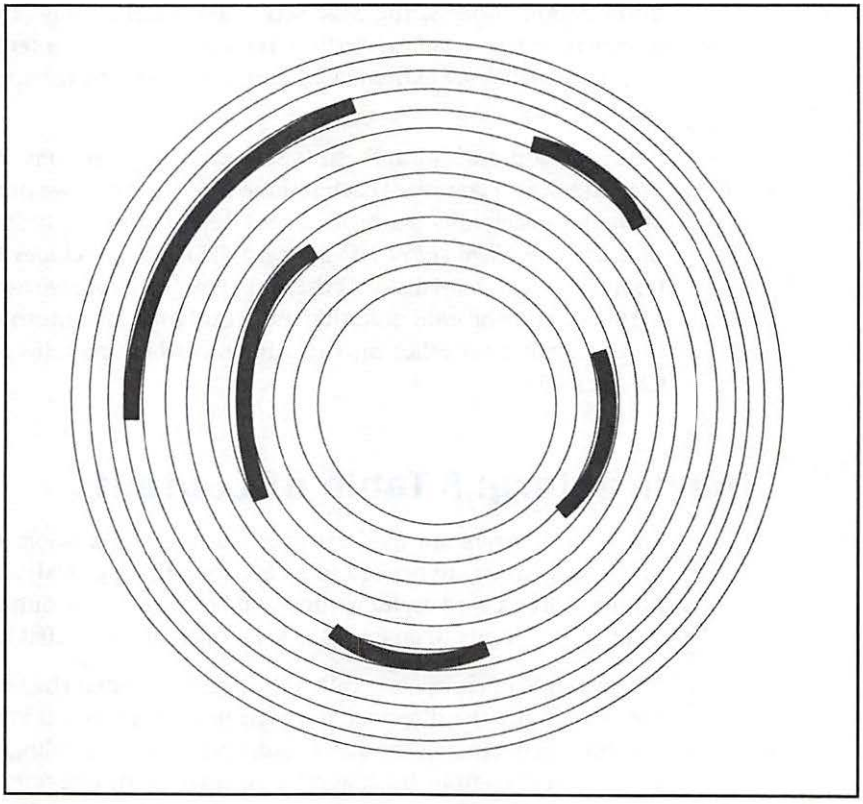


Figure 17.8: A fragmented file is scattered across physically non-contiguous sectors.

On MFS-format disks, the directory is located at a specific area of the disk (sectors 4 through 15). The fact that the directory is fixed in size has an important ramification: a large number of small files on a disk can fill the directory and, therefore, prevent you from adding more files, even though the disk may still contain free sectors. (This does not occur on HFS disks because their Catalog B-Tree and Extents B-Tree files can grow as needed to accommodate more files.)

The Volume Bit Map: A Seating Chart

When it's writing to the disk, the Mac uses another reserved area, the *volume bit map*, to determine which sectors are free and which are in use.

The volume bit map is like the seating chart that a restaurant host or hostess uses. When a large group of diners arrives, the host first checks the seating chart to make sure enough tables are free to accommodate them. Then, the host seats the diners and makes notations on the seating chart to indicate that those tables are taken.

Similarly, when the Mac needs to save a file, it first checks the volume bit map to determine if enough free sectors are available to hold the file. Then, while saving the file, it makes notations in the volume bit map to indicate which sectors are no longer free.

On MFS disks, an area called the *allocation block map* keeps track of free and used sectors. The allocation block map also enables the Mac to piece together files that are fragmented across the disk. On HFS disks, the latter job is performed by the Catalog B-Tree and Extents B-Tree files, as described earlier.

What Happens When You Delete a File

When you delete a file by dragging it to the Trash and then choosing the Empty Trash command, the Mac removes that file's directory entry and updates the volume bit map to indicate that the file's sectors are available again. There's an important subtlety here; the Mac doesn't actually delete the file's contents, it simply removes its directory entry and updates the volume bit map to free up its sectors. Disk utility programs, such as the *Norton Utilities*, can resurrect a file that you have deleted by recreating its directory entry and restoring the volume bit map to indicate that the file's sectors are again in use.

There is a catch, however. Because the volume bit map indicates that a deleted file's sectors are available, it's possible for a newly added or expanded file to use up some of those sectors, making it impossible for a disk utility to resurrect the entire file. To return to the restaurant analogy, imagine that our group of diners paid their bill and strolled out into the parking lot, but then decided to go back and have dessert. If any new diners have entered the restaurant since the old ones left, there is a chance that some or all of the original diners' tables will no longer be available.

The moral? A deleted file's sectors are free game for any newcomers. If you delete a file by mistake, don't make any modifications to that disk until you resurrect the file.

Volume Information

A disk's *volume information block* contains a collection of details about the disk, including the date and time that the disk was initialized, and the date and time that the disk was last modified. The Finder's Get Info command uses these pieces of information. Other data in the volume information block indicates how many times the disk has been written to, and specifies the size of other reserved areas of the disk.

The Boot Blocks

The Mac uses another reserved disk area, the *boot blocks*, when starting up. The boot blocks get their name from the computer term *boot*, which refers to the start-up process, during which the computer "pulls itself up by its *boot*straps." Both HFS and MFS disks use the same basic boot blocks.

The boot blocks contain information, such as the name of the System file, the name of the application to run after you quit a program (usually "Finder"), and values that specify the initial size of the *system heap*, the reserved area of memory that holds INITs and other system software. As you will see later, if the Mac ejects a disk during startup and displays the frowning Mac icon, one possible cause could be damaged boot blocks.

(Here's a trivia question for Mac historians: the first two bytes in the boot blocks contain the ASCII values for the letters *LK*. Whose initials are those? The answer is at the end of this section.)

Summary of Reserved Disk Areas

We have waded through a few technicalities in this section, so let's step back and summarize the reserved areas of the disk that we looked at. They include the following:

- The directory is an electronic table of contents that contains an entry for each file. On MFS disks, it's a fixed area, and that limits the number of files you can store on the disk. On HFS disks, it's comprised of two files, the Catalog B-Tree file and the Extents B-Tree file. Both files can grow or shrink as you alter a disk's contents.
- The volume bit map is a "seating chart" that indicates which sectors are free and which are in use.
- The volume information block contains various details about the disk, such as the date and time it was initialized and last modified.

- The boot blocks contain information used at start-up time. (And here's the answer to the trivia question: The initials *LK* belong to Larry Kenyon, the principal designer of the Mac's original file system.)



Some Common File Signatures

In previous chapters, you saw that the Mac uses four-character file signatures to identify the type and creator of a file. These signatures work together with the DeskTop file's application list to enable the Finder to start the appropriate application when you double-click on a document.

Generally, you don't need to know the type and creator codes for your program's documents. Having this information has its advantages, however. As you saw in Chapter 11, if you transfer a file from a DOS PC, for example, you can change its type and creator code so that you can open it by double-clicking it from the Finder.

Table 17.2 lists the type and creator codes for numerous popular applications. You can determine a file's type and creator codes for yourself by using ResEdit: select the file (click it once) and then choose Get Info from the File menu.

Table 17.2: A sampling of common type and creator codes.

Type of file	Type	Creator
Any application	APPL	Varies
Any text file	TEXT	Varies
HyperCard Stack	STAK	WILD
MacDraw II document	DRWG	MDPL
MacDraw Pro document	dDoc	dPro
MacPaint document	PNTG	MPNT
MacWrite document	WORD	MACA
Microsoft Excel 4 worksheet	XLS4	XCEL
Microsoft Word document	WDBN	MSWD
TIFF images	TIFF	Varies
PICT graphics	PICT	Varies
PageMaker 4 document	ALB4	ALD4
QuarkXpress document	XDOC	XPRS

continues

Table 17.2: Continued

Type of file	Type	Creator
System-Related Files		
System file	zsys	MACS
Finder	FNDR	MACS
DeskTop file	FNDR	ERIK
System extension	INIT	Varies
Control Panel	CDEV	Varies
Chooser extension	RDEV	Varies
FKEYs	FKEY	Varies
TeachText document	TEXT or ttro	ttxt
ResEdit file	rsrc	RSED



Disk Troubleshooting

Floppy and hard disks are generally very reliable, especially if you observe the guidelines presented in this chapter. Still, problems can arise. In this section, we look at some of the problems that can occur with disks, and at some remedies you can try. But remember, no remedy is as effective as a current set of backup disks. The best way to avoid losing work is to keep at least one set of backup disks current at all times.

What Can Go Wrong

The programs and data that reside on disks face many threats that fall into the following general categories:

Physical damage. Someone in your office may use a floppy disk as a Frisbee or run over it with an office chair. Your external hard disk may fry in a sun-baked car or be jostled during shipping. Or, a section of the disk's magnetic coating may become damaged or dislodged by dirt or old age. You may be able to recover data from a disk suffering from minor physical problems, but there's little hope for a disk doused with spilled soda.

Magnetic damage. As mentioned earlier, many appliances and other devices generate magnetic fields that can partially erase a disk's contents. If some of the disk's track and sector boundaries are

obliterated by a strong magnetic field, even a disk-recovery program isn't likely to help.

Logical damage. If a problem, such as a system error or power glitch, occurs while you're saving a file, the portion of the disk being accessed may contain invalid information. If a file was being accessed, some of its contents may appear scrambled. If the directory or other reserved area was being accessed, the problems could be more serious because they are likely to affect more than one file. Computer viruses also can damage disks and files.

Operator error. Everyone makes mistakes. You may throw away a file accidentally, or switch off your Mac without choosing the Shut Down command or waiting for the `It is now safe to switch off your Macintosh` message to appear.

What Can You Do?

First, always keep a set of current backups handy. (Yes, we're hammering this point into the ground, but it warrants the treatment.)

Second, invest in at least one disk-utility and file-recovery program. They're inexpensive, especially compared to the time it takes to redo your work from scratch. When disk illness strikes, you will be glad you had a well-stocked doctor's bag.

Finally, if you run untested public-domain software or shareware frequently, you may want to invest in a *virus-detection program*, such as Microcom's *Virex* or Symantec's *Symantec AntiVirus for Macintosh* (SAM). These programs look for the specific viral "strains" that were circulating when the product was released, and they monitor activity on your disk and warn you when an attempt is made to alter your System file or other system resource.

Viruses are like earthquakes in California: everyone worries about them, but your chances of being victimized by one are extremely small. And because a new virus can appear at any time, no virus-protection program can guarantee complete protection. Still, if you routinely swap files with others, you may consider some virus protection software.

How Disk Utility Programs Work

Disk utilities provide the following defenses against lost data:

- They can help you resurrect an accidentally deleted file. Most recovery programs include an extension that creates an invisible file on each disk you use. This invisible file contains a record of the modifications

you perform on that disk. If you delete a file by mistake, the recovery program can use the information in its invisible file to recover the file (assuming that a newly saved file hasn't taken over its sectors, as described earlier in this chapter).

- They can directly access any part of a disk. The Finder and application programs expect disks to be healthy, with directories and other reserved areas intact. When that isn't the case, error messages, system crashes, or data loss can result. Disk utility programs, however, make few assumptions about a disk; instead, they take it at face value, and therefore can display the contents of any sector that isn't magnetically or physically damaged. If a program's automatic recovery features don't work, you may be able to recover at least some information manually by locating it using the utility's track-and-sector display mode, and then retyping what you find into a text-editing Desk Accessory or word processing program.
- They can repair certain areas of the disk automatically. Most utilities can quickly repair damaged boot blocks, and many can repair damaged directories or files by scanning the disk's contents.



Troubleshooting Common Problems

This section is a guide to troubleshooting common disk-related problems. We do not provide details on using specific disk recovery programs because each program works differently. Instead, we describe the types of problems or error messages you may encounter, and then provide some general guidelines for recovering from them.

Symptom: When you start up from a floppy disk, the Mac ejects the disk and displays an "X" over the disk icon.

What's wrong. This is an easy one: the disk isn't a startup disk; that is, it doesn't contain the System and Finder files.

What to try. Turn the disk into a startup disk by copying a current System Folder to it, or start your Mac with a disk containing a System Folder.

Symptom: During startup, the Mac displays the `Welcome to Macintosh` message, but crashes shortly after that.

What's wrong. Two or more extensions or Control Panels may be conflicting with each other. Or one or more may be damaged. Or, the System and/or Finder files may be damaged.

What to try. Restart the Mac, and watch the bottom of the screen carefully. Most extensions display an icon when loading; by watching to see which extensions have successfully loaded, you may be able to

track down the offender. If the Mac always crashes just before a specific extension loads, try starting up the Mac with a different startup disk, and then renaming the offending extension to change its loading order. (Remember that the Mac loads extensions alphabetically. Under System 7, the loading order is a bit more complicated; see Chapter 5.)

If that doesn't fix the problem, one or more extensions may be damaged. Restart the Mac with extensions off (press Shift until the `Welcome to Macintosh` message appears), and then replace any damaged extensions with fresh copies from their original disks.

If these remedies fail, try reinstalling the disk's system software by using Apple's Installer utility, described in Chapter 5.

Symptom: An application program or the Finder appears to have "frozen"—the Mac will not respond to keystrokes or mouse sequences.

What's wrong. A software or hardware problem caused a crash.

What to try. If you're using System 7, you may be able to abort the crashed program by pressing Command+Option+Esc. If this sequence produces a dialog box saying, `Force` *`program`* `to quit? Unsaved changes will be lost.`, click the Force Quit button. If you regain control of the Mac, try to save any unsaved work and then restart. If this routine does not work, you will need to press the reset switch or power down and restart.

Symptom: You cannot start the Mac from a hard disk that was working previously.

What's wrong. The hard disk's boot blocks or its System and Finder files may be damaged. The hard disk's driver software may be corrupted. Or, the contents of the Mac's parameter RAM, which stores (among other things) the currently selected startup device, may be corrupted. Or, if you have just attached a new SCSI peripheral, you may have a SCSI address conflict or a problem with your cabling or terminators.

What to try. Try repairing the disk's boot blocks. If the drive came with a utility that enables you to reinstall its driver software, run it and do so.

To reset the Mac's parameter RAM under System 6, press Command+Shift+Option while opening the Control Panel. A dialog box appears warning that you're about to "zap the PRAM" and asking if you want to continue. Click Yes. To reset the parameter RAM under System 7, restart the Mac while holding down the Control (not Command), Option, P, and R keys.

After clearing the parameter RAM, you may need to readjust your basic Control Panel settings, such as the keyboard repeat rate and double-click speed.

If you just attached a new add-on, check your SCSI addresses, cabling, and terminators. (See Chapter 16 for more details on SCSI cabling and termination.)

Symptom: When you insert a disk, the Mac says it's unreadable and asks if you want to initialize it.

What's wrong. The disk may be magnetically or physically damaged, or it may not be seated properly in the drive. Or it may be that you inserted a double-sided disk into a single-sided drive, or a high-density disk into a non-FDHD drive. Or, the disk may be blank or formatted for a different type of computer.

What to try. First, eject the disk. Examine it to verify that it's the one you really wanted to insert and that it's compatible with your Mac. If it is, try inserting the disk again. (Use a different floppy drive, if possible—the first drive you tried may be misaligned or damaged.)

If that doesn't work, try using a disk utility program to recover as much of the disk's contents as possible.

Symptom: When you insert a disk while the Finder is active, the Mac says it needs minor repairs and asks if you want to repair it.

What's wrong. The disk's DeskTop file is probably damaged or inconsistent.

What to try. Click OK to tell the Finder to rebuild the DeskTop file. When the DeskTop file is rebuilt, you lose any Get Info comments you specified for that disk's contents.

You also may consider using ResEdit or a disk utility to rename the DeskTop file. After doing so, you can insert the disk at the Finder, and the Finder will create a new DeskTop file.

Symptom: The Mac is unable to open a document when you double-click it and displays a message that tells you the application is busy, missing, or cannot be found.

What's wrong. You may not have the application that originally created the document. Or, the document may not be intended to be opened from the Finder (for example, perhaps you accidentally double-clicked on a program's spelling checker dictionary or preferences file). Or, the disk's DeskTop file may be damaged.

What to try. If the application that created the document is missing, copy it to your hard disk or startup floppy disk in order to open the file. If you don't have the application (for example, MacWrite) but you do have an application that can read the document (for example, Microsoft Word), start the application you do have and then use its Open command to access the document.

If you do have the original application, try rebuilding the disk's DeskTop file. For floppy disks, insert the disk while pressing the Command and Option keys, then answer OK when asked if you want to rebuild the desktop. For hard disks, restart the Mac and press Command+Option before the menu bar appears.

Symptom: When you're using the Finder or MultiFinder, an error message appears that tells you `The disk is so full that the folder changes couldn't be recorded.`

What's wrong. The disk is so full that the Finder isn't able to record your changes to a folder's viewing mode or icon arrangement in the disk's DeskTop file. Or, the DeskTop file itself may be corrupt.

What to try. If the disk is full or nearly full, free up some space by removing unneeded files or copying some files to another disk.

If there's plenty of room on the disk, try rebuilding its DeskTop file.

Symptom: When you try to delete a file or folder, the Finder reports that the item is locked or busy and cannot be removed.

What's wrong. You may have tried to throw away a file that the Mac is currently using (for example, the Finder file, or an application or document that's currently open). Or, the file may be locked. Or, a bug in a program or a recent system crash may have simply caused the Mac to *think* the file is in use.

What to try. First, verify that the file you're trying to delete isn't currently open. The current startup disk's System and Finder files cannot be thrown away, nor can the MultiFinder file when you're running under System 6 MultiFinder. If you want to throw away these files, restart the Mac with a different startup disk.

If you really want to throw away an application or document, quit or close it first. If you're running under System 7 or System 6 MultiFinder and you want to delete a document you just closed, you also may need to quit the document's application in order for the Finder to "know" that the document is no longer in use.

To throw away a locked file, use the Finder's Get Info command to unlock it. Or simply press the Option key while dragging the file to the Trash.

If these techniques fail, restart the Mac and try again. If the problem was caused by a program bug or temporary inconsistency in the Mac's memory, restarting should clear the problem.

Symptom: A message appears that tells you `Please insert the disk` *disk name*.

What's wrong. Probably nothing. Chances are that the Mac simply needs to access a disk that you have ejected by using the Finder's Eject command, by clicking the Eject button in the Open or Save dialog box, or by using the Command+Shift+1 or Command+Shift+2 FKEYs. One time you may see this message is if you eject a disk and then double-click its dimmed icon in order to view its contents.

What to try. Insert the disk that the Mac is looking for. If you have double-clicked a dimmed icon and you don't want to insert the disk, press Command+period. The Finder displays an error message saying the disk couldn't be used or opened.

If the Mac asks you to swap between two disks over and over, there may be a temporary problem with memory or an application program. First, humor the Mac by swapping the disks a few times. The Mac may really need to alternately access the disks. If this floppy disk shuffle goes on for more than a half-dozen or so swaps, however, chances are there's a problem. Try pressing Command+period to break out of the disk-swap loop. Depending on why the Mac was asking for the other disk, however, this technique may cause a system crash. If Command+period seems to work, save all open documents and restart the Mac to clear its head.

To avoid these problems, it's always best to eject disks by dragging their icons to the Trash. Note, however, that you cannot use this technique to eject a disk containing an open document or application.

Symptom: When you're copying files, the Finder reports that a file couldn't be written (or read) and was skipped.

What's wrong. A disk error is preventing the Finder from writing to (or reading from) a disk successfully.

What to try. If the problem disk is a floppy, try ejecting and reinserting it. The disk may not have been seated properly in the drive, or the drive may be slightly out of alignment. If this fixes the problem but it occurs again with different disks, have the drive serviced.

If the problem disk is in an external disk drive, be sure that the drive isn't located to the left of the Mac or near a high-intensity or halogen desk lamp. It may be that a strong magnetic field is causing disk errors (or worse, that it magnetically damaged the disk).

With floppy or hard disks, try copying the files one at a time. If the Mac is having a problem writing to a disk, try using the Finder's Duplicate command to duplicate a small file on that disk. This causes subsequent files to be written on different sectors. If this works, back up the problem disk immediately and, if it's a floppy, stop using it. If it's a hard disk, consider having it serviced.

You also may want to use a disk utility to *verify* the disk's contents. During verification, the utility scans the disk for errors and inconsistencies.

APPENDIX



MAC APPLICATIONS GLOSSARY

In this book's Introduction, we mentioned that we don't describe specific application categories. From the beginning, we have assumed that you have at least a basic familiarity with the kinds of programs available for the Mac.

But even a seasoned Mac veteran may not be familiar with every application area. For that reason, we have included this glossary of the most common ways Macs are used. With each definition, we have mentioned some (but not all) of the programs available in that application category. Use these definitions as starting points for further investigation.

Accounting Managing financial information. Enables you to track payrolls, accounts receivable, accounts payable, maintaining a general ledger, and tracking expenses. Accounting programs include Survivor Software's MacMoney; Softsync's Accountant, Inc.; Intuit's Quicken; and Peachtree's Peachtree Accounting. Many database managers can also be used for accounting applications.

Animation. Combines sequences of images that, when played back, provide the illusion of motion. Macintosh animation programs include MacroMedia Director and FilmMaker; Gold Disk's Animation Works.

Business graphics. Creates charts that visually depict trends or relationships between values. Business graphics programs generally can create numerous types of charts; examples include pie charts, bar charts, and line charts. Most spreadsheet programs provide built-in graphing features; you also can choose stand-alone graphing programs, such as Computer Associates' CA Cricket Graph.

Computer-aided design (CAD). Creates architectural drawings, mechanical drawings, and circuit schematics. CAD programs provide sophisticated features for measuring the components in a drawing and for retrieving automatically often-used shapes from *symbol libraries.* CAD programs include VersaCAD, MiniCAD, and AutoCAD.

Database management. Enables you to store, edit, organize, and retrieve information, generally organized in a rigid format comprising *fields* (pieces of information, such as a person's first name, last name, and address) and *records* (a collection of fields pertaining to one entry, such as one person's complete name and address). Many Macintosh database managers also can store graphic images. Database programs include Claris' FileMaker Pro, Acius' 4th Dimension, and Microsoft's FoxBase/Mac. Most spreadsheet programs and integrated packages also provide limited data-management features.

Desktop publishing. Prepares final artwork, generally by combining text and graphics created in other programs, for documents you print and distribute. Desktop publishing programs generally have sophisticated text-formatting features that give you more control over character and line spacing than word processors provide. Examples of desktop publishing programs include Aldus' PageMaker, QuarkXpress, and Frame Technology's FrameMaker.

Drawing. Creates graphic images by using an object-oriented program, in which images are comprised of distinct shapes (circles, lines, polygons, and so on). Drawing programs include Claris' MacDraw series, Computer Associates' CA Cricket Draw, Deneba's Canvas, Adobe's Illustrator, and Aldus' FreeHand. See also *Painting.*

HyperCard. The application category that defies simple definitions. Apple calls HyperCard "system software," but more accurately, it's a programmable database that enables you to establish links between on-screen buttons and pieces of information. In a HyperCard stack about Mozart, for example, you may click on one button to read a biographical sketch, another button to view a picture of Mozart's home town, and a third button to listen to a musical passage. HyperCard's programming language is called *HyperTalk.* HyperCard documents are called *stacks.*

Image processing. Analyzing and altering the appearance of graphic images, usually those created by a *scanner.* Image processing programs enable you to electronically retouch images, removing spots or imperfections and changing brightness, contrast, or color balance. Most programs provide tools that correspond to real-world retouching tools, such as airbrushes and pencils. Image processing programs include Adobe's Photoshop, Aldus' Digital Darkroom, Fractal Design's ColorStudio, and MicroFrontier's Enhance.

Optical-character recognition (*OCR*). Interpreting the text in a scanned image and creating an editable text file containing its characters. Without OCR software, scanning a page of text is like photocopying it—you cannot edit the results. OCR programs include Caere's OmniPage series, Xerox's AccuText, and Olduvai Software's Read-It series.

Painting. Creating graphic images, generally by using pencil-and paintbrush-like tools that "apply" black pixels to an electronic canvas. Painting programs create bit-mapped images, which can show excellent shading and detail, but can become distorted when resized. Painting programs include Claris' MacPaint, Electronic Arts' Studio/1 and Studio/8, and SuperMac's PixelPaint.

Presentation graphics. Prepares presentation visuals, such as overhead transparencies, slides, and hand-outs. Presentation programs generally combine built-in outlining features to help organize your thoughts with drawing features that enable you to create your visuals. Presentation programs include Aldus' Persuasion, Microsoft's PowerPoint, and Symantec's MORE.

Project management. Analyzes and refines the steps in a project by supplying a list of required tasks, the time each takes to complete, and the resources available to complete it. Project management programs enable you to visually depict the work flow of a given project and claim to help you allocate resources and schedule appropriately. Project managers include Claris' MacProject II, Microsoft's Project, and Scitor's Project Scheduler 5.

Spreadsheets. One of the mainstay applications of the business world, spreadsheet programs enable you to enter values in a grid-like array of *cells,* specify relationships among the cells, and then perform calculations based on the relationships. Change a value in one cell, and the spreadsheet program *recalculates* other cells to show the result. Using this technique, you can play "what if?" games: What if sales rose 10 percent rather than 15 percent? What if costs were cut in half? What if interest rates rise next year? Spreadsheet programs include Microsoft Excel, Lotus 1-2-3, and Claris Resolve. Integrated packages, such as Microsoft Works and ClarisWorks, also include spreadsheet modules.

Telecommunications. Literally means "communicating at a distance." Specifically, connecting to other computers using the phone lines and telephone modems. With a modem and communications software, you can tap into the computers of information services, such as Connect and CompuServe. These offer a vast world of free software,

shareware, technical insights and advice (from fellow users and from hardware and software firms), stock quotes, weather forecasts, travel information, and much, much more. You also can send electronic mail to other computer users who have modems. Chapter 12 contains more information on telecommunications. Some popular communications programs include FreeSoft's Whight Knight, Hayes' Smartcom II, and Software Ventures' MicroPhone II.

Video editing. Enables you to assemble and edit digitized video clips created using hardware, such as SuperMac's Video Spigot. Video editing programs enable you to apply effects such as fades and dissolves. You can save the completed production as a QuickTime movie or, with appropriate hardware, record it to videotape. Video editing programs include Adobe's Premier and DiVA's VideoShop.

Word processing. This is the final definition in this appendix, but the most popular application in the microcomputer world. Word processing programs turn the Mac into a sophisticated electronic typewriter that enables you to enter and revise text and then commit it to paper. Word processing programs offer *search and replace* features that enable you to make wholesale revisions in one swoop—changing all occurrences of "Mac" to "Macintosh," for example. Some word processing programs also can compile indexes and tables of contents automatically. Many of today's Mac word processing programs have features that encroach on desktop publishing territory, such as fine control over line and letter spacing, the capability to combine text and graphics, and features for creating multiple-column pages. Word processing programs include Microsoft's Word, T/Maker's WriteNow, Claris' MacWrite series, and WordPerfect Corporation's WordPerfect. Integrated packages also include word processing features.

APPENDIX

B

BITS AND BYTES: HOW COMPUTERS WORK WITH NUMBERS

In our daily lives, we work with numbers using the *decimal* numbering system. By *decimal,* we mean *ten:* all of the numbers with which we work are based on arrangements of ten symbols—0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. When we need to represent a number larger than 9, we combine symbols. To represent the number "ten," for example, we put a 1 in the "tens" place and zero in the "ones" place. We use the same basic techniques to work with larger numbers. The value 5,480, for example, is represented by a 5 in the "thousands" place, a 4 in the "hundreds" place, an 8 in the "tens" place, and a zero in the "ones" place. Because our numbers are based on units of ten, our numbering system is called *base ten.*

There is no law of mathematics stating that numbers *must* be represented in base ten, however. That's simply the system we use—just as Americans measure distance using inches, feet, and miles, while Europeans use centimeters, meters, and kilometers. Numbers can be represented with fewer than ten symbols. If we want to use base eight, for example, we simply forget that the numeral 9—the symbol itself, not the value—exists. When we need to represent the value nine, we combine two symbols, putting a 1 in the "nines" place and a 0 in the "ones" place. We can represent other values by following this scheme:

Value	Representation	Description
Nine	11	one "eight" and one "one"
Eleven	13	one "eight" and three "ones"
Sixteen	20	two "eights" and no "ones"

Using these same techniques, we can represent values in base six, base three, or base two. Even if we forget that the numerals 2 through 9 exist, we can still represent any number by using the numerals 0 and 1. To represent the value two, we write 10: one "two" and no "ones." The value three becomes 11: one "two" and one "one." Representing values greater than three means adding additional places, like this:

Value	Representation	Description
Four	100	one "four," no "twos," no "ones"
Five	101	one "four," no "twos," one "one"
Nine	1001	one "eight," no "fours," no "twos," one "one"

Larger values require still more places: in binary, a base-ten value of 87 is written as 1010111: one "sixty-four," no "thirty-twos," one "sixteen," no "eights," one "four," one "two," and one "one." Obviously, base two is not a convenient way for people to represent numbers. You would need an awfully wide check to spell out most amounts.

Base Two and Computers

Base two may not be convenient for people, but it happens to be extremely convenient for a machine containing millions of electronic switches. Why? Because a switch can represent one of two values. We can say that when the switch is off, it reflects a value of zero, and when it's on, it reflects a value of one. By combining switches, we can represent larger values. If we combine eight switches, for example, we can represent any value between 0 and 255.

This base-two numbering system is called *binary*, and the two symbols in binary numbering, 1 and 0, are called *binary digits*. To chop out a few syllables, computer scientists shortened the phrase "binary digit," coining the term *bit*. A bit, then, is a one or a zero, and is the smallest piece of information with which a computer can work.

We just mentioned that computers can represent larger values by combining bits. We used eight as an example, and for a good reason. Because a group of eight bits is able to represent 255 different values, it makes a versatile building block for representing program instructions and information. These eight-bit building blocks are called *bytes*.

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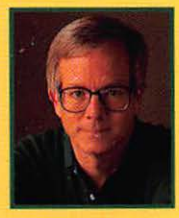
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