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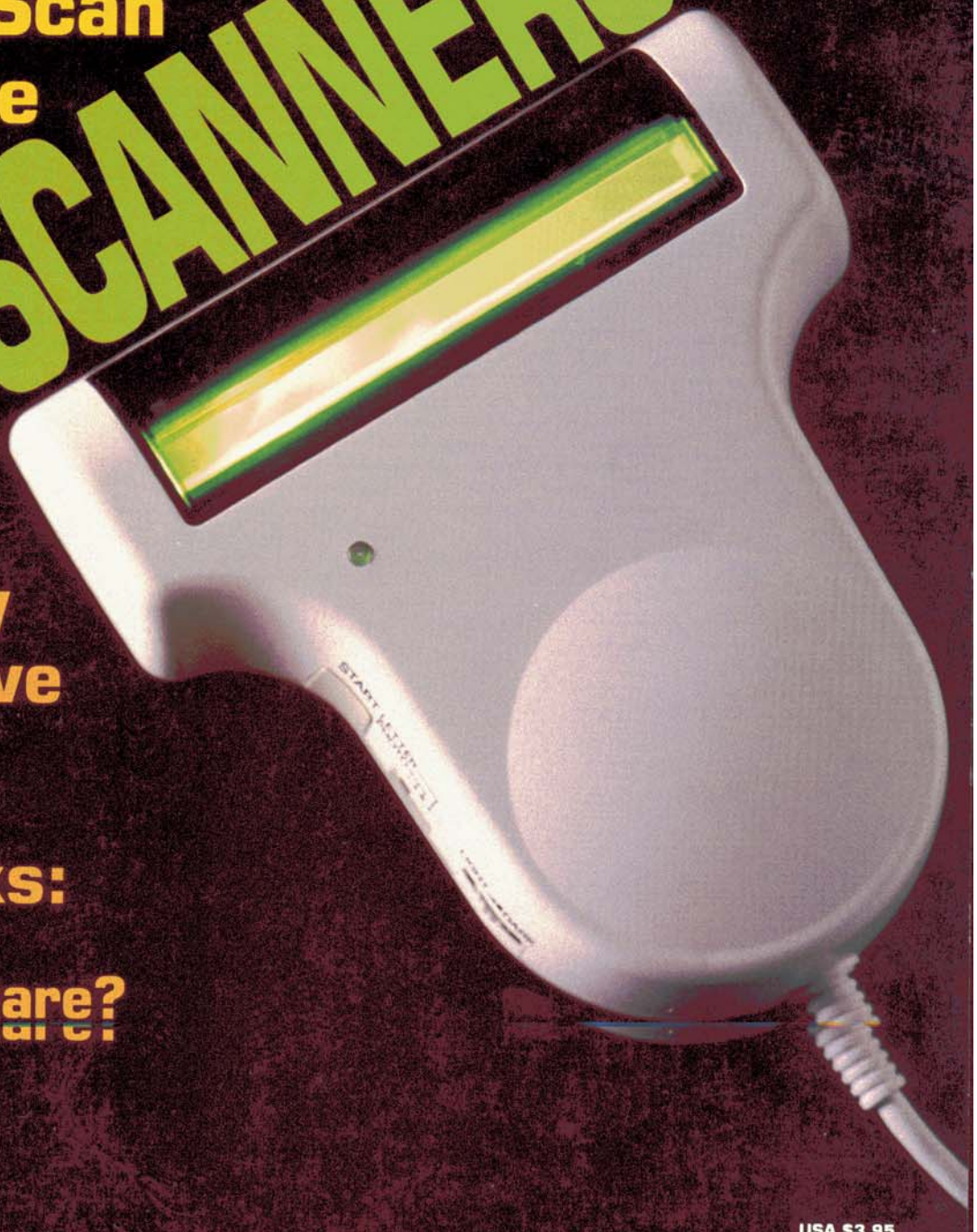

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SHOPPING FOR A SYSTEM

A hard-disk drive is probably the biggest investment you'll make in your computer system. In this first installment in a six-part series, we look at some key questions to ask before you buy.

By Gary R. Morrison and Walker Archer

What makes the personal computer truly "personal" is its ability to store data for future use. In early personal computers, every line of every program and every bit of data had to be typed in each time you used the machine.

Then came the cassette recorder, which let you save or record programs and data on magnetic tape. Finally, the floppy-disk drive appeared. Once you could save your spreadsheet data or word-processor files to disk, the computer became a more useful tool.

Since then, Apple computers have improved dramatically in the amount and types of data storage available: from the 143K Disk II in the early 1980s, to 800K 3.5-inch disks, to hard-disk drives that hold more than 100 megabytes (M) of data.

If you use your Apple II regularly, you might want to consider adding a hard drive to your system. A hard drive is an expensive purchase, however, and there are several questions you should ask before you hand over your money.

WHY DO I NEED ONE?

The two major advantages of a hard-disk drive are *speed* and *convenience*.

No doubt about it — hard drives are fast. A hard disk rotates faster than a floppy disk and the data residing on it is packed more densely. As a result, hard disks generally operate five to ten times faster than floppy disks. For example, on an Apple IIGS with a TransWarp card, an 85K word-processor file that takes 47 seconds to load from a 5.25-inch floppy disk and 38 seconds to load from a 3.5-inch disk takes only five seconds to load from a hard-disk system with the Apple II High Speed SCSI Card.

Because you can store both programs and data on a hard disk, these same speed increases are evident when you load applications such as AppleWorks, The Print Shop, Merlin, or ORCA into your computer's memory. For example, on a GS with a TransWarp card, it takes less than eight seconds for AppleWorks to boot up and ➪

Illustration ✦ Chris Spollen

load onto a 1M memory card from a hard disk; it takes 27 seconds to accomplish the same start-up process from a 3.5-inch disk, and 35 seconds plus one disk swap to boot AppleWorks from a 5.25-inch floppy disk. You'll also see improvements when you run disk-intensive programs such as Managing Your Money, because you won't have to wait as long for data and programs to load.

As for convenience, a single hard disk can store an entire collection of floppies. For example, a 20M drive stores the equivalent of 144 5.25-inch floppies or 25 3.5-inch disks. You can copy your programs and data from your floppies to the hard disk, and you won't have to trade floppy disks when you work. In addition, you no longer need to segment large files on different floppy disks; hard drives have the capacity to store dozens of large AppleWorks data files.

WHAT IS A HARD-DRIVE SYSTEM?

A hard-disk-drive system has two major components — the hard drive itself and the *controller card* — plus a cable to connect them. The hard drive consists of one or more aluminum disks enclosed in a special airtight container that prevents contamination from dust, humidity, smoke, and various other environmental hazards. Each platter is coated with an oxide material, similar to a floppy disk's, that records magnetic pulses. The platters rotate at high speed within the container. Riding on a cushion of air generated by the rapid spinning of the platters, a read/write head floats just above their surface.

The hard-drive controller card serves as an interface between an Apple IIe or GS computer and the hard drive. Most often the controller card should be installed in slot 7 in the computer. Because the Apple IIc has no slot to accommodate a controller card, the few hard drives available for that machine put the board in the same case that houses the drive unit and then use signals from the Smartport to control the drive. Most Macintosh computers have a built-in interface for hard-disk drives.

"The two major advantages are speed and convenience."

When you purchase a hard drive, be sure to check the cable that connects the drive to the interface. Some drives use a 50-pin connector, while others have a 25-pin type. Check to see that the other end of the cable matches the connector on the controller card, too.

Another factor to consider is where the drive will sit in relation to your computer. Some drives are shipped with a short cable (18 inches). If you need a longer one, see your dealer to determine the maximum length (usually 6 feet).

Most hard-drive systems for Apple II computers are "external" drives designed to be freestanding units that sit on the desk next to the computer. Applied Engineering manufactures an "internal" drive called the Vulcan, which mounts inside the Apple II case and replaces the power supply. All current Macintosh computers are designed to accept an internal hard drive, but they also have a connector for adding another external type. Although the physical size of hard drives varies, many modern external models are about the size of Apple's original 5.25-inch floppy-disk drive.

HOW MUCH STUFF CAN I STORE?

With the wide variety of drives on the market, selecting one has become as difficult as buying a car. Just a few years ago, the most popular size for Apple II hard drives was 20M. Today, you have the option of purchasing a drive with 100M or more. Prices range from about $500 for a 20M hard drive to $1000 or more for a 100M drive. Although such prices may appear high, the cost per megabyte changes drastically with the size of the drive. For example, 1 megabyte on a 20M drive costs about $25, while 1 megabyte on a 100M drive costs around $10.

Before you rush out and buy a 100M drive, remember that the ProDOS operating system can access up to only 32M on one volume or drive. That doesn't mean that you're limited to 32M drives. You can "partition" your hard drive by changing the jumpers on the controller card (as with CMS' models) or via software (such as Apple's or Chinook's SCSI Utilities). Partitioning tricks ProDOS into thinking you have more than one drive in the slot, each of which can have a capacity of 32M.

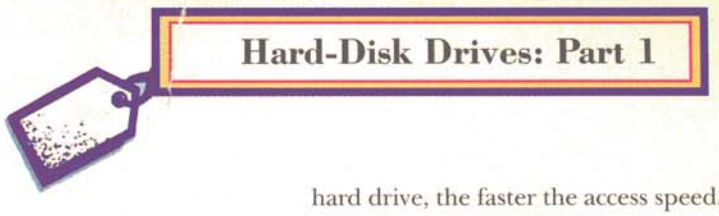
ProDOS restricts the number of volumes you can manage, but those limits are liberal. On all Apple II computers you can have two devices (or drives) in each slot. This feature lets you have two 32M partitions while using only one slot and interface card. If you have a GS and use ProDOS you can trick the computer into allowing up to four partitions on one drive (128 megabytes) by placing the card in slot 5. When you use four partitions, the GS firmware will automatically make it look as if any partitions over the two-partition limit are mapped to slot 2.

Although this method works for some people, there are some serious drawbacks. First, if you use a RAM disk, you'll be able to see only three of the partitions on the hard disk. Second, you must give up the 3.5-inch disk while using the hard drive, because they both map to slot 5.

GS/OS for the Apple IIGS is even more flexible than ProDOS. If you use an Apple-SCSI-compatible hard drive (more on SCSI protocol below) and install an Apple SCSI card in the GS, you can have up to seven hard drives or other SCSI devices connected to that card. There's a catch: When you switch to a ProDOS program, such as AppleWorks, you'll be able to access only the first two partitions, or the first four if the card is in slot 5.

HOW MUCH STORAGE SHOULD I BUY?

The size of the hard drive you buy should depend on how much money you



have available and how much you use your computer. Your personality makes a difference, too. Are you reckless and fast, or careful and slow? Some daring individuals store all their programs and data on their hard drives and essentially stop using floppy disks. More-conservative users prefer to keep their data stored on floppy disks, trading the convenience and speed of the hard drive for the relative safety of a floppy disk. Of course, a floppy disk could fail, but chances are you'd lose only a few files. Some users perfer to have have two hard drives and copy their work from one to the other as a daily backup.

If you decide to store both programs and data on your hard drive, you'll need more storage capacity than if you stored only programs. In either case, you can estimate your current needs by adding up the size of all the program and data files you want to store on the hard-drive system. A good guideline is 144 5.25-inch floppy disks or 25 3.5-inch disks per 20 megabytes.

Determining your future needs is more difficult. Remember, you can't expand a hard drive; if you run out of space, you'll have to add a drive to your system. Also, you'll probably need more disk space than you anticipate. For example, the AppleWorks GS program alone requires approximately 1.5M. To allow room to move, a rule of thumb is to add 25 to 50 percent to your estimate. For example, if you have 100 floppies you want to copy to your hard drive, consider a size larger than 20M. If you have an Apple IIe you'll probably want at least a 20M drive, while a GS owner will probably want at least a 40M drive, because both GS programs and data files tend to be larger.

WHAT KIND OF INTERFACE DO I NEED?

A few years ago, the major hardware manufacturers agreed on a standard way to connect computers with storage devices such as hard drives. This protocol, called the *small-computer-systems interface* (*SCSI*, pronounced "scuzzy"), specifies how a computer and its peripherals should communicate. All popular hard-drive systems for the Apple II and the Macintosh claim to adhere to the SCSI standard.

"A single hard disk stores the contents of an entire collection of floppies."

In theory, any drive from any company that follows the SCSI standard should be able to work on any Apple II equipped with a SCSI card and on a Macintosh with its built-in SCSI port. Unfortunately, different manufacturers implement the SCSI interface in various ways, resulting in drives that aren't Apple-SCSI compatible. If you plan to add a second hard drive or a CD-ROM drive to your system, you'll probably want to select products that are Apple-SCSI compatible; you'll need only one interface card. Also, if you want the option of moving your hard drive between your Apple II and a Macintosh, you'll need an Apple-SCSI compatible drive.

HOW FAST SHOULD MY HARD DRIVE BE?

Different hard-drive systems store and retrieve data at different rates. One measure of that speed is the *average seek time*, the time it takes the drive's read/write heads to move to the location on disk where the data is stored. It happens so quickly that it's always expressed in thousandths of a second, or *milliseconds*. It's expressed as an average because the read/write heads may not always have to go from one end of the platter to the other. As you'd expect, hard drives with low average seek times are faster than drives with higher average seek times. For example, a hard drive with an average seek time of 25 milliseconds will find data and programs on the drive about twice as fast as a hard drive with an average seek time of 65 milliseconds. In general, the larger and more expensive the hard drive, the faster the access speed.

The access time of the drive, however, is only one measure of drive speed. Of more concern is how fast the data is transferred from the drive to your computer's memory, or vice versa. This *throughput speed* is more a function of the computer, operating system, interface card, and cables. You can spend money purchasing a "faster" drive that in reality will work no faster than a "slower" drive owing to the limitations imposed by the system. Remember — even the slowest hard drive is many times faster than a floppy-disk system.

WHAT'S INSIDE A HARD-DISK DRIVE?

Another factor to consider is the drive mechanism. Many hard-drive manufacturers purchase the actual mechanism from another manufacturer and then add the power supply, fan, and cables. The two most common types of mechanisms on the Apple market are manufactured by Seagate and Connor. If you prefer a particular drive mechanism, you may want to ask your dealer or manufacturer what type of mechanism is used. Some mechanisms are simply better than others in both speed and reliability.

Mechanisms are built differently and can vary widely in durability. Manufacturers calculate the *mean time before failure*, or *MTBF*, for each drive mechanism. This rating is an estimate of how many hours of use the drive will survive, based on lab tests. While MTBF ratings can be useful in rating a drive's life expectancy, they aren't a good indication of how well a drive will stand up to abusive situations, such as dropping.

Important factors in drive reliability and speed are the types of components used internally in the mechanism. Many hard-drive mechanisms now use *plated media* (a hard coating over the magnetic medium to keep read/write heads from scratching it when the drive is bumped) and *voice coil actuators*. An *actuator* is the device that moves the read/write head back and forth across the platters to access files. The most common type of actuator to date has been the stepper ➪

motor. A newer mechanism, the voice coil actuator, is faster and more accurate.

A second aspect to be aware of is the air flow through the housing. How coolly does the drive operate? While the greatest threat to a drive is a sudden sharp movement such as dropping or bumping, another problem is heat. As with all electronic devices, heat can shorten the life of your hard drive, and in this case lead to loss of data.

ANYTHING ELSE?

When all else is equal, there are other factors to consider when you purchase a hard drive. If you have limited desk space, you should consider the physical size of the hard drive. For example, a Chinook 100M drive uses less than one-third of the desk space that a 46M Relax drive requires. The Relax model, however, is only one-third the height of the Chinook.

Some hard drive/controller card combinations require you to power up the hard drive and allow the drive to reach speed before turning on your computer. Other systems let you turn on both the computer and the hard drive at the same time. This feature is more convenient if you like to use the on/off switch on a power strip to control your computers. Drives connected to the Apple SCSI card must be powered up before you turn on the computer. If you're considering an Apple-SCSI-compatible system, you'll need a separate power switch for your hard drive. You may want to consider Applied Engineering's Conserver or Kensington's System Saver GS.

While you're looking at hard drives, you might want to listen to the drive and determine how much noise it makes. Hard drives run continuously and the hum of the drive is annoying to some people. Noise can come from the internal motor that runs continuously or during disk access when you load or save a file.

PARKING PROBLEMS

Another consideration is how you "park" the heads of the drive. When you turn off the power on a hard drive and the platters stop spinning, the drive read/write heads no longer have a cushion of air on which to float, so they settle into physical contact with the platters. "Parking" the drive heads means moving them to an area that doesn't contain data. If the drive is bumped in the parked position, the heads won't be able to scratch the platter in an area that contains data. You should always park the heads before moving your hard drive. Some systems park the heads automatically after a period of inactivity; others force you to park the heads manually by running a utility program, which may or may not come with the hard drive.

"The larger and more expensive the drive, the faster the access speed."

If you need to transport your drive, you might want to consider a hard-drive system with removable media. These drives store data on a cartridge that typically holds 45M of data. You can remove the cartridges for safe transportation. You can also buy additional cartridges to use for backup or as extra storage.

MATCHING HARDWARE AND SOFTWARE

Manufacturers of Apple II and Macintosh drives try to make it easy to install their systems and use their products. Many drives come formatted from the vendor, and most also come ready to boot. You can install the interface card in the appropriate slot and boot your system from the new hard drive.

If the drive isn't formatted or if it's formatted for another system, find out what utilities are shipped with the drive. Some manufacturers provide the necessary utilities to format and partition the drive.

If you purchase a SCSI drive for your Apple II, it might arrive with Mac software. In this case, you need to use a SCSI utility such as Chinook's SCSI Utilities, the GS' System Software, or software supplied with your interface card to format and partition your drive.

CARE AND FEEDING

Finally, you'll want to consider the disk-management software that comes with the drive. Because your programs will now be on the hard drive, you'll no longer need to change disks and reboot the computer. But how do you select the different programs?

If you have an Apple IIGS or a Macintosh, you'll have access to the Finder, which lets you launch programs, delete files, and create new folders. A number of program selectors and utilities are also available for the Apple II. The more common ones are Quality Computers' EasyDrive, Glen Bredon's ProSel, and Vitesse's Wings. Each of these applications lets you build a menu of the programs on your hard drive. All you need to do is highlight the program's name to run it. When you're finished with one application, you're returned to the program selector so that you can choose your next application.

Next month, we'll look at the interface issue in more detail. How important is it that you buy a hard-disk drive that adheres to the SCSI standard? And if you don't go with SCSI, what other choices do you have? ❑

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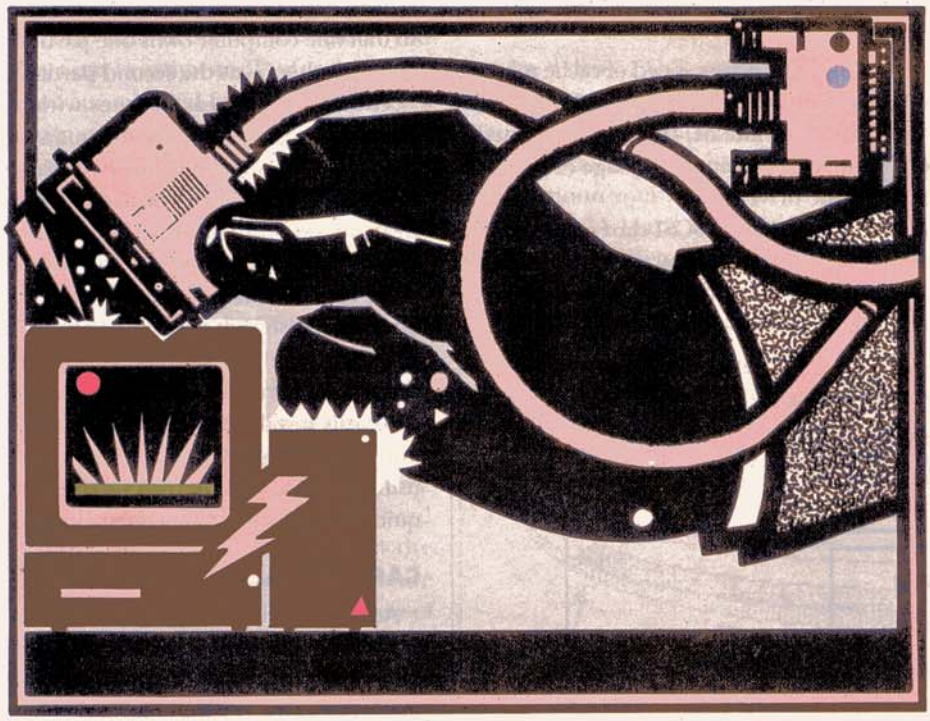
Hard-Disk Drives Made Easy: Part 2

THE SCSI SIDE OF LIFE



Are you tired of doing the floppy-disk shuffle? With a SCSI card and a hard drive you can "cache" in on speed and storage.

By Gary R. Morrison and Walker Archer

As any good advertiser knows, consumers will buy any product marketed to save time. But while most of you wouldn't dream of cooking in a conventional oven or brewing your morning coffee in a percolator, some of you still stare blankly at the monitor as you swap floppy disks and wait for your computer to load your programs. With a hard-disk drive, however, you won't need to suffer any longer. Because buying a hard drive can be as big a decision as it is an investment, this six-part series takes a look at some questions to ask before you pull out your VISA card. This month we focus on several SCSI interface cards (pronounced "scuzzy," *small-computer-systems interface*) that work with a host of SCSI hard drives. Read on and see how the **Apple High-Speed SCSI**, the **RamFast SCSI**, and the **CMS SCSI** cards stack up.

A STANDARD TO FOLLOW

The Apple High-Speed SCSI card is the worthy successor to the original Apple SCSI card. Its most notable new feature is its capability to do DMA (*direct memory access*) transfers. DMA lets the interface card put data directly into memory, without using the computer's microprocessor. (See **Figure 1**.) Information is transferred faster and more efficiently because it travels a shorter path to the final memory location.

Depending on the configuration of your computer, however, you may not be able to use this feature. Make sure you have no other cards in your computer that also utilize their own DMA, for example. If you have an Apple IIGS with a memory card, make sure that the card can handle DMA transfers. If you can't use this DMA transfer capability, disable it by setting a switch on the card during installation.

A well-illustrated installation and owner's guide is included with the Apple II High-Speed SCSI card, as well as all the hardware you need to install the card and mount the connector to the back of your computer. You'll also find software for formatting and partitioning a new hard drive, as well as drivers and installation scripts for use with GS/OS on the Apple IIGS. (More on ➪

Illustration ✦ Chris Spollen

card installation and configuration below.) In addition, you'll find a copy of Backup II software for safeguarding the data on your hard drive. This updated version the program includes support for GS/OS forked files, and uses the full 80-column screen.

"Information moves faster — it travels a shorter path to RAM."

A SPEEDY ALTERNATIVE

The RamFast SCSI card also uses DMA to achieve quick data transfer. It keeps up to 256K of the disk data you use most often in a bit of RAM called a *cache*, a scheme perfected by Ohio Kache Systems. The *cache* (or *look-ahead* memory) temporarily remembers information that has been transferred to or from the hard disk. (The access speed of cache memory is similar to that of a RAM disk.) By thinking ahead, the RamFast card is capable of taking advantage of each spin of the drive.

The RamFast SCSI card comes with an installation and owners guide and is illustrated only with several screen dumps. This card doesn't include any

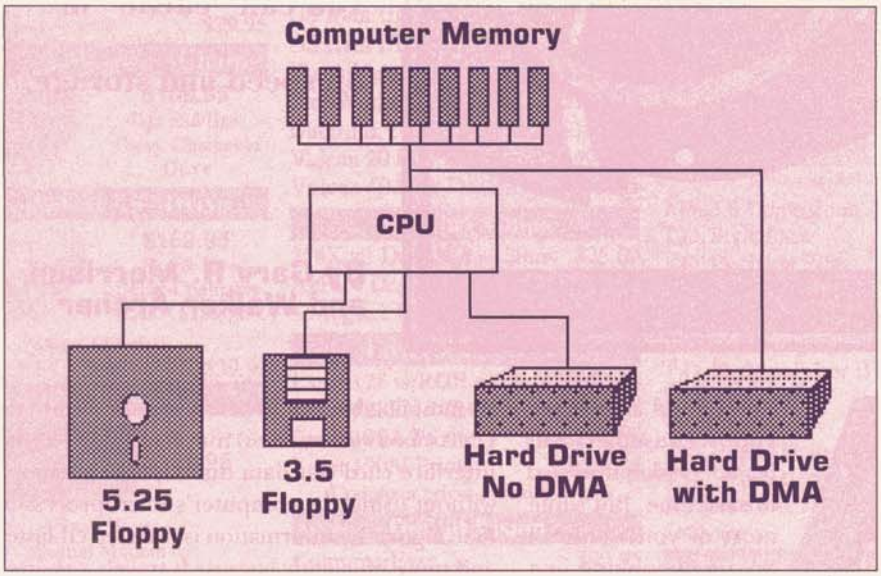


Figure 1. Data flows from a floppy disk, a hard disk, and a hard disk with DMA capability.

drive. If the RamFast card receives another request for the same data, it will take it from cache memory instead of accessing the hard drive. In other words, when you request a block of data, the RamFast card actually reads that block and a number of other consecutive blocks into look-ahead memory. (See **Figure 2**.)

Because GS/OS or ProDOS attempts to store most programs and data consecutively on a hard drive, the result is faster access from the RamFast internal memory and fewer reads from the hard drive. Reading data from look-ahead memory is like reading data from a RAM

software on disk; everything you'll need to use is included in a clever ROM-disk scheme built into the card.

AN UNDERCOVER OPTION

The CMS SCSI card is usually bundled with CMS hard drives, but you can use it with just about any SCSI-compatible hard drive. With it you can partition a hard drive using the card's jumper pins instead of its software. As a result, you'll have an easier time setting up the CMS SCSI card to share one hard drive between two computers.

Although the Apple High-Speed SCSI card lets two computers share a hard drive, both machines will see the drive exactly the same way, because partitioning information is in a table on the drive. The CMS partitioning information, however, is on the SCSI card, so each machine will see the drive differently. In other words, you can configure the cards so that one computer owns one partition and the other owns the second partition.

The CMS SCSI card comes with an installation guide that details many of the most common jumper configurations. In addition, CMS provides configuration software that will report the card's jumper settings. The latest CMS SCSI-card ROMs also supply an initial boot screen so that you can change the priority of the partitions and boot from the second partition. With this setup you can easily install GS/OS on one partition and ProDOS 8 or GEOS on another. By using the initial boot screen you can boot quickly into either operating system.

CARD INSTALLATION

Actually seating one of the SCSI cards is no more difficult than installing any other card in an Apple computer. Simply insert it into the slot and run the cable to the back of the computer. On the back plate, you can remove one of the plugs and use the hex nuts attached to the cable connector to bolt it in place. This procedure is common to all three cards. Most of the time you'll want to place the interface card in slot 7, because it's the first slot in which your Apple IIe searches for a bootable disk device, and it's the only slot that doesn't have an alternative function on the Apple IIGS.

Configuring the card is another matter entirely. The configuration steps vary widely for each card. The following is a description of the steps and considerations for configuring each card.

HIGH-SPEED ID

The Apple High-Speed SCSI card has a set of four DIP switches located toward the front of the card. Switch 1 controls whether the card will use DMA; the other three switches select the SCSI ID number for the computer. Every device on the SCSI chain must have a different ID

number. The computer's SCSI ID is usually 7. On an Apple II, the hard drive can have any SCSI ID between 0 and 6. Apple has attempted to set a convention by assigning a 0 to the Macintosh's internal hard drive and a 3 to the CD-ROM drive. Scanners and the LaserWriter IIsc will also have SCSI IDs; therefore, you may want to assign an ID of 1, 2, 4, 5, or 6 to your external hard drive for future compatibility and expansion. Once you've assigned the proper ID to the card, you're finished configuring your Apple SCSI card. You have few decisions to make, so installation is simple.

It's also important to note that the Apple High-Speed SCSI card treats terminator power differently from the older Apple SCSI card. If you have the older card and want to upgrade to the High-Speed SCSI card, you may need to use a different number of terminators. Also, we've found that some Mac hard drives won't work correctly with the Apple High-Speed SCSI card — some manufacturers have cut one or more of the lines inside the drive unit that the Mac SCSI interface normally doesn't need. You can correct this problem by replacing the internal cable with one that has all the lines intact, but getting the vendor's assurance that the drive works with your SCSI card before you buy would be easier.

"By thinking ahead, RamFast takes advantage of each spin of the drive."

FROM RAM TO ROM

The RamFast SCSI card has a set of eight DIP switches on board. Similarly to the Apple High-Speed SCSI card's switch 1, this card's switch 4 controls whether the card will use DMA transfers. Switch 1 on the RamFast SCSI card lets you choose whether the RamFast will supply the terminator power that allows the card to work easily with a wider variety of hard drives than does the Apple card. Other DIP switches specify what kind of machine you're running, the amount of time to search for a drive on power-up, and whether the ROM disk should be disabled.

After installing the RamFast card, boot up the accompanying software and you'll see the configuration screen. (You don't need any additional software to set up a new hard drive.) This screen will let you override many of the DIP-switch settings that you set up initially, do a low-level format (including setting the interleave), and partition your hard drive. (See the sidebar in "A Hard Drive Is Good to Find," July 1990, p. 45, for more information on low-level formatting and setting interleaves.) You can also set the size of the look-ahead buffer. Experiment with this value freely, but we've found that 12K produces the best general results, especially when booting GS/OS.

After you finish configuring the drive and booting the operating system, a special ROM disk is available that contains configuration software and drivers for GS/OS. This software is actually contained in the ROM chips of the RamFast card, but you can copy them to your hard drive as though you were copying the files from a floppy disk. Don't worry: You can't lose the software that comes with the RamFast card. After copying the software, you can then disable the ROM disk so that it doesn't take up a slot/drive allocation or clutter your IIGS desktop.

Also, with the RamFast card you can set up slot-allocation priorities for partitions beyond the first two allowed under ProDOS 8. When you buy a hard drive for use under ProDOS 8 you can normally use only 64 megabytes of storage, because ProDOS 8 allows only two devices per slot, with a maximum of 32 megabytes per device. The RamFast lets you use a drive larger than 64 megabytes. The card maps the partitions it can't access to other slots, such as the IIe slots it doesn't use and the IIGS internal ports it does use (a printer or a modem port, for example). Another feature is its ability to lock or write-protect any partition via the configuration software.

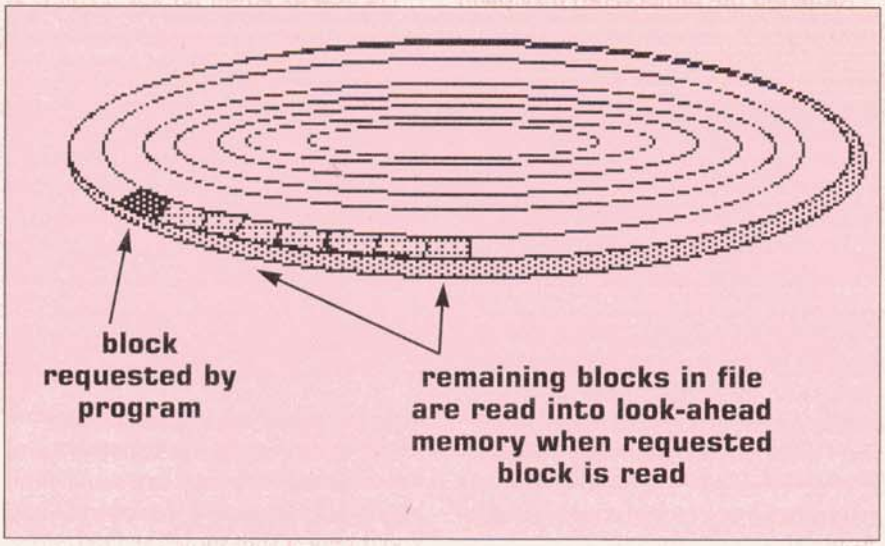


Figure 2. RamFast cache – look-ahead memory.

One of RamFast's weaknesses of the is its lack of support for removable-media drives such as removable hard drives and SCSI tape drives. Support for these devices, however, has been promised in the near future and should come in the form of a simple ROM upgrade.

The RamFast card does currently support a number of SASI standard drives (Shugart Associates Standard Interface), however, such as First Class Peripherals' Sider models.

COMPLICATED CMS

Initial configuration for the CMS SCSI card is considerably more difficult. In most cases the card comes configured from the factory exactly the way you'll ➪

want to use it. If you want to change any of the factory settings (size of partitions, or SCSI IDs) there's quite a bit to learn. With the card's accompanying software, you must set SCSI IDs for both the card and the hard drive.

In addition, you'll need to understand the concepts of partition size and position to physically set the jumper-pin settings for both partitions. There are no configuration options for DMA because the CMS SCSI card doesn't support DMA transfers. Also, no native drivers are available for the CMS SCSI card for use under GS/OS despite persistent rumors that CMS has been working on them.

Although the initial setup may seem complicated, the up side is that it's possible to configure the system so that two Apple II computers can share one hard drive. It's even possible to share a hard drive between a Macintosh and an Apple II.

"The optimum card will make your work time more productive."

THE RESULTS ARE IN

We performed all our tests by connecting the same hard drive to each of the SCSI cards. The test unit was a 40-megabyte Conner hard drive with an average seek time of 25 milliseconds. This drive mechanism also had a built-in 8K track-cache buffer, so we expected to see more comparable timings between the RamFast and Apple SCSI cards. As you'll see, the results were surprising.

We implemented three different "real-world" tests under both ProDOS 8 and GS/OS version 5.02. (See the accompanying **Table**.) All results are shown at a 1:1 interleave that turned out to be the best interleave for all cards tested. You'll probably find a 1:1 interleave to be optimum on most drives with DMA equipped cards. The CMS card, however, will probably require a different interleave for mechanisms that don't have a track-cache feature. We performed all tests on a ROM 1 Apple IIGS computer with 3 megabytes of memory with an Applied Engineering GS RAM+ extended-memory card.

These tests are in no way a comprehensive evaluation of the performance of these cards, but they should help indicate what you can expect if you install one of the cards in your computer.

Table. Putting SCSI interface cards to the test.

	Apple	RamFast	CMS
Boot to GS/OS Finder	00:43	00:18	00:33
Boot to ProDOS 8 (BASIC.SYSTEM)	00:07	00:04	00:04
Verify 32 meg partition (Finder)	02:28	01:19	19:31
Verify 32 meg partition (Copy II Plus)	19:04	03:55	19:05
Copy 1 meg file (Finder)	00:15	00:13	01:20
Copy 1 meg file (Copy II Plus)	02:04	00:30	01:58

Some of the results were surprising. You'd expect the Apple card to outperform the CMS card during a boot of GS/OS, but it didn't — possibly because the Apple card pauses when booted and loads a driver.

You'd expect the comparably slow performance of the CMS card under GS/OS, because no loaded driver device is available; GS/OS must create a driver internally that simply transfers program control to the ROM code on the card every time it requests disk I/O. When it transfers control, the GS must slow down to 1 megahertz and shift to 6502 emulation mode. The CMS card, however, performed quite comparably to the Apple card under ProDOS 8, even though it doesn't support DMA transfers.

The difference in speed between the RamFast and the Apple cards was particularly noticeable under ProDOS 8. The Apple High-Speed SCSI card performs most admirably under GS/OS where it has access to special operating system features, such as multiblock reads and caching. Under ProDOS 8 where these features aren't available, the Apple card's only advantage is DMA transfers. Because the RamFast cache is built into the card, it performs well under both GS/OS and ProDOS 8.

Each of these SCSI cards has its strengths and weaknesses, so base your decision to buy one on your needs and your system's requirements. The manufacturer of each of these cards has taken the extra effort to provide detailed instructions for installing and configuring it. Selecting the optimum card for your system will make your work time more productive. After all, isn't that what using a computer is all about? ❑

GARY R. MORRISON IS AN ASSOCIATE PROFESSOR IN THE DEPARTMENT OF CURRICULUM AND INSTRUCTION AT MEMPHIS STATE UNIVERSITY, WHERE HE TEACHES COURSES IN INSTRUCTIONAL DESIGN AND TECHNOLOGY. HE'S THE AUTHOR OF REPAIRWORKS, PUBLISHED BY QUALITY COMPUTERS, AND *THE APPLE II HARD DISK PRIMER*, PUBLISHED BY NAUG. WALKER ARCHER IS MANAGER OF SOFTWARE DEVELOPMENT AT QUALITY COMPUTERS AND IS THE DEVELOPER OF EASY-DRIVE AND RAMUP. ARCHER AND MORRISON HAVE ALSO WRITTEN AN ON-LINE COURSE ON C PROGRAMMING FOR THE GS. WRITE TO THEM C/O *INCIDER*, 80 ELM STREET, PETERBOROUGH, NH 03458. ENCLOSE AN SASE IF YOU'D LIKE A REPLY.

Product Information

Apple II High-Speed SCSI Card
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$129

RamFast SCSI Card
CV Technologies
9431 Saddlebrook Lane
Suite #2C
Miamisburg, OH 45342
(513) 453-5743
$289

CMS SCSI Card
CMS Enhancements
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Hard-Disk Drives Made Easy: Part 3

Off the Beaten TRACK

Knowing the ins and outs of formatting and partitioning can help you preserve your data and manage your system more efficiently.

By Gary R. Morrison and Walker Archer

So you bit the bullet and bought a hard disk. You shopped, compared, and found the best model at the best price. The Macintosh drive was a bargain, so you settled on that one. Sure, you have an Apple IIGS, but you've been reading *inCider/A+* and know that's no problem. But when you opened the box, took out the drive, and attached it to your Apple High Speed SCSI card, nothing happened. What now?

You're the proud owner of a brand-new, low cost, high-powered hard-disk drive that's not packaged especially for the Apple II. It comes with configuration software for the Macintosh, but not for the Apple II. In fact, many Macintosh hard-drive manufacturers are unaware that their products might sell in the Apple II marketplace.

Fortunately, however, several options are available for IIe and GS owners who want to use a generic SCSI hard drive with their computers. We'll look at a number of software packages you can use with various hard drives, but first let's drop some jargon guaranteed to amaze and confuse your friends — and bring any party to a crashing halt.

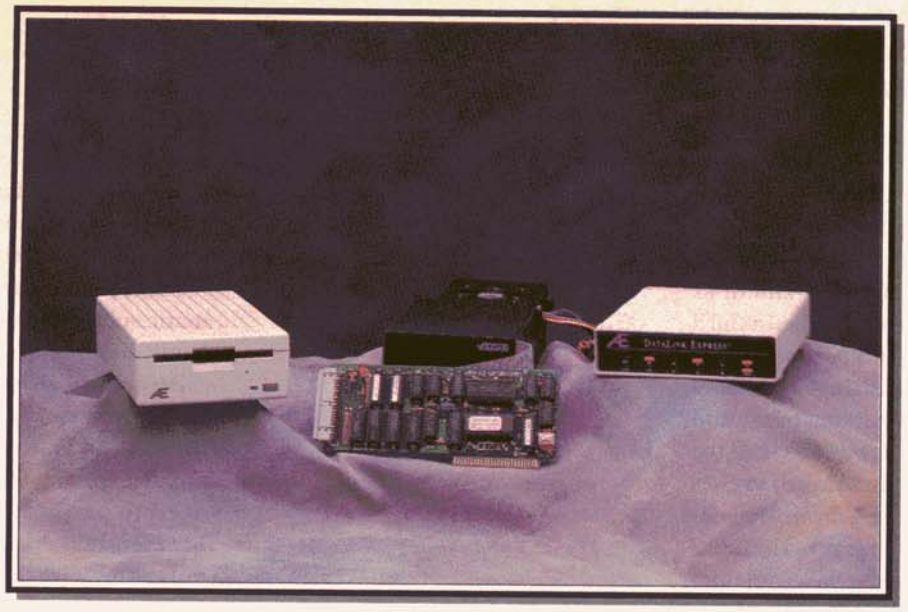
HIGH ROAD, LOW ROAD

Any disk you use with your Apple II or Macintosh computer must be *formatted* before you can use it for storing data. That's true for 5.25- and 3.5-inch floppy disks, and it's true for hard drives, too.

When you format a floppy on your Apple II, your computer actually does two things. First, the formatting software creates concentric *tracks* and wedge-shaped *sectors* (see the accompanying **Figure**) that divide the disk into areas called *blocks*. Track and sector markings serve as roads the operating system follows to find the blocks to store your files. Then once the disk is sectioned into blocks, it's ready to receive data. The formatting software writes an empty volume directory to the disk so that ProDOS can keep track of the data you store. The volume now has a name you've designated, such as */Data.Disk*.

Formatting a hard drive is similar, but two ➪

Illustration ✻ Chris Spollen



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different pieces of software normally perform the two tasks of "drawing lines" on the disk, also called *low-level formatting*, and "naming" it, known as *high-level formatting*. In addition, a third step — *partitioning* — fits in between low- and high-level formatting. Low-level formatting includes marking tracks and sectors, just as with a floppy disk, and the process destroys any data already present on the disk. Partitioning involves dividing a disk that's larger than 32 megabytes into separate smaller volumes ProDOS can recognize. (If your drive is 32 megabytes or smaller you may not need to partition it.) A high-level or *system* format uses the tracks and sectors already on the disk; it doesn't destroy any data, but merely creates an empty volume directory and renames the disk, making it difficult, but not impossible, to use the old data. Let's look at this process in more detail.

A low-level format creates a number of tracks, which are divided into sectors. The information in these sectors is in blocks of 512 bytes each. You might think that the sectors would be spaced on the disk contiguously — in numerical order as sectors 1, 2, 3, 4, 5, and so on up to 16. Contiguous numerical order is called a *1:1 interleave*.

This arrangement isn't very efficient, however. As the computer reads data from the disk, it must also figure out where to place that information in memory. If it has to read data from sector 1 first and then sector 2, it doesn't have enough time to process the first block of data before reading the second; it won't read data from sector 2 until the second revolution, about one 500th of a second later. Failing to read a block is called "blowing a rev" (revolution), because it takes extra time for that sector to spin around again to the drive heads.

To speed up reading and writing, drive formats are designed with staggered sectors, such as 1, x, x, 2, x, x, 3, and so on — a *3:1 interleave*. (See the accompanying **Figure**.) With this layout, the computer can read data from the first sector and process it while the next two sectors pass by. When it's ready to read the next

"Track and sector markings are the roads the operating system follows to find the blocks to store your files."

block of data, the second sector will be positioned beneath the drive's read head. Interleaving the disk's sectors improves the drive's efficiency.

The optimum interleave can enhance your drive's performance — but *finding* the optimum interleave for your drive is the tricky part. As one option, the formatting software in Chinook's **SCSI Utilities** selects the optimum interleave for you automatically, or you can run an interleave test to determine that and then select manually. (You'd have to put some data on your hard drive, set an interleave, time your data retrieval, try another interleave, compare times, and so on.) Once you've set an interleave, you can change it only by doing a low-level format, and that destroys all files stored on the drive. Because a low-level format is a lengthy process and deletes all data, trying every different interleave combination to see which is most efficient is inconvenient at best. Chinook's automatic selection feature comes in very handy here.

Because a hard drive has many more tracks and sectors than a floppy, low-level formatting is a lengthy process and requires special software. You may never need to perform a low-level format, however, and certainly not on a new hard disk, as most hard drives come delivered with a low-level format.

There may be times, however, when a low-level format is called for even if your hard drive has been installed correctly. If a computer virus infects your hard drive, for instance, you may decide to start all over from scratch rather than try to repair it. Get a second opinion from a reputable expert first — make sure it's indeed a virus on your drive before you "cure" it with a low-level format. A low-level format is as much a cure for a virus as cutting off your nose is a cure for the sniffles.

Or you may have to rejuvenate some of that low-level data you hardly ever use — precisely because you seldom need it. That seems ironic, but it makes sense when you consider that the data stored on your drive is after all only a series of

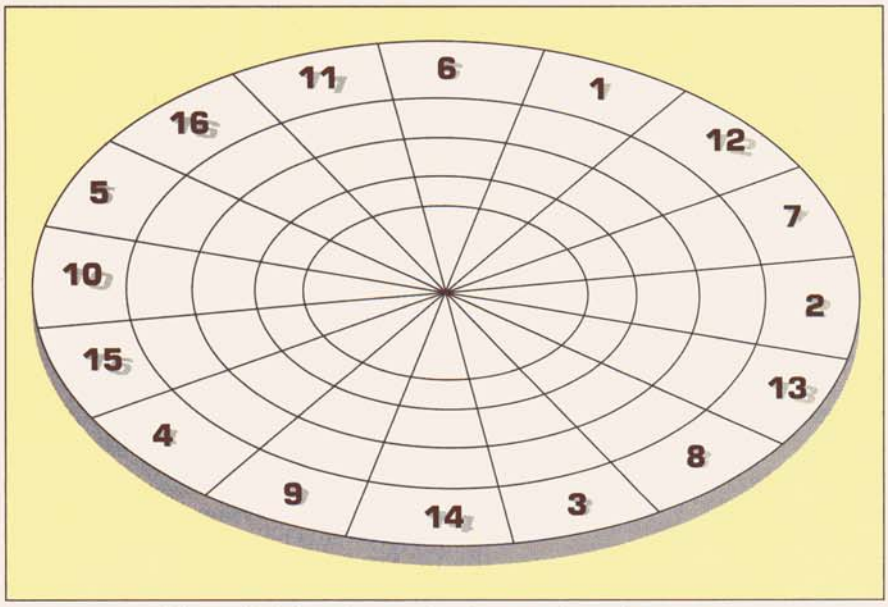

Figure. 3:1 interleave, showing tracks and sectors.

fragile magnetic pulses. They're at full strength when you write them originally to the hard-disk platter, but over a long period of time they grow weaker and weaker until they're no longer readable. When pieces of information on a hard disk decay this way, they're called *orphan bits* — data the drive can no longer read.

Because some pieces of data, such as your AppleWorks files or Tetris high scores, are written frequently to the blocks of the hard drive, chances are small that these bits will become orphans. A low-level format, however, writes only track and sector information, which is never written again unless you do another low-level format. If this information grows weak, you may lose all information contained in that block.

Although it can take several years for orphan bits to appear on a hard drive, simply doing another low-level format can fix it in a few minutes. (But remember to back up all your data first.)

Formatting a hard drive at the low level with Apple's **Advanced Disk Utility** (part of the GS/OS operating-system software that comes with your computer) is simple — you just select the drive and enter a volume name. Chinook's SCSI Utilities are also easy to use, and offer some additional features as well: a series of tests to determine the interleave (as noted above), times to read and write data, and a test for bad blocks. CV Technologies' **RamFast SCSI Card** can also do a low-level format of a hard drive. (See part 2 of this series, "The SCSI Side of Life," February 1991, p. 47, and Editors' Choice, November 1990, p. 96, for more on RamFast.) In addition, a number of shareware programs do low-level formatting on SCSI hard drives. (Check your favorite on-line service and your local user group for information.)

If you've been forced to reformat your disk at the low level and are now ready to rename it, keep in mind that ProDOS won't allow a high-level format on a volume larger than 32 megabytes; if you need to partition your disk, you must do so after a low-level and before a high-level format. On an Apple IIGS, you can use Apple's Advanced Disk Utility to partition your hard drive (and do a low-level format). If you have an Apple Revision C or **High-Speed SCSI Card** (see "The SCSI Side of Life," February 1991, p. 47, and "New SCSI Card," What's New, June 1990, p. 14, for details), Chinook's SCSI Utilities as well as the utilities that come with these cards can partition your hard disk (and do a low-level format, as noted above).

"You may have to rejuvenate some of that low-level data you hardly ever use — precisely because you seldom need it."

More commonly, all you'll have to worry about after installing your hard drive is naming it. There's just one glitch, though: Some hard disks come directly from the manufacturer already preformatted at the high level for a Macintosh — in *HFS* (*hierarchical file structure*, the Mac directory structure) instead of in ProDOS. A simple high-level format under ProDOS may be all you need to do to make the disk readable on your Apple II — you shouldn't need to do a low-level format.

Simply "renaming" the disk, however — doing a high-level format — doesn't always work, because HFS allows partitions larger than the 32-megabyte ProDOS limit. If one of the partitions on the hard disk is larger than 32 megabytes, you'll also have to repartition.

A number of popular utility packages on the market — **EasyDrive**, **ProSel**, **Copy II Plus**, and the **Finder** among them — include modules for partitioning a hard drive, and most also perform the high-level format for each partition automatically. (Apple' Advanced Disk Utility as well as the Chinook and RamFast SCSI utilities also offer high-level formatting. Only if neither renaming nor partitioning works should you attempt a low-level format, though.) Let's examine this critical step in more detail.

DIVVY IT UP

Partitioning on an Apple II is necessary only when your drive is larger than 32 megabytes, but it can be helpful no matter what size drive you have. You may want to store your applications on one partition and data on a second, for instance, with maybe a third partition for GS/OS files only; with this arrangement, you need to back up only the partitions containing data. (Don't back up your data on another partition of the same disk, though.)

Selecting partition sizes is a matter of personal preference, although you may want to make the partition holding your applications larger than the others. Once you've formatted and partitioned your disk, you can install your system software and copy your applications and data files to the appropriate partition.

Apple's Advanced Disk Utility makes partitioning particularly easy. Selecting the drive brings up a screen listing existing partitions by name, along with a chart showing their size, and buttons to delete, add, change, or partition the disk. Highlight one of the partitions and move a slider to adjust its size. When you've added all the partitions you'll need and selected appropriate sizes, click on the *Partition* button to carry it out and format the drive (high level).

Chinook's SCSI software asks you the number of partitions you want and creates that number, all of equal size, automatically. You can then select each one to change the default name of the partition and adjust its size. On the IIe, you use the open-apple/up-arrow key combination for 1-megabyte increments, the up arrow for 128K chunks, and the spacebar for 1K increments. On the GS, the utility provides a slider for size determination, as well as buttons for adding, deleting, or selecting partitions. When you've decided on volume names and partition sizes, select *No Further Revisions* or the *Partition* button and the software writes the partition map to disk.

CV's RamFast SCSI software, built into ➪

the read-only memory (ROM) of the RamFast card, is more convenient to use, but also a bit confusing. Unlike other SCSI cards, RamFast uses two data tables on the hard drive: the SCSI partition table, plus its own configuration table, containing information about the way the card partitions its on-board random-access memory. It's important to remember the difference between the two: Hitting Open apple-S saves the RamFast table to the hard disk (harmless), but Open apple-P saves the SCSI partition table (potentially disastrous, as it wipes out your programs and data). Fortunately, the RamFast software includes safety prompts to let you back up if you hit the incorrect sequence accidentally.

To change partitions with the RamFast card, use the arrow keys to highlight the partition and select the volume name and size. You can change the increment of the partition by 1, 100, or 1000 bytes by pressing the open-apple key in combination with the left or right arrow. The up- and down-arrow keys change the partition size. Pressing OA-P writes the partition table to disk. Remember, partitioning a hard disk erases all your programs and data.

If you already have data on your hard disk you may be wondering how to restore your files to a partition of a different size if you used an *image-backup* program — one that takes an exact "snapshot" of your data, fragmentation and all — such as those included with ProSel or EasyDrive.

"A simple high-level format under ProDOS may be all you need to do to make a Mac disk readable on your Apple II."

Let's say you have a 46-megabyte hard disk with two partitions of equal size — 20 megabytes, for instance. What if you wanted to take advantage of the full drive by creating one 26- and one 20-megabyte partition?

You'd restore the first volume's 20-megabyte backup to the 20-megabyte second partition and duplicate it with a file-copy program to the new 26-megabyte partition, then restore the second volume to the second 20-megabyte partition. If you want to change partition sizes but must restore data to a partition of the same size, keep at least one partition the same size as your original volume.

A WORD TO THE WISE

Remember: You can put any SCSI hard drive to work as an Apple II hard drive — but you may need to perform two different types of formatting, plus some partitioning. To recap, if ProDOS won't recognize your SCSI hard drive after installation, check the following points carefully:

1. Examine the cable connections first. Make sure cables are plugged in tightly and the power is on. Read the drive's documentation to find out whether you need a *terminator*. (Because you can chain SCSI devices, each one has to have an "in" and an "out" port. A SCSI terminator goes into the "out" port of the last device.)
2. If your hard drive is smaller than 32 megabytes, boot your system from a floppy disk and try to do a high-level format.
3. If your drive is larger than 32 megabytes, partition the drive. Because most partitioning software also performs a high-level format, nothing else should be necessary except to install the operating system.

Like building a driveway to your home through the woods, a low-level format writes tracks and sectors on your disk. A high-level format — more like a sign that identifies your house, which you can change in a moment — is something you can do with any Apple utility software: It simply writes a blank volume directory on the drive. You may never need to bulldoze that new driveway, but if your disk is badly infected with a virus or overrun with orphan bits, it's good to know the resources are out there to help you manage your system and meet your data-storage needs. ❑

PRODUCT INFORMATION

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Hard-Disk Drives Made Easy: Part 4

THE WIZARD OF OS

A little operational sleight of hand lets you install your system software and device drivers with a minimum of fuss.

By Gary R. Morrison and Walker Archer

Ever wonder how your computer "knows" which peripheral to talk to — without getting its wires crossed? Simply put, the mastermind of this operation is a program or group of related modules collectively called *system software*. Every Apple II and Macintosh computer requires system software to save your data to disk or load a program.

Back in the days when floppies were the only storage media, the formal name for this type of software was "disk operating system." Now that there are so many alternative devices for data storage, though, it's known as "system software." Basically, it manages your computer's input from and output to whatever peripherals you've attached.

As a separate disk that comes with your machine or as part of an application package, system software is also the program that lets you turn on your computer and boot into a Finder-type screen, a main menu, or some other "user friendly" environment, depending on which computer model you're using. In relation to the topic of this series, it tells your hard drive how to retrieve and save your files. In addition, placing ("installing") the operating system on your hard drive will let you boot your computer fast without inserting any disks.

Which operating system should you install? Over the past several years, there have been many different versions of system software for the Apple II line. In the early days, the most popular operating system was the plainly named DOS. Alternatives included the Pascal operating system, which was considerably more difficult to use, and CP/M (Control Program for Microcomputers) if you were interested in adding a Z80 coprocessor board to your Apple.

In 1983 Apple developed ProDOS (Professional Disk Operating System), which allowed for a wider variety of connected devices and much larger storage capacity. Then, soon after releasing the GS in 1986, Apple came up with ProDOS 16 and renamed the old software ProDOS 8. ProDOS 16 was a 16-bit operating system written specifically for the Apple IIGS, yet it also ➪

Illustration ✻ Chris Spollen

remained compatible with 8-bit ProDOS.

In 1988 Apple released a considerable enhancement to ProDOS 16 called GS/OS version 3.2, a robust operating system that takes full advantage of the machine's power. Another difference is that while ProDOS 8 was written to be compact, GS/OS was written to be highly modular. That is, it's designed so that you need to install only the parts you're going to use.

This feature saves memory and makes the system much faster for most users. On the other hand, it also makes installing and using the operating system more complicated. While ProDOS 8 needs only one file, GS/OS disks may contain well over 100 files.

Modularity allows for easy updating — adding improvements or correcting bugs — without reinstalling the complete system. A modular operating system also lets third-party software developers add features to the system.

For example, Seven Hills and Vitesse have written printer "drivers" (software that facilitates communication between your computer and its peripherals) for non-Apple models, and other companies may soon be releasing drivers for non-Apple CD-ROM drives and tape-backup units.

Is there any leeway here? If you have a IIe or IIc, you must use ProDOS 8. If you have a GS, you may use either ProDOS 8 or GS/OS. In addition to formatting drives before shipment (as discussed in last month's feature, "Off the Beaten Track," p. 88), many vendors, including Chinook and CMS Peripherals, will also install the proper operating system on request.

If the vendor is willing to do the work of installing the operating system for you, that'll save you a considerable amount of time. Quality Computers takes another tack: Its Q-Drive automatically installs ProDOS 8 on Apple IIes and GS/OS on GSes when you boot it the first time.

PLUGGING IT IN

Installing ProDOS 8 on your Apple IIe or IIc's hard drive is easy. All you need is a reliable copy program, such as the **Apple II System Utilities** that came with your machine or a third-party product like **Copy II Plus**, **Easy Drive**, or the CatDoctor module from **ProSel**.

"Every Apple II and Mac computer requires system software to save your data or load a program."

Simply follow the prompts and menus to copy the file named *ProDOS* from your ProDOS system disk that came with your computer (or any application disk that contains the ProDOS file) to your hard drive.

Although it isn't strictly necessary for the operating system, it's generally a good idea to copy BASIC.SYSTEM to the hard drive as well. The BASIC .SYSTEM file acts as a go-between for BASIC programs and ProDOS. You'll need it if any of your programs are written in BASIC; your machine-language and assembly-language programs will use ProDOS directly, however.

Note also that if you've partitioned your drive into two volumes, make sure you copy these files only to the first volume — system software is necessary only on the boot volume or drive. Putting it on both wastes space and may incur other problems.

If you update the system on one volume and not the other, for instance, your machine may boot the older version, the one you don't want.

Now when you reboot, the operating system will be active. You can tell the current version of ProDOS by watching the screen as your system boots: The version number will flash on screen for a moment.

If you have a GS, you'll probably want to install the GS/OS operating system, because of its many advantages over ProDOS 8. (Of course, you can still use your ProDOS 8 programs from GS/OS.)

Things are a little trickier if you have a SCSI hard drive connected to an Apple High-Speed SCSI card (*small computer systems interface* — a type of standard electronics protocol — see part 2, "The SCSI Side of Life," February 1991, p. 47, for more information).

You're facing a problem with the system disk even before you try to install the operating-system software on your hard drive: You need to install a SCSI driver in your system file before you can access a SCSI drive via an Apple card.

If you boot the GS/OS system disk as is, you'll get an error message and won't be able to access the hard drive once you reach the Finder. (If you have a third-party SCSI card such as the CMS model

Mac Notes

On the Macintosh, the operating system is generally referred to by its version number (System 6.0.7, for instance, or the soon-to-be-released System 7.0), and is similar in many ways to GS/OS.

Installing Macintosh system software is easy:

1. First, find your System Tools disk.

2. If your computer is off, turn it on. If your computer is on, select Restart under the Special option on the Finder screen's pull-down menu.

3. Now, insert the System Tools disk into the disk drive so that you boot from the floppy. If the computer ejects your floppy, reinsert it, but not forcefully. (You won't be able to install the system software if you boot from your hard drive.)

4. When you see the desktop, double-click on Installer. The software will determine which machine you have and the name of your hard drive. If you agree, indicate that you want to continue with the installation of the system software.

5. When the system software finishes copying to your hard drive, restart your computer. Simple!

or CV Technologies' RamFast, GS/OS will recognize it as a floppy drive, oddly enough, not as a SCSI hard drive: The firmware on these cards gets around GS/OS' problem of SCSI nonrecognition by using a standard GS/OS floppy-disk driver to access the SCSI drive.)

So the first step — before you install GS/OS on your hard disk — is to add SCSI drivers to the original operating system. (Note that if your hard drive is non-SCSI, the procedure's simpler — skip steps 3, 4, 5, and 6 outlined below.) You'll be deleting the tutorial file and certain other nonessential modules to do that, but there's no way around it. Here's a rundown:

1. Don't use your original disks — make copies. Use the Finder, ProSel 16, or some other program capable of copying GS/OS files to duplicate your system disk and the System Tools disk that came with your computer. Store your originals in a safe place.

2. Boot from your copy of the system disk. Press Open apple/Control/Escape, select *Control Panel* from the menu, and press Return. Now select *Slots* and press Return. Highlight *Startup Slot* and use the left- or right-arrow key to cycle through the slots until you come to one in which your 3.5-inch drive is installed (usually 5). Exit the Control Panel, insert your copy of the system disk into the 3.5-inch drive, and press Control/Open apple/Reset to boot your computer.

3. Ignore the error message. When you see "SCSI device requires a driver. Please install SCSI driver on boot disk and reboot system," press Return.

4. Run the Installer program. Insert your copy of the System Tools disk and double-click on *Installer*. Move through the list of drivers and installation options to the left of your screen until you find *SCSI Hard Disk*, and highlight it.

5. Install the SCSI hard-disk driver from the System Tools disk onto the system disk. If you have two drives, insert your copy of the system disk into the other drive and click on the *Drive* button to select it. If you have only one 3.5-inch drive, click on the *Drive* button until *System.Tools* shows at the top of the window. Press the eject button on the disk drive; then insert your copy of the system disk and select *Install*. This process will copy the SCSI drivers from the System Tools disk to your copy of the operating system.

"Installing the operating sytem on your hard drive lets you boot your computer fast without inserting any disks."

Note that if you have a UniDisk, there's one precaution you must take when switching disks. When you highlight *System.Tools* and eject the disk, don't insert your system disk right away. Click on the *Drive* button first so that you cycle through your drives one time without a disk in the drive. (The light will flicker for a second.) Otherwise you'll get an error message when you select *Install*. GS/OS has trouble telling when a disk has been ejected from a UniDisk if the correct driver isn't installed. After you add the SCSI drivers to your system software, follow the same procedure to install the UniDisk driver.

Now you're ready to copy your system software, complete with SCSI drivers, to your hard disk. Follow these steps:

6. Reboot your computer with the your copy of the system disk in the drive. This time, you shouldn't get the message about installing the SCSI device driver. Once you're in the Finder, you should see icons of all your drives, including your SCSI hard drive. If you don't see its name and icon, make sure it's turned on before you boot and check to see that the connections are tight.

7. Run the Installer program. Insert the System Tools disk and click on *Installer*. From the list to the left of the screen select either *Latest System Files (No Finder)* or *Latest System Files*. Select *Latest System Files (No Finder)* only if you've already installed a program launcher such as EasyDrive or ProSel. Most likely, you'll want to select *Latest System Files* so that you have access to the Finder. Make sure the name of the first volume of your hard drive appears near the top of the window beside *Disk to Update*. If not, click on the *Disk* button until you select the correct volume. (As with ProDOS, you need to install GS/OS on only one volume. Note also that when you copy an application program to your hard drive in the future, don't copy the operating-system files or BASIC.SYSTEM from it — they're already on your drive.)

8. Install the operating system on your hard drive. Click on the *Install* button and wait while your system software is copied automatically to your hard drive, along with drivers for the Apple 3.5-inch disk drive and the ImageWriter printer.

9. Check the list of optional drivers. If you have an Epson printer, a 5.25-inch drive, or other peripherals, you may want to highlight and install their drivers at this time. (You can do it directly from System Tools right now; if you wait, you'll ➪

PRODUCT INFORMATION

Copy II Plus
Central Point Software
15220 NW Greenbriar Parkway #200
Beaverton, OR 97006
(503) 690-8090
$39.95

EasyDrive
Quality Computers
20222 E. Nine Mile Road
Box 666
St. Clair Shores, MI 48080
(313) 774-7200
$39.95

ProSel
Charlie's Apple Seeds
9081 Hadley Place
San Diego, CA 92126
(619) 566-1297
$40 (8), $89.95 (16)

have to install them on your system disk, starting from step 1, first.)

10. Tell your system to use your SCSI hard disk as the boot drive. Access the Control Panel and change the *Startup Slot* to *Scan*. You can now boot your computer from your SCSI hard drive.

AN ONGOING PROCESS

Apple Computer has maintained a strong tradition of offering continual improvements in its system software for both the Apple II and Macintosh lines.

If you need a new revision of the system software, you can obtain free copies from most local Apple Computer dealers. You supply only the disks: ProDOS 8 version 1.9 requires one 5.25-inch disk, GS/OS version 5.0.4 requires two 3.5-inch disks, and Macintosh system software such as 6.0.7 requires four 3.5-inch disks.

"Modularity allows for easy updating — adding improvements, correcting bugs — without reinstalling the whole system."

You can also download the most current system software from electronic services such as CompuServe, GEnie, and America Online. If you want the accompanying documentation, you'll have to purchase the manuals and system disks from your dealer.

Updates may come from Apple Computer as often as once a year. Check with your local dealer or favorite on-line service periodically to make sure you have the most recent version of the operating system, so that you can access all the features of the latest hardware and software on the market. ❑

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Hard-Disk Drives Made Easy: Part 5

IT PAYS TO BE ORGANIZED

Don't let your hard drive's speed and convenience go to waste — follow your operating system's own file structure to manage your data effectively and efficiently.

By Gary R. Morrison and Walker Archer

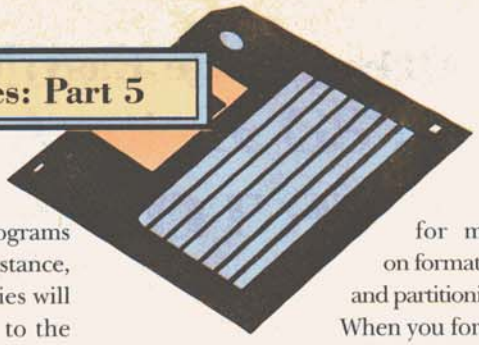
No doubt about it — a hard-disk drive represents no small investment of your hard-earned cash. Getting more for your money isn't just a matter of careful bargain hunting, though. Once you take that hard drive home, making your venture pay off may depend on how well you understand the way ProDOS or GS/OS — your computer's *operating system*, or *system software* — organizes your program and data files on disk. If you ignore the system software's *hierarchical file structure* (HFS), you'll use only a fraction of your hard disk's storage capacity.

If you've installed GS/OS on your hard drive (see "The Wizard of OS," April 1991, p. 53, for details) and used the Finder to examine the contents of your disk, you've probably noticed a number of file-folder icons on screen. (Or if you're familiar with the Macintosh, you know that machine's operating system is similar in form and function. See "Family Ties: A Striking Resemblance in System Software," February 1991, p. 52.) So the HFS concept isn't new, really — it's analogous to an older method of organization that's quite familiar to all of us. After all, you wouldn't stuff papers randomly into a file drawer. You'd sort them first — alphabetically, or by topic — in separate folders so that you could find them easily again. GS/OS uses this metaphor to illustrate its organizational system. (ProDOS' system is similar; ProDOS files are grouped under subdirectory names instead of file-folder icons.) Just as a file cabinet can contain several folders organized by topic, a hard drive can store information in subdirectories (ProDOS) or folders (GS/OS) containing similar files grouped together.

A PATH TO YOUR DOOR

GS/OS and ProDOS disks, both floppy and hard, are also known as *volumes*. If you've subdivided your hard drive, each partition is a separate volume, as well. When you format a disk, you give it a name. Each volume is identified by a beginning slash — /APPLEWORKS, /DICT, /PAINT, for example. If you don't choose ➪

Illustration ✦ Chris Spollen



a name, most drive-formatting programs will assign one as a default. For instance, the GS/OS Advanced Disk Utilities will assign the name /UNTITLED1 to the first partition of any drive for which you neglect to specify a name. (See part 3, "Off the Beaten Track," March 1991, p. 88, for more on formatting and partitioning.)

When you format a disk, the operating system also sets aside an area on the disk for the volume's *directory* — a listing of names and sizes of files stored on disk. GS/OS and ProDOS store data on any disk according to a filename that is at least one letter long and can have as many as 15 letters, numbers, or periods (just as long as it starts with a letter). If you've ever created a new file with AppleWorks, for instance,

Getting Around in GS/OS

/SYSTEM.DISK

PRODOS	Similar to 8-bit ProDOS (P8 below) only in that it's the first file executed when you boot GS/OS. Unlike ProDOS 8, this file is only a small part of the operating system — it merely starts things off.
BASIC.LAUNCHER	Used by the Finder to launch ProDOS 8 BAS or BIN files from GS/OS.
BASIC.SYSTEM	Run to access the Applesoft BASIC interpreter. Contains only a small part of the language; the rest resides in ROM (read-only memory). Primary function is to provide a file I/O (input/ouptput) interface between ProDOS and BASIC. Without this file in memory you can't use file I/O commands such as CATALOG and OPEN.

/SYSTEM.DISK/SYSTEM

START.GS.OS **GS.OS** **GS.OS.DEV**	Contain the primary routines GS/OS uses. START.GS.OS is second part of GS/OS bootstrap process; called directly by PRODOS file. You can launch START.GS.OS directly from ProDOS 8 to get into GS/OS (not recommended). When GS/OS boots it assumes the computer is either being reset or powered on; if any interrupt processes are still installed when GS/OS starts up, the result could be a crash with dire consequences.
ERROR.MSG	Contains GS/OS error messages.
EXPRESSLOAD	Contains additional routines for fast loading of disk files.
START	Finder program. When GS/OS starts up, it looks for any S16-type (GS/OS system file) program named START in this subdirectory. If it finds one it will automatically launch it at boot time.
P8	ProDOS 8 PRODOS file; launches ProDOS 8 applications.

/SYSTEM.DISK/SYSTEM/FSTS/ Contains file system translators. GS/OS can't perform lower-level operating-system tasks, such as reading from and writing to disks itself. Instead it looks for driver and FST programs to do the work for it. GS/OS includes an FST that can read and write ProDOS disks, as well as one that can input from and output to any device that deals with data character by character, such as a printer or modem. A GS running GS/OS could write to or read disks for any operating system, if someone would write a Mac or MS-DOS FST, or send to and receive information from any kind of device. An FST that retrieves data from a CD-ROM disc in standard High Sierra format is already available.

PRO.FST	ProDOS file system translator.
CHAR.FST	File system translator for character devices, such as modems and printers.

/SYSTEM.DISK/SYSTEM/DRIVERS/ Contains drivers for specific devices; takes care of the low-level requests from GS/OS, such as reading and writing blocks to and from disk. Drivers describe to GS/OS exactly how to use the particular device for which they were written. Modular driver design lets you connect many different kinds of computer equipment to GS; any software that makes standard GS/OS calls can use it.

APPLEDISK3.5	Apple 3.5-inch disk driver.	**APPLEDISK5.25**	Apple 5.25-inch disk driver.
CONSOLE.DRIVER	Text screen and keyboard driver.	**IMAGEWRITER**	ImageWriter printer driver.
MODEM	GS modem-port driver.	**PRINTER**	GS printer-port driver.
PRINTER.SETUP	Default settings for GS/OS print manager.		

/SYSTEM.DISK/SYSTEM/SYSTEM.SETUP/ Contains files for initialization (preparing computer for GS/OS) at boot time.

TOOL.SETUP	Loads tools that patch ROM for different GS computers.
TS2	Tool patches for ROM 01 computers.
TS3	Tool patches for ROM 03 computers.

you'll recall typing in a filename, which ProDOS then used to identify the file when storing it on the disk drive and finding it later when you wanted to load it again.

A *pathname* is a complete listing of the volume name and subdirectories that lead to a particular file. Pathnames are similar to the directions you might give for finding the local post office — left on Main Street, two blocks to Second Street, then left on Lincoln. If you're using a ProDOS-based application such as AppleWorks, you may need to type pathnames during operations such as printing files to disk or creating a word-processor (or spreadsheet or database) file from an ASCII file. If you're running 16-bit programs on your GS, you're somewhat more insulated from subdirectory names and pathnames because of

RESOURCE.MGR	Contains GS/OS routines for handling new forked file resource format. Must be located here or GS/OS will fail to boot.
SYS.RESOURCES	Contains resources used by GS/OS tools and desktop-based Control Panel.
CDEV.INIT	Installs the CDEVs used by desktop control panel (utilities for desktop accessed via Control Panel).

/SYSTEM.DISK/SYSTEM/DESK.ACCS/ **Contains desk-accessory utilities you access within applications: CDAs (classic desk accessories), text-based utilities accessed from any program via Open apple/Control/Escape key sequence; and NDAs (new desk accessories), graphics-based utilities accessed only within programs adhering to desktop interface via Apple menu.**

CTLPANEL.NDA	Allows access to Control Panel CDEVs.

/SYSTEM.DISK/SYSTEM/TOOLS/ **Contains disk-based tool sets in addition to GS ROM tool sets; used to program pull-down menus and windows. With code to produce windows and menus provided by Apple, developers can utilize a standard user interface without writing it themselves.**

TOOL014	Window-manager tool.	**TOOL015**	Menu-manager tool.
TOOL016	Control-manager tool.	**TOOL018**	QuickDraw auxiliary tool.
TOOL019	Print-manager tool.	**TOOL020**	Line-edit tool.
TOOL021	Dialog-manager tool.	**TOOL022**	Scrap-manager tool.
TOOL023	Standard-file tool.	**TOOL025**	Note-synthesizer tool.
TOOL026	Note-sequencer tool.	**TOOL027**	Font-manager tool.
TOOL028	List-manager tool.	**TOOL034**	Text-edit tool.

/SYSTEM.DISK/SYSTEM/CDEVS/ **Contains Control Panel devices for standard GS features; used by CTLPANEL.NDA to provide graphics interface to Control Panel.**

ALPHABET	Sets language for display.	**DIRECTCONNECT**	Selects direct-connect printers.
GENERAL	Sets general system features.	**KEYBOARD**	Sets keyboard parameters.
MODEM	Sets modem-port parameters.	**MONITOR**	Sets monitor parameters such as colors.
MOUSE	Sets mouse parameters.	**PRINTER**	Sets printer-port parameters.
RAM	Sets RAM-disk and disk-cache sizes.	**SLOTS**	Sets slot parameters.
SOUND	Sets volume and pitch parameters.	**TIME**	Sets internal clock.
CDEV.DATA	List of Control Panel parameters.		

/SYSTEM.DISK/SYSTEM/FONTS/ **Contains all system fonts available when using desktop-based programs.**

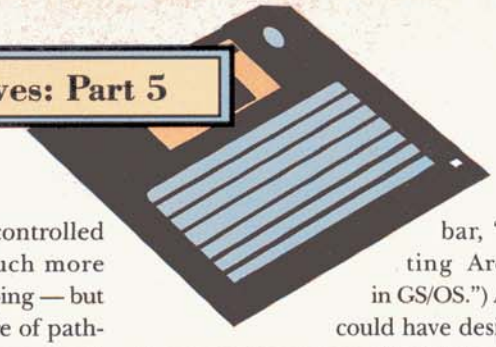
NNN.10	Example: NNN is name of font family; number is point size.
FASTFONT	Contains routines to speed up normal text drawing on machines with more than 512K of RAM.
FONT.LISTS	List maintained by GS/OS at boot time; lets fonts load into memory fast.

/SYSTEM.DISK/ICONS/ **Contains all icons used by Finder.**

FINDER.ICONS	Minimum set of Finder icons.
FINDER.ICONS.X	Additional Finder icons when system has more than 512K of RAM.
FTYPE.MAIN	Minimum set of filetype names used by Finder.
FTYPE.MAIN.AUX	Additional filetype names used by Finder when system has more than 512K of RAM.

/SYSTEM.DISK/APPLETALK/ **Contains no files currently; can contain files to let GS/OS use AppleTalk network.**

Hard-Disk Drives: Part 5



the system's simple mouse-controlled iconic interface — with much more pointing-and-clicking than typing — but you may still need to be aware of pathnames when using a disk-management program such as EasyDrive or ProSel.

Let's look at the GS/OS system disk itself, or your hard drive if you've already installed GS/OS, to see a good example of hierarchical file structure in action. (If you compare the GS/OS files with the ProDOS system disk, you'll be amazed at the difference: ProDOS consists simply of the files ProDOS and BASIC.SYSTEM.)

Figure 1 shows the GS/OS system disk's main volume directory and subdirectories. (See the accompanying sidebar, "Getting Around in GS/OS.") Apple could have designed the operating system with all files in the System subdirectory. Imagine how confusing your drive would be with all the font files and desk-accessory files, for instance, grouped together. By placing all fonts in one subdirectory and desk accessories in another, you can easily add or delete files of each kind without searching through a long listing of all types of system files.

Note that the full pathname for the Start file on the system disk is /System.Disk/System/Start. Because /System.Disk is the first name in the path and begins with a slash, you can identify it as the name of the volume directory. From the volume directory, you enter the System subdirectory; lastly you see the name of a particular file, Start. Similarly, the full pathname for the 10-point Times font is /System.Disk/System/Fonts/Times.10. Each pair of names (remember, subdirectories follow all filename rules) is separated by a slash. Each time you open a folder with the Finder, you add a subdirectory's name to the pathname.

As you can see, those "directions" can get pretty lengthy. A *prefix* is a way of getting around typing in a file's full pathname. It's similar to a prefix in the phone system. In New Hampshire, for example, the area code is set to 603, so that you don't need to enter 603 before dialing another New Hampshire number.

Similarly, you can set a prefix to represent a partial pathname, such as /System.Disk/System/, making it easier to access files on disk. How so? When you use a hierarchical file system such as ProDOS or GS/OS, you use only one group of files at a time. That is, you may be working currently on the files in the /System.Disk subdirectory, perhaps in the /System.Disk/System subdirectory, or even in the /System.Disk/System/Drivers subdirectory. The active pathname is called a prefix because the operating system assumes automatically that part of the pathname is at the beginning of any filename you type.

Under ProDOS, you can tell what the active prefix is by typing PREFIX at the BASIC prompt, or you can set the prefix yourself — to /Pathname, say — by typing PREFIX /PATHNAME. When you boot your Apple II under GS/OS or ProDOS, the operating system uses the pathname of the boot disk as the current prefix.

If you're using a GS and type CATALOG at the BASIC prompt after you boot from the system disk, you'll see this short listing:

```
BASIC.LAUNCHER
PRODOS
APPLETALK
ICONS
SYSTEM
BASIC.SYSTEM
```

```
/System.Disk
    ÎÍÍÍÍÍÍÍÍÍProDOS
                System
                    ÎÍÍÍStart.GS.OS
                        GS.OS
                        Error.Msg
                        FSTS
                            ÎÍÍÍÍÍÍPro.FST
                                   Char.Fst
                        ExpressLoad
                        Drivers
                            ÎÍÍÍÍÍÍAppleDisk3.5
                                   AppleDisk5.25
                                   ImageWriter
                        System.Setup
                            ÎÍÍÍÍÍÍTool.Setup
                                   TS2
                                   TS3
                                   Resource.Mgr
                                   System.Resources
                                   CDev.Init
                        Desk.Acces
                            ÎÍÍÍÍÍÍCtlPanel.NDA
                        Start
                        Tools
                            ÎÍÍÍÍÍTool014
                                   Tool015
                                   Tool016
                                   Tool018
                        CDevs
                            ÎÍÍÍÍÍGeneral
                                   Keyboard
                                   Modem
                                   Monitor
                        Fonts
                            ÎÍÍÍÍÍCourier.10
                                   Courier.12
                                   Geneva.10
                                   Times.10
                        P8
                        Icons
                            ÎÍÍÍÍÍFinder.Icons
                                  Finder.Icons.X
                                  FType.Aux
                                  Ftype.Main
                        AppleTalk

                        BASIC.Launcher

                        BASIC.SYSTEM
```

Figure 1. GS/OS system-disk file structure (partial listing).

```
/System.Disk/System
        Start.GS.OS
        GS.OS
        Error.Msg
        FSTS
        ExpressLoad
        System.Setup
        Start
        Tools
        CDevs
        Fonts
        P8
```

Figure 2. Files in System directory.

To see the longer listing in **Figure 2**, for example, first type PREFIX /SYSTEM.DISK/SYSTEM to set your active prefix to that subdirectory. To see a list of fonts, make the path to the Fonts file your active prefix by typing PREFIX /SYSTEM.DISK/SYSTEM/FONTS, then CATALOG.

You can use the prefix more liberally in GS/OS, compared with its limited role in ProDOS, but you can't control prefixes from BASIC as you can in ProDOS. GS/OS refers to as many as 33 different pathnames by a numeric shorthand: Each is tagged with a number from zero to 32, or the asterisk character. The asterisk always refers to the pathname of the boot disk: /System.Disk/System if you boot from a floppy, perhaps /Harddisk /System if you boot from your hard drive. Prefix /0 is the default prefix, like the single active pathname prefix in ProDOS. Prefixes /1 and /9 identify the pathname of the current application, and certain others are reserved, as well. So it's best not to mess with prefix numbers, which you can't do from BASIC anyway. (You'd have to use the GS/OS machine-language interface.)

You can't follow it from BASIC, but GS/OS also keeps track of the various devices available — such as hard, floppy, and CD-ROM drives — by assigning each a number when GS/OS is booted. You can find the device number of any drive on the *Where* page of the *Icon Info* window in GS/OS: Just highlight a disk or file in the Finder and press Open apple-I. You can also see the full pathname of any file, with subdirectory names separated by colons.

THE OUTER LIMITS

So just how does HFS protect your investment in mass storage?

Initially, your system software sets aside enough space to store information for only 51 filenames or subdirectory names. This area, a subdirectory in itself, is usually called the *volume directory*, or *root directory*. As a result, if you have a 20-megabyte hard drive and store 51 AppleWorks word-processing files, you'll "fill" the drive (even if each file is only one page long) — but not because all the space on the hard drive is gone. Your hard disk is full only because you've taken up all the space the operating system has allowed for filenames.

Fortunately, HFS and its subdirectory scheme provide a way to use all the space on your drive. Unlike a volume, a subdirectory can hold an unlimited number of filenames or additional subdirectories, subject only to the maximum total storage capacity of your hard disk. (And you can even create one or more subdirectories in the volume directory to go beyond its 51-file limit.) You'll then be storing your files in subdirectories (ProDOS) or folders (GS/OS) instead of the volume directory.

For example, you might use subdirectories to separate different kinds of programs on your hard drive: One might be GAMES, while another might be named BUSINESS. You might also use separate subdirectories to organize data files produced by different programs. It might be a good idea to keep correspondence created in AppleWorks in a subdirectory named AW.LETTERS; within it you might have additional subdirectories for business, home, and Christmas letters.

Subdirectories are easy to set up for your own program and data files. If you're using a ProDOS-based program, it probably includes an option like AppleWorks' *Create Subdirectory* under the *Other Activities* menu; in 16-bit GS programs, look for an option to create a new folder from the Finder.

Apple's innovative hierarchical file structure gives you the means to stay organized with very little effort — and helps ensure that in terms of speed, convenience, and storage capacity, your well-considered purchase will soon pay for itself. ❑

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