

# inCider

AN IDG COMMUNICATIONS  
PUBLICATION  
July 1990



THE APPLE II MAGAZINE



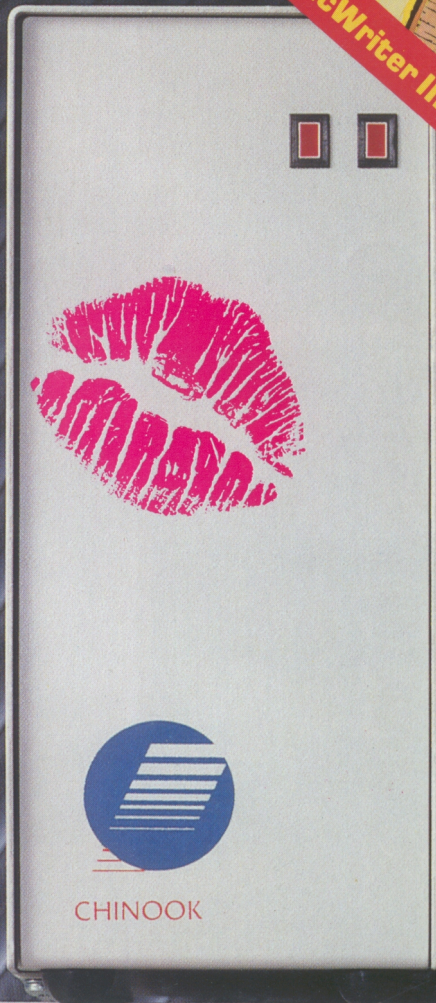
## A Good Drive Is Hard to Find. . .

The Inside Story  
Vulcan, InnerDrive, InSyder  
Compared, p. 49

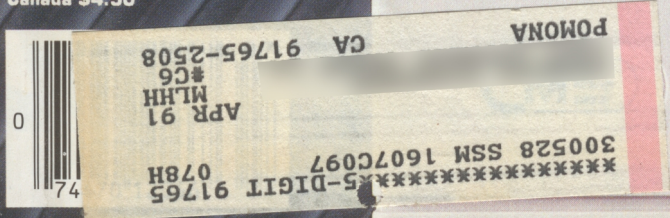
**Programming**  
Choosing a Language,  
p. 56

### Reviews:

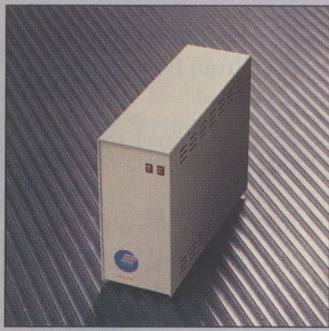
- Softdisk G-S
- Once Upon a Time II
- Program Writer vs. MD-BASIC
- Alge-Blaster Plus
- Jack Nicklaus Course Disk Volume II: The International Course Disk
- Mines of Titan
- Dark Castle



USA \$3.95  
Canada \$4.50



# ... A HARD DRIVE IS GOOD TO FIND



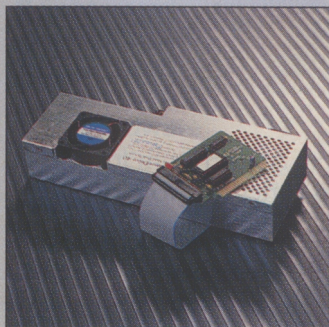
Chinook CT-40



By **BOB CONSORTI** and **WILLIAM P. KENNEDY, Ph.D.**



CMS SD45RM/A2S



Ingenuity InnerDrive

**A**NOTHER *INCIDER* ARTICLE ABOUT hard-disk drives? You bet. We're not beating a dead horse — several new drives have appeared on the market recently, most notably the removable-cartridge variety. In addition, the new **Apple II High-Speed SCSI Card** not only leaps tall buildings in speed and performance, but also makes all those Macintosh-bound SCSI (small-computer-systems interface) hard-disk drives even more attractive as additions to your Apple II. (See "New SCSI Card," What's New, June 1990, p. 14, for details.)

There's no point in belaboring the many reasons why you should think seriously about purchasing a hard-disk drive. The primary reason is simple, if not blatantly obvious: You want to avoid the floppy-disk shuffle. Instead of starting up your computer with a different disk for each program and storing your letters, spreadsheets, databases, and so on on a pile of floppies, you can put most of your applications as well as your data in one place — a hard disk. Centralized storage helps you organize your computing time and resources better so that your productivity software can make you even more productive.

## WHAT'S IT ALL ABOUT?

In this article, we'll discuss what goes into a hard-disk drive and what to consider when purchasing a mass-storage device. To better help you make your decision, we've tested a selection of popular 40- to 50-megabyte drives connected to both an Apple IIe and a GS. The results of those hard-disk labors are discussed later in this article. (See the accompanying **Table**, as well.)

Size, speed, and price are the usual considerations when purchasing a hard-disk drive; those areas are a good place to start, but after we cover the basics we'll complicate matters with some

other considerations that are just as important.

The phrase *hard disk* is simply descriptive: The platter inside the drive's housing on which your computer programs and data are stored is inflexible. That rigidity is necessary to hold the fine magnetic medium in near-perfect proximity to read/write heads so that the density of stored information is greatly increased compared to that on floppy disks. A solid platter is also necessary to withstand the high speeds at which the disk spins; the increased speed lets the device handle and store data much faster than a floppy-disk drive can.

A hard-disk drive's data-storage capacity is measured in *megabytes*. One megabyte (M) is 1024 *kilobytes* (K), or 1024 times 1024 bytes. ProDOS and GS/OS typically use *blocks* as a storage measure. One block is 512 bytes, or .5K; so 1M is equal to 2048 blocks, for example. In comparison, 3.5-inch and 5.25-inch floppy disks hold 800K and 140K bytes, respectively. You can store literally hundreds of floppies' worth of data or programs on a single hard disk.

The most popular hard-disk drives these days hold about 40M, although you can find some that hold as little as 5M or more than 100M. A rough way to measure your storage needs is to count the program and data floppy disks you use, multiply the sum by their storage capacity (either 140 or 800), and multiply that by 5.

Careful, though: Without special utilities, ProDOS, the disk-operating system used most often with 8-bit Apples (IIe, IIc, IIc Plus, and II Plus), can access only up to two 32M "volumes" or "partitions" (64M total) on your hard disk. GS/OS, the operating system of choice for the 16-bit GS, has no such limitation. However, most software written for the older, 8-bit machines, such as AppleWorks Classic, retain that 64M

## Looking for extra speed and storage space?

## How much is enough — and how much is too much?

What should you watch for in terms of position, noise, and parking problems? What's the going price of support?

The test results are in — if you're in the market for a hard-disk drive, *inCider* has the answers.

barrier because they use ProDOS even when executed from a GS.

Don't get obsessed with size, however. Choose only those programs and data you use often to calculate your needs. Remember that drive maintenance — backing up your hard disk and so on — is a necessary evil for hard-disk owners. (See "Do You Know Where Your Data Are?" May 1989, p. 54, for details.) The larger the drive, the more laborious the maintenance and the bigger the disaster should your drive develop problems.

Speed — how fast you can retrieve data and programs or write to disk — is perhaps the most complicated and misleading issue to resolve when shopping for a hard drive. Advertisements often tout speed in terms of "access" times; average access is the time it takes for the disk to move its read/write head from one section of the disk to another. The lower the average access time the faster the drive will execute a disk-intensive operation, such as a database search.

Access times, however, are only one part of the story. Manufacturers use similar, sometimes identical, hard-disk mechanisms in their drives. Where the drives differ is in the speed of the interface card and the unit's internal circuitry, in the utility software that formats and maintains the drive, and, in the case of the GS, in the GS/OS driver — a collection of disk-handling software. A drive's speed depends not only on mechanical operation, but on a number of other factors that add up to a more revealing and accurate measure of speed: the data-transfer rate. That's why we've performed our "real world" benchmark tests of a number of hard-disk drives.

### THE PRICE OF TECHNOLOGY

Any purchasing decision, of course, involves price. As you'd expect, lower-capacity drives do

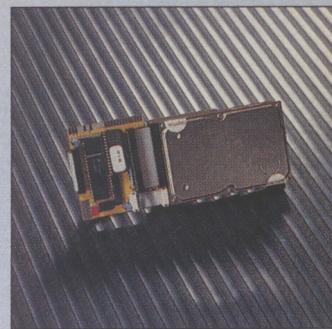
typically cost less than larger ones. Also, mass-storage technology advances every year; you may find that the drive you purchase today will be obsolete in five years. Accordingly, make sure you choose a size that realistically fits your current and short-term future needs. And don't hesitate to purchase a more expensive drive if it provides you with better support. An established reputation for quality and Apple II-specific support software are just two of the many factors that overshadow price.

One type of drive that carries a bigger price tag and that you may not have considered before is the *removable-cartridge hard disk*. Similar to a floppy, the hard disk itself is encased in a protective cartridge you can remove and replace with another disk. The entire mechanism represents a greater cost per megabyte than that of comparable "fixed" hard-disk drives. Additional disk cartridges, which typically have a capacity of about 45 megabytes, cost a fraction of what you would pay for a second hard-disk drive, however. If you own both an Apple II and a Macintosh, a removable-cartridge drive can serve double duty: Because it's Apple SCSI-compatible, you can switch it between the two computers. Just format one cartridge (or more) for the Apple and another for the Mac.

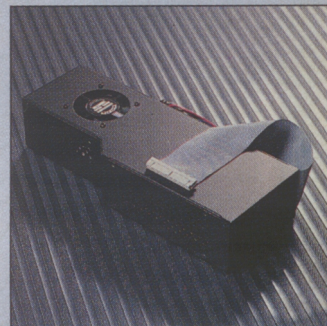
### COMPLICATING CONCERNS

If choosing a hard-disk drive were simply a matter of finding the fastest and largest to fit your budget, things would be easy. For the Apple IIc owner, it's that simple. Chinook Technologies is currently the only manufacturer that makes hard-disk drives (the CTxc series) that plug into the external disk-drive port on the back of that machine.

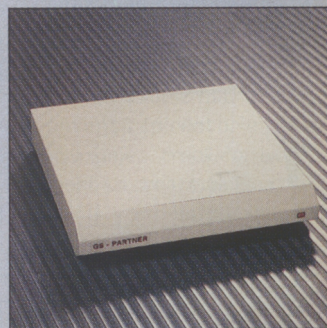
Apple II owners who want to share a hard-



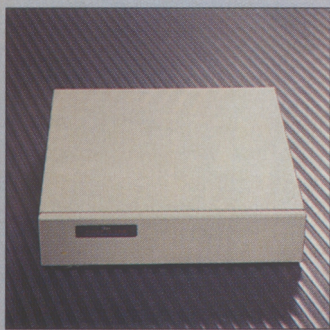
Cirtech InSyder



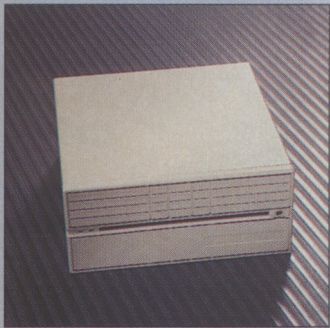
AE Vulcan



AMR GS-Partner



**First Class Sider DF4**



**Tulin TL48GSH**



**DMA 181-ES**

disk drive but don't want to invest in a network and its dedicated file server (another computer) also have only two options: You can share some of CMS' hard drives using additional interfaces, and Johnson & Associates' **MicroMUX** system lets several Apples share the same First Class **Sider** hard disk (Multi-OS model D2 only).

If you own an Apple II Plus, you also have a somewhat limited range of options. The new and improved high-speed version of Apple's SCSI card for the Apple II won't work in a II Plus. And the earlier versions of the Apple II SCSI card were s-l-o-w compared to other proprietary interfaces. II Plus folks should look to these proprietary drives, which are still available from a few manufacturers.

If you own an Apple IIe or a GS, though, the hard-disk marketplace rivals any of the fanciest bazaars: It's got everything from different interface cable lengths to multiple operating systems. Size, speed, and price aren't the only purchasing factors.

The various Apple II-compatible hard-disk drives on the market have some things in common: They come complete with an interface connecting cable and a power cord. Other factors, however, may tip the balance in favor of one drive over another: For example, if your Apple II computing needs dictate that you use a combination of DOS 3.3, Pascal, CP/M, and/or ProDOS (GS/OS), your choice is limited to the internal **Vulcan** from Applied Engineering or an external Sider from First Class Peripherals.

### IN OR OUT

Another factor to consider when selecting a hard-disk drive is where you're going to put it after you buy it. You might want to put it inside your Apple II. Three internally mounted drives are now available. Applied Engineering's **Vulcan** and Ingenuity's **InnerDrive** both replace the II's power supply with a heftier, fan-cooled hard-disk/power system. Cirtech's **InSyder** plugs directly into one of the II's expansion slots and fits nicely. (See the accompanying comparison of these three drives in this issue, p. 49.)

If you don't like the idea of putting your drive inside your Apple, you could try putting it between your computer and the screen. "Twixt" drives with thin profiles and wide footprints fit solidly between the Apple II's CPU (central processing unit) and the monitor. Many Macintosh-ready hard drives are designed to fit under a Mac Plus or SE. They may or may not be solid or wide or long enough to hold your GS' RGB (red-green-blue) monitor, however. In addition, none of the "twixt" drives attempts to distinguish itself

from the competition by providing a whole-system fan or conveniently switched power outlets, such as those offered by Kensington's **System Saver** or the **Conserver** from Applied Engineering, which you'll probably have to abandon if you plan on using a twixt drive. That prospect is even less attractive because you must start and warm most drives before you switch on the power to your Apple II. You can place any of the rest of the external drives nearly anywhere in the general vicinity of your Apple II. Beside it, under the desk, in a closet, out the window? Well, that is... as far as the connecting cable will reach. The standard connecting-cable length appears to be a whopping 2.5 feet, tip to tip — so out the window is probably not a realistic option, although you can purchase longer cables at no small expense.

Another important feature to note is the way you "park" a drive before shutting off the power after a work session. Parking protects the drive's sensitive mechanics. Failure to park your drive properly may damage the disk permanently. Some drives expect you to execute a special "parking" program; the GS Finder's "shutdown" sequence usually works as well. Other drives have an "auto-park" feature; the heads are protected whenever you remove power, thereby removing concern and extra trouble on your part.

### WHAT WAS THAT?

Noise and cooling are two other areas to consider. Most hard-disk drives have their own internal fans. But it's important to note whether or not convection holes are punched at the top of the drive's case to let heat escape by a more natural route.

Noise is generated both by the whirring, whining hard disk and by the fan. Some drives are louder than others. Quantifying noise requires complicated equipment, but the best noise-detecting instrument is your ear. If possible, listen to the drive you're interested in purchasing. (Maybe out the window isn't such an unreasonable place after all.)

### NAME YOUR INTERFACE

Your final hard-disk-drive consideration centers around the issues of interfaces and supporting software. All hard-disk drives require an interface that plugs into one of your Apple II's expansion slots, preferably slot 7 if you intend to start up your II from the hard drive. Some hard-disk drives are designed to use a proprietary interface and won't work with any other. Others include a proprietary interface, but will also operate with some others (at extra cost), most

notably the Apple II High-Speed SCSI Card. Some drives, particularly those designed for use with Macintosh computers, don't include an interface, but are Apple SCSI-compatible — so add \$129 to the cost of the drive. Not all Apple SCSI-compatible drives will work with your Apple II. Most do, but consult your dealer, or, because many dealers don't even know Mac drives can work with the II, call the manufacturer.

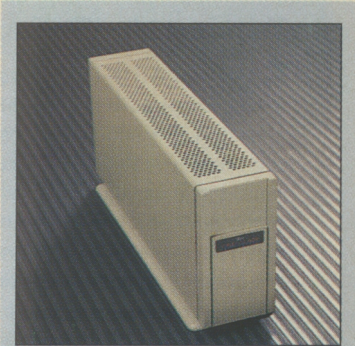
Ideally, support software for your hard-disk drive should include formatting, partitioning, defragmentation, parking, backup, file maintenance (copy, delete, and so on), and application launch utilities, as well as a GS/OS driver for the GS. (See the sidebar below for a discussion of some of these features, as well as "Do You Know Where Your Data Are?" May 1989, p. 54.)

Drives that operate from a proprietary inter-

face should include their own support software on floppies as well as on the drive. Most do, but to varying degrees; we'll leave that comparison to your shopping acuity. The Apple SCSI interface comes with the formatting, partitioning, and backup utilities you'll need for compatible drives. For all hard-disk drives, GS owners can use Apple's GS/OS 5.0.2 System Disk and System Tools for additional support software. Other Apple II owners can use the Apple ProDOS System Disk or a variety of other commercially available file maintenance programs, such as Glen Bredon's **ProSel**, Central Point Software's **Copy II Plus**, or Quality Computers' **Easy Drive**.

### THE WINNERS

Let's cut right to the awards. (No, the UniDisk 3.5 isn't the drive of choice.) According to our ►



First Class Sider D4T



## Format, Initialize, Interleave, Defragment, and Partition

Ever watch a child write his or her first story? Lined paper helps children keep the words from running together. While a child can eventually forego lines, however, your hard disk, or any type of disk for that matter, needs them to keep its stored data from running amok. In fact, your hard disk needs a well-organized form — something like an insurance claim or a tax document. That's what "formatting" and "initialization" are all about.

Formatting "lines" the hard disk electronically into concentric tracks and subdivides those tracks into blocks. And, much like the fill-in boxes that run across a paper form, initialization labels each block so that your system can locate it quickly. Access speed is particularly important for hard-disk drives: Formatting creates tens of thousands of blocks; it's faster and easier to find a numbered box on a form than to count from the beginning each time.

"Interleaving" takes into account that your disk spins much faster than your interface and your Apple can read and digest data. In the time it takes to decode and put a block's worth of data into your Apple's memory and then figure out where to read next, the drive's read/write head will have spun beyond several physically adjacent blocks. Rather than make a time-consuming complete revolution of the disk, the block order is skewed electronically during formatting and initialization so that the next block is positioned properly when the drive is ready to read it.

The actual interleave you should use for your hard disk depends on your drive, the

interface, and which Apple model you're using. An illustration of these effects is shown in the benchmarks for the First Class Sider model D4T in the **Table** accompanying this article. A 1:1 block interleave works well when connected to a IIe, but an 8:1 interleave is best with a GS, particularly when using the GS/OS driver. Don't be surprised if your drive suddenly starts operating as though it were immersed in molasses if you change your system by adding an accelerated processor.

Fortunately, First Class and most other manufacturers, including Apple, provide formatting utilities that let you select the optimum interleave for your system manually. In fact, we recommend that you format your new hard disk unless you're absolutely sure a preformatted one fits your particular system and needs.

Still wondering why your files are broken down and saved as so many small blocks? This technique allows for efficient use of the disk's storage space. Like a mosaic, small pieces permit greater detail and diversity than large ones.

Storage efficiency comes at a price, however. Initially, your files are arranged end to end in continuous blocks. Then when you erase a file from disk ("replace" erases first, then writes the new data), its blocks are "freed" for use by another file, thereby creating a gap. The next saved file might be smaller than that gap and, hence, will again fill the space using consecutive blocks. A larger file, however, will fill that gap and then look elsewhere for more.

Because like all computer users you erase

and save data constantly, gaps of varying sizes and locations exist. Eventually, data for a particular file can be scattered all over the disk. That's known as "fragmentation," and it slows down your disk significantly because your disk and the interface are optimized to read data linearly. "Random-type" access of a fragmented file is quite slow in comparison, as the linear- versus random-read benchmarks for any drive in the **Table** demonstrate.

When you notice your hard disk operating more slowly than usual, try defragmenting it. Defragmentation utilities, such as Pro-Sel's Beach.Comber for the IIe/IIc and Optimizer for the GS, to name just two, are available. Or simply copy (don't use backup) every file on the disk, erase it, then copy the files back. The process can be time-consuming, but you'll make up that lost time as the drive operates noticeably faster.

While you're bothering to back up and reformat your disk, "partition" it as well to suit your needs. Partitioning simply divides your disk into separate volumes, much like books in a library. Each volume maintains its own table of contents (directories) and doesn't use other volumes' tracks or blocks. Most often, it's best to create at least one volume containing your applications. Because you'll rarely delete and resave these files, they tend not to become fragmented. Create at least one other volume for those data files you change often and that therefore become fragmented quickly. That way you need to back up and defragment only the data volume(s) on a regular basis, saving time and trouble. — W.K.

## Testing the Drives

Before you write out a check for a hard drive, consult our benchmark results shown in the accompanying **Table** to get the best buy. While the drives listed represent the variety of units marketed for both the II and the Mac, the list is by no means comprehensive. Some manufacturers couldn't supply a test drive in time for this writing; we'll report our benchmark findings for those in later issues. Others refused to participate because they didn't feel they could provide adequate service to the II market in addition to the Macintosh.

We ran the hard disks through eight performance tests. Each test measures one of the many operations a hard-disk drive and its interface must perform to save and retrieve your stored programs and data. We used both an Apple IIGS and a IIe for the tests. Each had the hard-disk drive's interface card installed in slot 7, the default boot slot for the IIe and the GS. The GS' Control Panel slot assignment was set to "your card" and the boot slot to "scan."

The GS contained the standard ROM 01 and 1.25 megabytes of RAM. Cache RAM and the /RAM5 disk were deactivated. A 5.25-inch drive was attached to slot 6 in both computers; a 3.5-inch drive and a Uni-

Disk 3.5 were connected to slot 5 in the GS and the IIe, respectively. The Apple IIe was "enhanced," as required by the Apple SCSI card, and contained an Applied Engineering RamWorks memory-expansion card.

Each drive was formatted before testing with either the manufacturer's software for proprietary interfaces, or the SCSI Utilities provided with the Apple II High-Speed SCSI Card. The block interleave for each drive indicated in the **Table** was used with the GS; a 1:1 interleave is best for most drives, particularly those connected to the Apple SCSI card. The most efficient IIe interleave was either set by the manufacturer's software or by the Apple SCSI utilities. When allowed, the hard disk was also partitioned into a 32-megabyte (32M) boot volume; the remaining 8M to 15M segment was used as a data volume. For comparison, we've also performed some of the benchmark tests on an Apple 3.5-inch drive connected to a GS and a UniDisk 3.5 connected to a IIe.

Test 1 (Warmup) gives you an idea of how long you must wait after turning on your hard drive before it's "up to speed" and ready for access, regardless of the particular Apple II model to which it's connected.

What complicates this measurement is that you can turn on some drives simultaneously with the computer; the interface will wait until the drive is ready. Other interfaces, including Apple's SCSI card, don't wait; if the drive isn't ready, your Apple moves on to another potential boot device. If it finds one, it will ignore your hard drive; if it doesn't, it will crash into a system error such as "Check the Boot Drive." You must turn on these latter hard-disk systems sometime before the computer.

To perform Test 1, we had to do some "hand waving," because some drives' only indication of readiness was the cessation of audible startup clicks and shuffles. The actual times measured are therefore in some cases a few seconds longer than the minimum warmup time.

The remaining benchmarks measure the rates at which an Apple IIe or GS accesses data from the hard-disk drive through the interface indicated in the **Table** and, if used, the GS/OS driver. The reported numbers are the mean of three evaluations; no individual test varied from the others by more than 5 percent of that mean.

Tests 2 through 4 evaluate "real world" operations: the time it takes to start up

## Benchmark Test Results

Model	Manufacturer	Size <sup>1</sup>	Price <sup>2</sup>	Placement	Interface	OS Format	Auto-Part <sup>3</sup>
CT-40	Chinook Technologies	40	\$718. <sup>3</sup>	side	Apple-SCSI	GS/OS	yes
40SC	Apple Computer	41	\$1,508. <sup>3</sup>	side <sup>7</sup>	Apple-SCSI	GS/OS	yes
UltraDrive	GCC Technologies	47	\$828. <sup>3</sup>	side <sup>7</sup>	Apple-SCSI	GS/OS	yes
TL48GSH	Tulin Corporation	47	\$589. <sup>3</sup>	side <sup>7</sup>	Apple-SCSI	GS/OS	yes
GS-Partner	American Micro Research	40	\$799. <sup>3</sup>	twixt	Apple-SCSI	GS/OS	yes
Sider DF4	First Class Peripherals	47	\$895.	twixt	proprietary	GS/OS	yes
Sider DF4	First Class Peripherals	47	\$1,024. <sup>3</sup>	twixt	Apple-SCSI	GS/OS	yes
Sider D4T	First Class Peripherals	38	\$849.	side	proprietary	multi-OS	yes
Sider D4T	First Class Peripherals	38	\$914. <sup>4</sup>	side	proprietary	multi-OS	yes
TL44GSH	Tulin Corporation	43	\$785. <sup>3,5</sup>	side <sup>7</sup>	Apple-SCSI	GS/OS	yes
181-ES	DMA Technologies	47	\$1574. <sup>3,6</sup>	side <sup>7</sup>	Apple-SCSI	GS/OS	yes
SD45RM/A2S	CMS	43	\$1399.	side <sup>7</sup>	proprietary	GS/OS	yes
Vulcan-GS/e	Applied Engineering	40	\$899.	inside	proprietary	multi-OS	yes
InnerDrive	Ingenuity	40	\$575.	inside	proprietary	GS/OS	yes
Apple 3.5	Apple Computer	0.8	\$429.	side	SmartPort	GS/OS	yes

1. Total capacity according to the GS Finder Get Info rounded to the nearest megabyte (M).

2. Manufacturer's suggested retail price.

3. Includes cost of the Apple High Speed SCSI card (\$129); card not included with drive.

4. ProDOS-only ROM and GS/OS driver (\$65) sold as extra accessory.



and launch applications. For GS applications, GS/OS version 5.0.2 was installed on each drive with the System.Disk and the System.Tools Installer program. The GS/OS drivers SCSIHD.Driver and SCSI.Manager, as found on the SCSI.Utilities disk, were also installed. Otherwise, the appropriate GS/OS driver, if available, was installed for the proprietary interfaces.

Test 2 (Boot to Finder) measures the time taken from the point when the familiar "Welcome to the IIGs" screen appears during bootup to that when the mouse pointer (not the watch) appears in the upper left-hand corner of the Finder desktop. Note that the time required to initialize the Apple systems as well as the interface card isn't represented in this value, and that the GS/OS drivers that make disk accesses more efficient aren't activated until late in the boot process. This test measures what might be called the drive's "raw" speed.

Test 3 measures the time it takes to launch AppleWorks GS (version 1.1 ExpressLoad program) and is a good indicator of a drive's "real world" operation when all its faculties are active: The drive's warmed up, the GS/OS driver is active, and so on. The AWGS program was copied to

the hard-disk boot volume and its icon moved to the desktop in preparation for launch. The file AWGS.Config was also installed on the boot volume and programmed so that all AWGS program modules were loaded during launch.

Test 4 (AppleWorks 3.0 launch) measures the time taken from bootup directly into AppleWorks 3.0 (AW 3.0). Each hard-disk drive was prewarmed. Launch time was measured from startup (using the familiar Open apple-Control-Reset "warm" boot) to the appearance of the AW 3.0 main menu on the Apple IIe screen. Note that this time includes interface initialization times, which, for the Apple II High Speed SCSI Card, added about five seconds to the overall boot time.

Tests 5 through 8 were performed on the GS to evaluate the hard-disk drives' individual operations more closely and vigorously. Test 5 (Verify) measures the time taken by the GS Finder's disk-verification utility to read each block of the hard-disk drive's boot partition and to ensure their integrity. It measures the mean data-access rates for the entire volume. For comparison, because not all boot volumes were partitioned as 32M (65,536 blocks),

the reported values in the **Table** are normalized by dividing the total time for verification by the number of verified blocks.

Tests 6 through 8 were performed using Glen Bredon's ProSel Volume Repair Utilities, which provide statistical benchmarks for a disk drive's linear- and random-read and operating-system overhead operations. The listed times are the mean rates required to perform the operation on selected portions of the disk.

Similar to the verification benchmark (Test 5), Test 6 (Linear Read) is the mean time taken to read adjacent blocks from the disk. Linear reading is the fastest rate at which the drive and interface can transfer data, as the necessary "search" for the next block is kept to a minimum.

Test 7 (Random Read), on the other hand, measures the rate for data transfer when the read blocks aren't adjacent, but randomly selected, as when your data files are "fragmented." (See the accompanying sidebar.) The benchmark evaluates the drive's and interface's search efficiency.

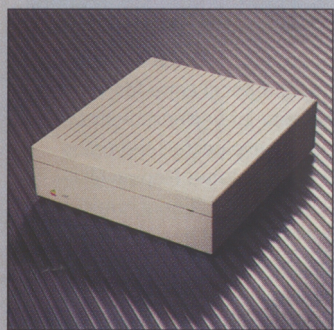
Finally, Test 8 (OS Overhead) isolates the drive and interface from the operating-system software, in this case GS/OS and the GS/OS driver, if present.

—W.K.

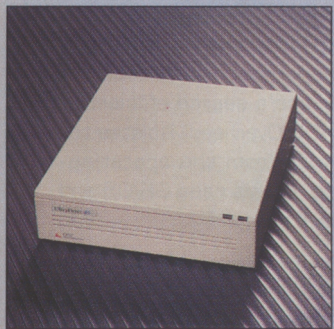
Interleave (GS/OS)	GS/OS Driver	Warm-up (sec)	Welcome to Finder (sec)	Launch AWGS (sec)	Boot AW V.3.0 (sec)	Verify (K/sec)	Linear Read (msec/block)	Random Read (msec/block)	OS Overhead (msec/block)
1:1	SCSIHD	7	25	23	11	390	1.2	27.5	10.7
1:1	SCSIHD	9	29	26	14	287	1.6	32.4	13.4
1:1	SCSIHD	18	32	26	16	237	2.1	31.9	13.8
1:1	SCSIHD	21	33	26	16	234	2.1	33.1	13.8
1:1	SCSIHD	12	38	27	14	216	2.2	33.0	15.2
1:1	Sider.DF4.157N1	20	25	29	11	88	5.5	26.2	33.3
1:1	SCSIHD	20	33	26	10	232	2.1	33.4	13.8
1:1	none	12	32	50	9	28	17.9	33.1	2.2
8:1	Sider 4.0	12	28	33	12	59	8.3	27.5	2.0
1:1	SCSIHD	22	35	28	16	334	1.4	38.1	13.2
1:1	SCSIHD	23	33	29	15	282	1.6	46.6	15.1
1:1	none	14	35	52	10	25	19.5	32.2	4.3
1:1	Vulcan	11	19	25	8 <sup>B</sup>	137	3.6	21.7	1.0
1:1	InnerDrive	11	27	31	9	96	4.9	18.6	1.3
2:1	Apple 3.5	<1	58	82	27	27	16.2	151.3	6.9

- 5. Cartridges (44M) cost an additional \$95 each.
- 6. Cartridges (50M) cost an additional \$160 each.

- 7. Case designed to fit under Macintosh Plus- or SE-series computers and may be installed "twixt" GS and RGB monitor.
- 8. Benchmark performed with IIe version of Vulcan drive.



Apple 40SC



GCC UltraDrive 45



Tulin TLT44GSH

benchmark results, Chinook's **CT-40** connected to the Apple II High Speed SCSI Card is the best performer of the lot — that is, if you want a compact, competitively priced, fast, quiet, fixed, external hard-disk drive.

The two top performers in the removable hard-disk line are the Tulin **TLT44GSH** and DMA Technologies' **181-ES**, which are difficult to separate except in price. The Tulin drive outperformed DMA's slightly, although the differences are negligible, particularly when compared to the other hard drives.

The internal drives from Applied Engineering and Ingenuity operate well compared to other drives, and run virtually neck-and-neck when compared directly. The Vulcan outperformed the InnerDrive, however — particularly when launching applications. (For a more definitive look at a selection of internal hard drives, see the accompanying feature article on p. 49.)

Everything outperformed CMS' removable hard disk when used with the the GS. It did a little better when working with a IIe. Even the Apple 3.5-inch floppy drive came close to the **SD45RM/A2S'** performance on a GS. Now perhaps if the manufacturer would abandon its proprietary SCSI for Apple's and produce a GS/OS driver. . . .

**LOOKING AHEAD**

It isn't surprising that the Apple II High Speed SCSI Card makes just about any compatible hard-disk drive competitive with, if not superior to, drives that use proprietary interfaces. The

Apple SCSI card uses what's known as *DMA* (direct memory access) to put data directly into your Apple's memory.

That's faster than having to move the data through a temporary buffer, as earlier, slower versions of the Apple SCSI card did, and as drives with proprietary interfaces still do today. In fact, direct memory access is such an asset that the competitive speeds of some of the proprietary drives is a tribute to the efforts of the engineers who developed them.

But the biggest effect of Apple's new SCSI card is that Apple II owners can now efficiently use hard-disk drives that in the past have been marketed almost exclusively to the Macintosh market. With the ensuing flood of competition among the various manufacturers of hard-disk drives, you can expect to see distinguishing innovations, particularly built-in accessories, as companies attempt to gain a marketing advantage — and that will be good for all of us.

We'll keep you posted on the changing marketplace and provide benchmark results for additional hard-disk drives in upcoming issues. If you're ready to buy now, however, just about any one of the hard disks evaluated here sure beats the floppy-disk shuffle hands down. □

BOB CONSORTI IS PRESIDENT OF ON THREE, A HARDWARE AND SOFTWARE DEVELOPMENT COMPANY. HE HAS EXTENSIVE EXPERIENCE IN HARD-DRIVE RESEARCH AND TESTING. WILLIAM P. KENNEDY IS *INCIDER'S* SENIOR TECHNICAL EDITOR AND WRITES OUR APPLE CLINIC COLUMN EACH MONTH. ADDRESS YOUR CORRESPONDENCE C/O *INCIDER*, 80 ELM STREET, PETERBOROUGH, NH 03458.

**PRODUCT INFORMATION**

**181-ES**  
DMA Technologies  
601 Pine Ave.  
Goleta, CA 93117  
(805) 964-0733  
\$1574

**Copy II Plus**  
Central Point Software  
15220 N.W. Greenbrier  
Pkwy. #200  
Beaverton, OR 97006  
(503) 690-8090  
\$39.95

**MicroMUX**  
Johnson & Associates  
P.O. Box 42073  
Phoenix, AZ 85080  
(602) 542-2203  
\$695 base unit  
\$150/interface card

**Sider DF4**, \$895  
**Sider D4T**, \$849  
First Class Peripherals  
3579 Highway 50E  
Carson City, NV 89701  
(800) 982-3232

**Apple II High-Speed SCSI Card**, \$129  
**Apple 3.5 Drive**, \$429  
**Apple 40SC**, \$1508  
Apple Computer  
20525 Mariani Ave.  
Cupertino, CA 95014  
(408) 996-1010

**CT-40**  
Chinook Technologies  
601 Main St., # 635  
Longmont, CO 80501  
(303) 678-5544  
\$718

**ProSel 8**, \$40  
**ProSel 16**, \$60  
Glen Bredon  
521 State St.  
Princeton, NJ 08540

**System Saver**  
Kensington Microware  
251 Park Ave. South  
New York, NY 10010  
(212) 475-5200  
\$89.95 IIe, \$99.95 GS

**Conserver**  
Applied Engineering  
P.O. Box 5100  
Carrollton, TX 75011  
(214) 241-6060  
\$99

**Easy Drive**  
Quality Computers  
15102 Charlevoix  
Grosse Pointe, MI  
48230  
\$59.95

**SD45RM/A2S**  
CMS  
1372 Valencia Ave.  
Tustin, CA 92680  
(714) 259-4352  
\$1399

**TLT44GSH**, \$785  
**TL48GSH**, \$589  
Tulin Corp.  
2156H O'Toole Ave.  
San Jose, CA 95131  
(408) 432-9025  
\$785

**GS-Partner**  
Amer. Micro Research  
1305 Yorba Ave. Unit A  
Chino, CA 91710  
(714) 590-3900  
\$799

**UltraDrive 45**  
GCC Technologies  
580 Winter St.  
Waltham, MA 02154  
(800) 422-7777  
\$828





# BATTLE OF THE INTERNAL HARD DRIVES



Space-saving internal hard-disk drives face off in a stiff competition for first place in *inCider's* benchmark tests. Read on for a report on this fierce three-way struggle.

By OWEN W. LINZMAYER \* CONTRIBUTING EDITOR

InnerDrive? Vulcan? The new InSyder? It's time to finally settle the issue. What's the best internal hard-disk drive for the Apple II?

We rounded up the three internal models on the market — the **InnerDrive** from Ingenuity, the **InSyder** from Cirtech, and the **Vulcan** from Applied Engineering — and put them through a series of rigorous benchmark tests designed to simulate real-world use. (See the accompanying **Table**.) We found more similarities than differences among the competing products, but each drive excels in certain areas.

## THE INTERNAL DEBATE

Before you can decide which internal drive to buy, it's important to decide whether you really want one at all. Aside from the gee-whiz factor of actually having a hard-disk drive inside your computer case, there are few substantive benefits to internal drives. Sure, you save a little desk space and eliminate some cabling confusion. Internal drives also make it easy to pack up your system and move it to another location. But do those benefits outweigh the disadvantages?

On a cost-per-megabyte basis, internal drives are more expensive than external models; the large market for external drives has led to intense competition and low prices. Also, most external drives are SCSI (small-computer-systems interface) devices you can use with an Apple IIe or GS (with an appropriate interface card) or attached directly to a Mac Plus, SE, or II; the custom interfaces internal drives use can cause compatibility problems. Internal drives also can't match the data-transfer rate of the new Apple II

High Speed SCSI Card, which uses *DMA* (direct memory access). And even though they may contain built-in fans, internal drives raise the temperature inside your computer, increasing the likelihood of mechanical failure for both the drive and your other peripheral cards.

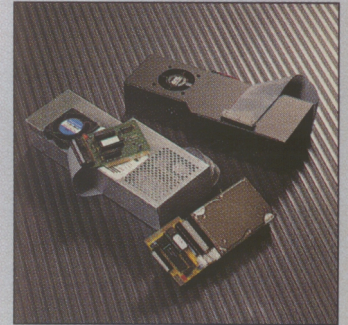
Lastly, it's important to look to the future. If you want to add more disk storage later, can you upgrade to a larger internal model, or will you have to buy an external drive after all? And what if you buy a Macintosh? If you have an external drive, chances are you can reformat it for use with your next system. You'd probably have to sell your internal drive at fire-sale prices, however.

## SURVEYING THE MARKET

Although there were some early aborted attempts to market internal hard-disk drives for the Apple II, the concept didn't really catch on until Ingenuity (then Applied Ingenuity) released its InnerDrive series. Applied Engineering followed suit with a similarly designed line called the Vulcan. The two firms offer 20-, 40-, and 100-megabyte (M) versions of their hard drives.

Both the InnerDrive and the Vulcan are combination hard drives and power supplies. To install the drives, you must remove your Apple's existing power supply and replace it with the slightly larger drive/power-supply combo. Then you insert a proprietary interface card into one of your II's empty expansion slots and run a cable between the board and the hard drive. You can use the Vulcan in a II Plus, IIe, or GS; the InnerDrive works only with the IIe and the GS.

Cirtech took a different approach with its



The inside story —  
internal hard-disk drives  
from Ingenuity (left),  
Applied Engineering  
(top right), and Cirtech  
(bottom).



Everyone wants his  
or her computer  
to work faster.  
Aside from an  
accelerator, the  
best thing you can  
add to your slow  
computer is a  
hard-disk drive.

InSyder drive (nice name, by the way). Currently available only in a 20M configuration (Cirtech promises to have a 40M drive by the time you read this), the InSyder is a 2.5-inch disk drive mounted directly on a SCSI interface card. The InSyder card's cable terminates in a DB-25 connector you attach to the back panel of the computer. You can plug an external SCSI drive into this connector or, with an optional adapter, a parallel printer. According to its U.S. distributor, A2-Central, the InSyder works with an Apple II, II Plus, IIe, or GS; we tested it on a GS.

#### OPERATING ROOM

You can format all internal drives tested here as either ProDOS or GS/OS volumes. Under GS/OS, these models use custom device drivers. Under ProDOS, you can segment the larger drives into several partitions to bypass the 32M limit. The InSyder comes with a program that patches ProDOS to bypass this limitation.

The Vulcan and the InSyder also come with partitioning software that lets you create DOS 3.3, Pascal, and CP/M sections on disk. With the InSyder, you can specify up to two 400K DOS 3.3 partitions, a 16M Pascal 1.3 partition, an 8-gigabyte CP/M Plus partition, and an 1.5M SoftCard CP/M 2.23 partition. These operating-system partitions exist as ProDOS files on the hard drive. To boot into the new operating system, you launch that particular file. You can't exchange programs and data files among the different operating-system partitions.

The Vulcan comes with a program called the Partition Manager, which lets you format up to 16 segments with different operating systems. Under ProDOS 8, the largest partition can be only 32M, but the Vulcan comes with a modified version of ProDOS 8 that lets it recognize more than two partitions. DOS 3.3 allows any number of 140K or 400K volumes. With Pascal you have a maximum partition size of 16M, and under CP/M you can define a partition as large as 8M.

#### SPEED DEMONS

When it comes to hard-disk drives, the three most important things to consider are cost per

megabyte (easy to calculate), long-term reliability (almost impossible to test), and access speed (a little tricky to measure accurately). Sure, the bundled software is important, too, but most people are interested in speed, speed, and more speed. It's hard to argue with that point of view: Everyone wants his or her computer to work faster. Aside from an accelerator such as the TransWarp or the Zip Chip, the best thing you can add to a slow computer is a hard-disk drive.

Even the slowest hard-disk drive is much faster than the fastest 3.5- or 5.25-inch floppy-disk drive. Applications that take minutes to load from floppy disk are available in seconds from a hard disk. The point is that if you're used to a floppy-disk drive, any hard drive is going to be a great improvement. How well it performs relative to other hard drives isn't really important. That said, let's see how the internal drives stack up.

#### FINDING THE FASTEST

To test drive speed, we devised a number of benchmarks designed to simulate real-world uses of hard disks with a GS. The tests are also revealing, however, if you own an 8-bit Apple. (For more details on our test system and methods, see the sidebar "Testing the Drives" in our cover story, "A Hard Drive Is Good to Find," p. 46.)

First we booted each drive and timed how long it took for the mouse pointer to appear on the Finder's desktop. This tells you how long you can expect to wait each time you restart or cold-boot your computer. The Vulcan performed best in this test, requiring a half minute from flipping the switch to being able to go to work. That's about a third faster than either the InnerDrive and InSyder. One reason the InSyder didn't do as well in this test is because the drive doesn't spin on power-up, but rather only on first access (when your system polls the slots for devices). Although you sacrifice some speed, there's less demand on the power supply.

The second test verifies the boot partition of each drive from the Finder's Disk menu. To arrive at a fair unit of measure, the total number of blocks verified was divided by the time required. This tells you how fast the drive can

**Internal Hard-Disk Drive Benchmarks**

	\$/M	Boot to Finder	Verify (blocks/sec)	Launch AWGS (sec)	Random Read
InnerDrive	\$14	38	187	31	18ms
InSyder	\$35	41	190	33	28ms
Vulcan	\$22	30	325	25	21ms

## INTERNAL HARD DRIVES

read each spot on the disk in a linear fashion. Once again, the Vulcan proved the fastest of the lot, able to verify 325 blocks per second. That's more than 40 percent faster than the InnerDrive and the InSyder, both of which verified about 190 blocks per second.

Our third speed test was to launch AppleWorks GS version 1.1 with all modules preloaded. This real-world test gives you some idea as to how much time you'll spend staring at the watch icon as opposed to actually getting down to business. By now it should come as no surprise that the Vulcan beat the competition, taking only 25 seconds to launch the integrated program. The InnerDrive was in second place with 31 seconds, followed closely by the InSyder at 33 seconds.

The Vulcan outperformed its internal competition in every category but one: It took second place in the random-access race. The InnerDrive's winning time of 18 milliseconds is about 15 percent faster than the Vulcan's, and 35 percent faster than the InSyder's. (For more results, see the **Table** in "A Hard Drive Is Good to Find," p. 46.)

Overall, the test numbers tell us that the Vulcan is clearly faster than its competitors when reading and writing files on a freshly formatted drive with wide-open spaces. But the InnerDrive is a bit faster at random access, arguably a more important specification. The InSyder was the slowest of the lot, but not by much. When nitty meets gritty, keep in mind that although one drive may be 30 percent faster than another, the absolute difference between them is measured in seconds and milliseconds.

### COMPARING COST

You'll have to decide for yourself just how much you're prepared to pay for shaving a few seconds off normal disk access. In most of our tests, the Vulcan proved the fastest drive, but it also carries the highest cost per megabyte. On average, its list price is 45 percent higher than similarly sized InnerDrives. That's a gap that's hard to ignore. When you compare street prices offered by dealers and mail-order houses, however, the Vulcan is only marginally more expensive than the InnerDrive.

The InSyder, on the other hand, is currently distributed only by A2-Central and carries a rather high price tag given its capacity. Keep in mind, however, that it includes the cost of a SCSI card (a \$129 value) as well as some unique programming: Its multi-user software lets you share an external SCSI hard drive with another user, provided you both have InSyder cards. The software correctly handles SCSI arbitration so that you can both access the drive at the same time. You can even lock out other users from certain partitions of the shared drive.

### LIVE LONG AND PROSPER

The InSyder is the only drive that works with the original Apple II. If that's what you own and you have your heart set on an internal drive, the InSyder is the way to go. If you have an Apple II Plus, you can choose between the InSyder and the Vulcan. They both cost about the same and run virtually every major operating system. In general, I'd stick with the faster, proven Vulcan technology, unless you want to take advantage of the InSyder's SCSI interface for an external drive or multi-user capability.

The InnerDrive can't handle DOS 3.3, Pascal, or CP/M partitions, so if you need those operating systems, you must again choose between the InSyder and the Vulcan. If you have an IIe or a GS running ProDOS or GS/OS, you can use any one of the three internal drives. The Vulcan, however, is generally the fastest, reasonably discounted, covered by a one-year warranty, thoroughly documented, and guaranteed to be compatible with all other Applied Engineering products. The InnerDrive and the InSyder are fine alternatives with unique features that might sway you to consider them. For most people, though, the Vulcan is the way to go. □

BETWEEN OVERSEEING A REPORT ON 101 EXTERNAL HARD-DISK DRIVES FOR THE FEBRUARY 1990 ISSUE OF *MACUSER* MAGAZINE AND REVIEWING THE THREE INTERNAL MODELS THIS MONTH FOR *INCIDER*, CONTRIBUTING EDITOR OWEN W. LINZMAYER NOW KNOWS HARD-DISK DRIVES INSIDE AND OUT. WRITE TO HIM *C/O INCIDER*, 80 ELM STREET, PETERBOROUGH, NH 03458.

### PRODUCT INFORMATION

**InnerDrive 20**, \$475

**InnerDrive 40**, \$575

**InnerDrive 100**, \$1199

Ingenuity, Inc.

14922M Ramona Blvd.

Baldwin Park, CA 91706

(800) 346-0811

(818) 960-1485

**InSyder 20**, \$695

**InSyder 40**, \$895

A2-Central

P.O. Box 11250

Overland Park, KS 66207

(913) 469-6502

**Vulcan 20**, \$699

**Vulcan 40**, \$899

**Vulcan 100**, \$1749

Applied Engineering

P.O. Box 5100

Dallas, TX 75011

(214) 241-6060

If you're used to  
a floppy-disk drive,  
any hard drive  
is a great  
improvement. How  
well it performs  
relative to other  
drives isn't really  
important.





## A new kind of hard disk from Applied Engineering.

And it will be like no other hard disk you've seen before. For more than two years, our sales department has been asking our R & D department to design a hard disk, but management was concerned about the less-than-perfect reliability record associated with hard disks. So, frankly, research in this area received a lower priority.

Working primarily in their spare time, a few of our best hardware and software engineers have made some exciting breakthroughs. Management had no choice but to support their work.

This new line of internal and external hard disks from Applied Engineering will achieve new reliability, performance, ease-of-use and low price standards. Our engineers say we'll be ready to ship in two to three months. No, we're not taking orders yet (we hate vaporware as much as you do). But we *will* take your name and mail more information as soon as it's available. You see, the final design isn't complete yet. An exact shipping date isn't known. And we're still expanding the specifications. But we *are* being up front and honest about this new product breakthrough. We *can* tell you two things about our new Apple compatible hard disks. They will be the best and they will be called Vulcan.

**AE** APPLIED ENGINEERING®  
*The Apple enhancement experts.*

A Division of AE Research Corporation.

P.O. Box 5100, Carrollton, TX 75011, 214/241-6060

*inCider* May 1989