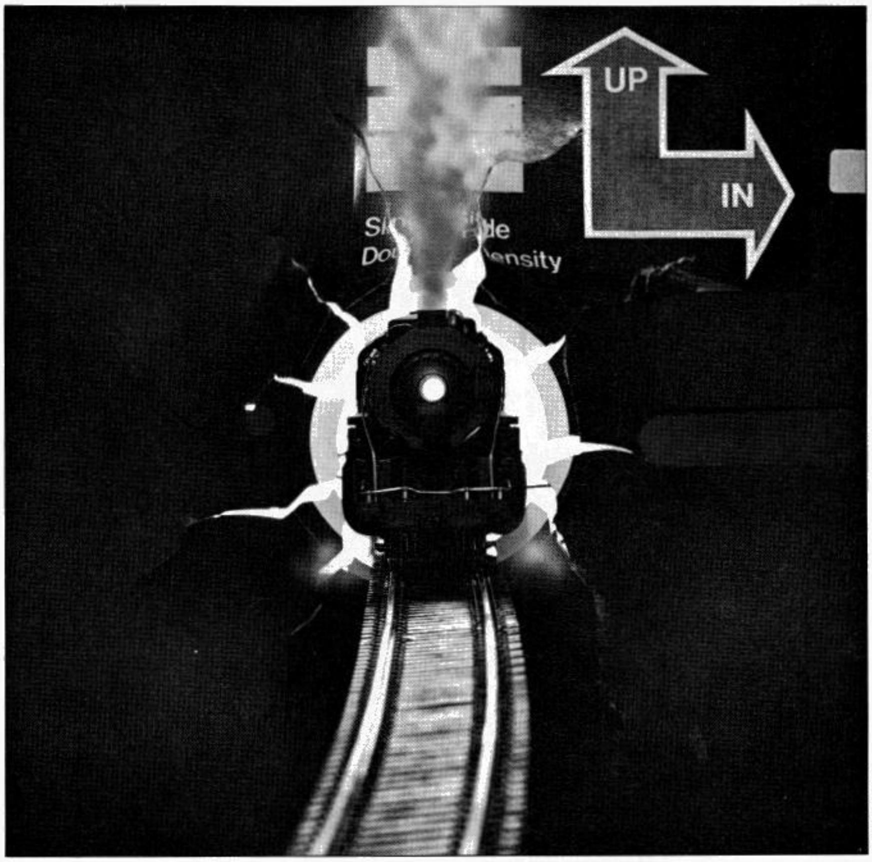
HOW DURABLE ARE YOUR DISKS? VERY!

You can cook them; you can cool them; you can even expose them to airport security machines. Your disks, though, won't lose their data

By Howard A. Karten



JOHN BENTLEY

NO MATTER WHAT SIZE OF COMPUTER you're using, one of life's lurking nightmares is the fear that data recorded on a diskette will somehow become unusable. A mythology has grown up regarding the vulnerability of diskettes to such energy sources as X-rays and microwaves—not to mention more tangible threats, such as spilled coffee. In any case, a failure involving a $2 floppy disk can be more catastrophic than one involving a more expensive piece of hardware.

To find out just how vulnerable diskettes are, I did some research to learn just how much torture they could take before losing their data. I was particularly interested in subjecting them to various forms of electrical energy—to try to destroy data without physically altering the diskette.

I bought two boxes of IBM Corp.'s double-sided diskettes at an IBM product centre. Each diskette was prepared to receive data on a 128K-byte IBM Personal Computer, on the same double-sided disk drive. Then I used a popular word-processing program, EasyWriter 1.1, to create 18 distinct files on one of the diskettes. Each file consisted of a single letter or character repeated 17,152 times. (The reason for doing it this way was to make the diskette easier to check—a single "unlike" character among thousands grabs one's eye.)

Finally, I used a standard IBM utility program to make 20 identical copies of the diskette within an hour of each other. The idea was to get each one moderately filled with data and thereby simulate conditions in the real world. Each diskette contained 309,000 of a possible maximum 320,000 bytes.

Then I took some of them to Sylvester Testing Labs in Rockland, Mass. The lab specializes in metallurgical and material testing, and it subjected the diskettes to the following:

Corrosive gases. Two diskettes were placed in a Plexiglas test chamber containing 1% carbon dioxide for 72 hours. This test was repeated in an environment of 0.5% sulfur dioxide.

X-radiation. Using a Picker X-Ray Corp. X-ray camera, one diskette was irradiated with 120 kilovolts per minute (kvm) at a distance of 91 cm from the X-ray source. A second disk was irradiated with 250 kvm at the same distance. A conventional chest X-ray at that distance and level would be shot for only 0.005 seconds.

Humidity. Two diskettes were placed in a humidity chamber for 24 hours and exposed to air with a relative humidity of 85% (plus or minus 5%), at a temperature of 25°C (plus or minus 2°C).

Thermal shock. Thermal shock occurs when diskettes are taken from a cold to a warm environment. Although it seemed unlikely that thermal shock would affect magnetic impulses on a diskette, I ran this test, since it simulates a reasonably common situation.

Two diskettes were put into a thermal shock chamber and subjected to

−62°C for one hour, and then to 82°C for an hour.

Welding cable. A Miller welding machine supplying 115 amps DC (source) was turned on, and two diskettes were subjected to the magnetic field produced. One was placed 30 cm from the cable, the other, 61 cm.

The remaining diskettes were tested in yet more cruel and unusual ways.

Magnets. Information is stored on diskettes as magnetic impulses; virtually the first thing computer users learn is that diskettes are supposed to be kept away from sources of magnetism. To see if this were necessary, I took a hardware-store-variety magnet and moved it back and forth across the surface of a diskette, approximately 5 cm–7 cm away. I moved another magnet back and forth on the diskette's Tyvek envelope, with the diskette inside.

Telephone receivers. Telephone receivers have been known to destroy data. With a diskette in its protective Tyvek envelope, I conducted a 10-minute conversation, during which the diskette was rubbed repeatedly over the transmitter, receiver and base of a standard push-button phone.

Microwaves. Microwaves are all around us, but to put the diskettes to the most severe test I could think of, I went out to a local department store that sells microwave ovens. When the salesman's back was turned, I put a diskette into a Sharp Model 771R Carousel microwave oven for one minute, set at medium-high. I then put a second disk in a Litton Corp. Generation II microwave oven for 90 seconds, with the controls set for a well-done hot dog.

Since microwave cooking works by heating up water molecules, I had thought that the diskette would come through physically unscathed. (The point, after all, was not to fool with the physical or mechanical attributes of the diskette, but with the data recorded on it.) But apparently, the Litton oven heats up inside, since the diskette came out looking like a record left on a car dashboard in the August sun. The other diskette came out physically unscathed.

Fluorescent lights. Fluorescent lights have been known to clobber data recorded on a floppy disk. They contain a transformerlike component called a ballast, which can have an adverse affect on radio receivers. Transformers generate magnetic fields; I thought perhaps a ballast might, too. Two diskettes (both in their Tyvek envelopes) were rubbed along a conventional fluorescent light in my office, and also rubbed along a desk fluorescent in which the ballast and other electrical items were encased in a separate unit.

Airport security machines. Many people pass through the ubiquitous airport X-ray security machines; it would be easy to pass an attaché case through and not remember that it contained diskettes. With that in mind, I walked up to the person manning the X-ray device at the Eastern Airlines shuttle terminal at Boston's Logan Airport and convinced the security guards manning the device to put the diskette case (containing two diskettes) through their examining machine four or five times.

Automobiles. An automobile's ignition system produces high-frequency voltage to ignite the gas mixture. With the diskette in a Tyvek envelope to protect it from grease and other contaminants, I moved it over and around the ignition coil, ignition wires and engine of a 1983 Toyota Tercel station wagon.

Televisions and calculators. Color televisions use high voltage to operate the picture tube and a television has numerous transformers. For good measure, I took one of the diskettes (as always, in its Tyvek envelope), turned on an RCA XL 100 48-cm color television to a daytime soap opera and rubbed the diskette over each of the set's six surfaces.

Additionally, I keyed some figures into a several-years-old Sharp Compet CS-2108 desk calculator and rubbed the diskette all over the device.

The results? It's obvious, from my tests, that floppies are a lot more robust than is commonly thought. Two tests caused physical damage to the diskettes—the Litton microwave test, and the thermal shock test, which caused heat distortion of both diskettes. That's not surprising, since the IBM Tyvek envelope recommends keeping the disk between 10°C and 51.7°C. Additionally, the American National Standard specification for floppy disks says that they should be able to withstand operation and storage in that range and at a relative humidity of 8%–80%. The only test that resulted in a data loss (without physically damaging the diskette) was the one in which I touched the disk's Tyvek envelope with the magnet.

If all this seems silly or eccentric, remember that major US tape and diskette manufacturers have conducted little or no original research in these areas. Calls that I placed to some manufacturers indicated they were unaware of any research at all.

And my work is hardly definitive. It's always possible, for example, that a particular energy source, such as a microwave field or a computer tomography scanner might use stronger fields than the ones we used. So, it's a good idea to give diskettes the care you'd give any valuable object, such as a rare book or artifact. ‹

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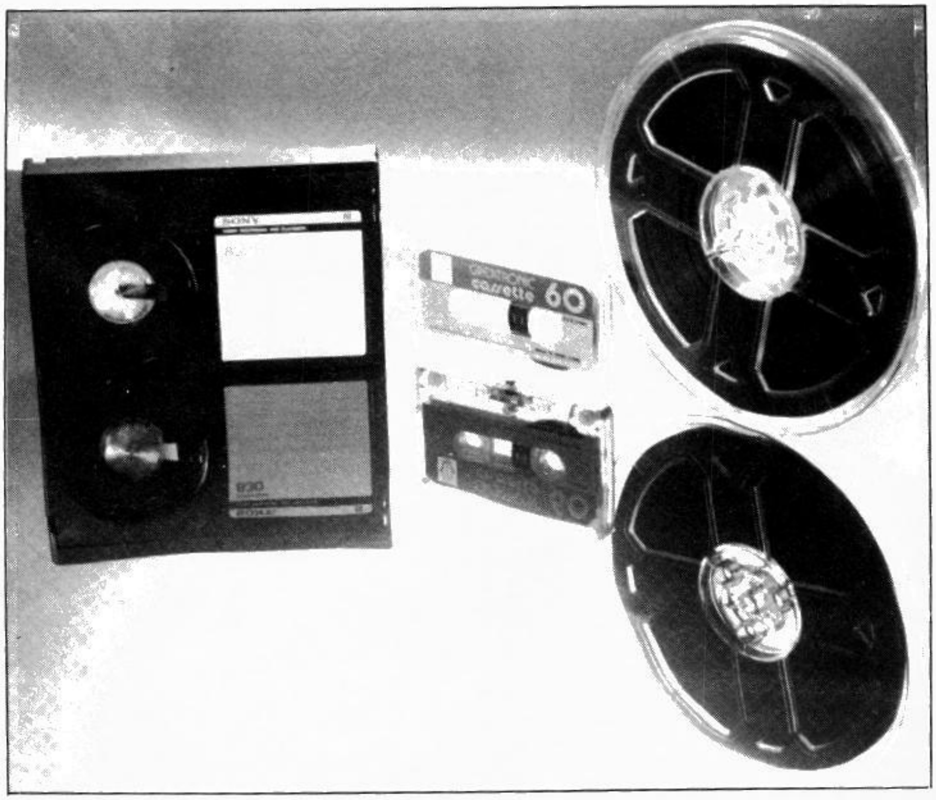
Magnetic Permanence

Audio, video and computer information is recorded on some form of magnetic storage. How permanent is it?

By Vivian Capel



Some years ago it was reported that the British Broadcasting Corporation were considering whether or not to dispose of their vast library of sound recordings on disk after dubbing them onto tapes. The decision was against, because although there would be considerable saving in space, magnetic recordings were deemed too ephemeral to trust as the medium for preserving so many historic and unrepeatable sounds.

This decision would seem to be justified by the fact that on more than one occasion broadcasts have had to be cancelled because the tape had been inadvertently wiped. Imagine if this had happened to a historic only copy. Most users of magnetic storage for sound, video and computer programs will know that this is all too easily done.

Video recordings in particular would seem to be vulnerable. Each picture field, with all its colour information and light and shade detail, is stored in a single micro-thin magnetic diagonal line much narrower than a human hair, across the width of the tape which itself is a think plastic film. Compared to that, a movie film seems positively robust.

As most readers are aware, erasure of a magnetic recording is done with a magnetic field. This is an alternating field, applied either from an erasing head or from a special bulk erasing unit. In some older cheap recorders, erasure was achieved by bringing a permanent magnet into contact with the tape.

There are fascinating and probably apocryphal stories which tell, for instance, of a credit-card company put out of business when a workman walked through the computer centre with a magnet in his toolbox, thus erasing all the magnetically stored data. An even more interesting one concerns the tax records that were wiped out by a nearby airport radar. Hope springs eternal...

Another way that the magnetization of a tape can be destroyed is by heat. Apart from the effect of heat on the plastic substrate, above a certain temperature known as the Curie point a magnetic material will lose its ability to hold magnetization. This phenomenon is made use of in some brands of thermostatic soldering irons. Here, a disk made of magnetic material is placed in the bit of the iron. In the barrel of the iron is another small magnet which, because it is attracted to the material in the bit, holds a contact shut. When the iron comes to the required temperature, which is also the Curie point of the bit, the attraction ceases, opening the contact and cutting off the heating current.

Before everyone rushes out to dispose of their video recorders and floppy disk drives, let's take a closer look at the process of demagnetization. A fully magnetized tape, like any other magnetized material, needs a certain minimum field strength applied to its surface to impress or remove magnetism. This field strength is known as the *coercivity* of the material. Some materials are much harder to magnetize (and demagnetize) than others.

For audio cassettes a figure for coercivity of about 300 to 400 oersteds (24 to 32 thousand A/m) is common; video tapes are usually somewhat higher. This means that a magnetic field of that order would be required to demagnetize a fully magnetized (saturated) tape. Of course, tapes are not recorded into saturation or the signal would suffer distortion, so a normally recorded tape would be completely erased by a lesser field than that of the specified coercivity. Even so, it would take a field of about 100 oersteds to do any damage to a recording.

What sort of fields do we find around domestic equipment? External fields depend on the current flowing in the apparatus and the number of turns if a transformer, motor winding or other inductive component is involved. It also depends on the efficiency of the internal magnetic path. For instance, a toroidal transformer is more efficient in containing the field through its core than an E-core type. Thus there is very little field external to a toroidal transformer. Equipment shielding is another factor.

A power drill running under full load has a surprisingly low external field; the field at the casing has been measured at about 10 oersteds. This is well below that which could affect a magnetic tape. House wiring and flexible power leads also generate fields, but even when carrying a heavy current these are not great. The reason is that a cable is reasonably straight and amounts to only a single turn. Further, both live and neutral are contained in the cable and this results in some degree of cancellation.

Permanent magnets are common in much equipment: loudspeakers, headphones, door catches, alarm switches, etc. Some have fields of 1,000 oersteds or more, and could certainly wipe a tape coming into direct contact.

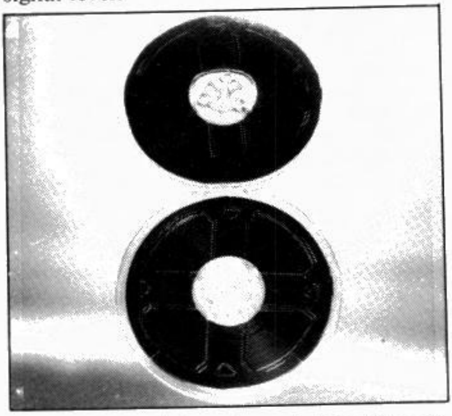
One factor that saves the endangered recordings is that magnetic fields are very strongly dependent on distance; for a single pole,the field falls off with the inverse square of the distance. However, magnets come in opposite pairs, and the field falls off even more quickly.

This has the consequence that the casing around a video cassette, for example, will be thick enough to protect it from most small magnets. The situation is somewhat different with a floppy disk, which has a much thinner case; special care is needed in the storage and handling of these.

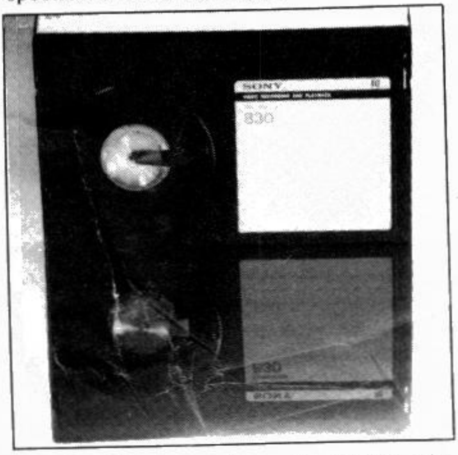
There are stories of radar installations causing erasures of magnetic recordings. The 3M Company in the US conducted some experiments to investigate this. Reels of tape were placed in a microwave oven and power applied until the reels of tape began to melt and burn. Those parts of the tape that were not physically damaged were examined and found to be unaffected. The tape had not demagnetized.

A further experiment was tried using radar. Reels of recorded tape were placed directly in front of a radar dish having a range of 250 miles. Two lots of tape were used, one at 18 feet and the other at 16 inches. These were scanned by the radar beam for 16 minutes, then removed and examined. There was no physical damage, and the recorded level was the same as before.

Next, recorded tapes were exposed to X-rays of a much higher level than those used for parcel examination. Again, the recordings were intact, with no loss of signal level.



The metal detectors at most airports do not generate a magnetic field, but measure the disturbance of the earth's magnetic field; they pose no threat to recordings. There are some detectors that are active and generate a field, but they are below 20 oersteds; in other instances, a field of up to 100 oersteds may be generated. The best answer to the metal detector problem is to request a visual inspection of recorded tapes.



Could temperature go sufficiently high to harm recordings? The Cure point for iron oxide is 450 C, or 850 F; physical damage to the tape would occur long before demagnetization. However, the Curie point for chromium dioxide is only 250 F, or 120 C; although this still seems fairly high, the tape becomes more susceptible to small magnetic fields as the Curie point is approached. One possible effect of heat is print-through from one layer to the next, especially in the presence of a stray magnetic field which in itself is not strong enough to erase the tape.

To sum up, there is not much danger to magnetic recordings in a domestic environment, provided that common sense precautions are taken, such as keeping recordings away from heat and direct contact with magnets.

Floppy Technology:

What they are & how they work

Floppy disks have a fairly simple basic design, regardless of size. A circular piece of oxide-coated, flexible mylar or polyvinyl chloride (PVC) is the source of their name: floppy disk. The mylar or PVC disk lies between two sheets of non-woven cloth or synthetic fabric, called a liner. This material serves to inhibit the friction of the disk as it spins against the outer shell or envelope. The liner also sweeps away dust and other particles as the PVC disk rotates, thus keeping these tiny objects from contaminating the disk.

The 3 1/2" micro-floppy has an outer shell of molded plastic,a much more rigid material than the flexible sheet of plastic used to produce the protective sleeve on the 5 1/4" disk. The micro-floppy disk also utilizes a special metal shutter that covers its head opening—an aperture through which a disk drive's read/write heads access the disk's recording surface—when the disk isn't being used. This shutter slides back every time you place the microfloppy into a drive to allow read/write operations.

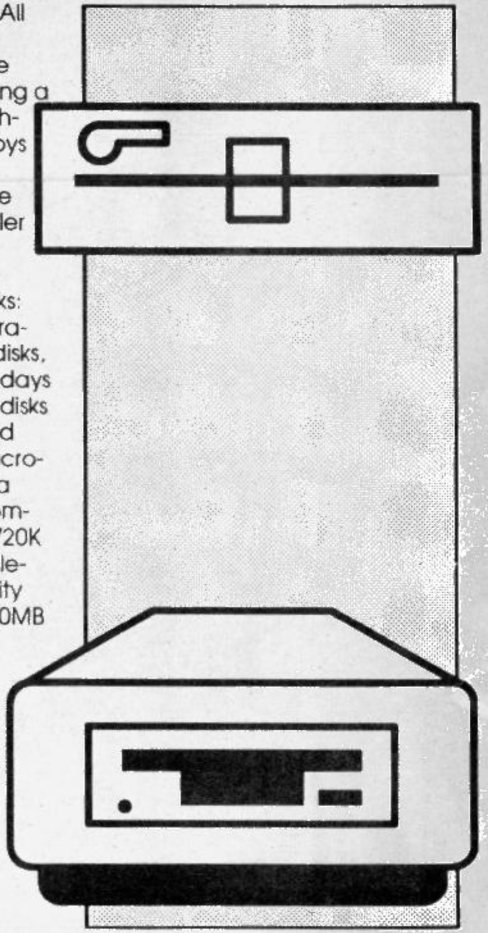
TALE OF TWO SIDES. Floppy disks store data by recording magnetic fluxes on an oxide coating that's been applied to the mylar or PVC disk. One type of flux corresponds to a binary 0, while a different one is associated with a binary 1. The pattern of these fluxes are then compared to specific data values in much the same way that the binary notation 00000101 represents a numeric value of 5. Three factors come into play when determining how much data a specific floppy disk can store: number of sides, density and Formatting.

A floppy disk can be single-sided or double-sided, meaning data can be held on either one or both surfaces of its disk. Both types of disk are made with the same methods and materials. A manufacturer certifies a disk as single-or-double-sided according to a number of quality control tests. If both sides of a disk pass these tests, the disk is certified double-sided. However, if only one side is up to scratch, the company is expected to sell that diskette for use in single-sided disk drives.

Density refers to how tightly information can be packed together on a storage medium. Higher density means that data are closer together, so the disk can hold more information. All this depends on the type of oxide coating applied to the disk's PVC. Rather than having a standard oxide coating, high-density, disks use special alloys (a mixture of metals) that allow more information to be safely crowded onto a smaller space.

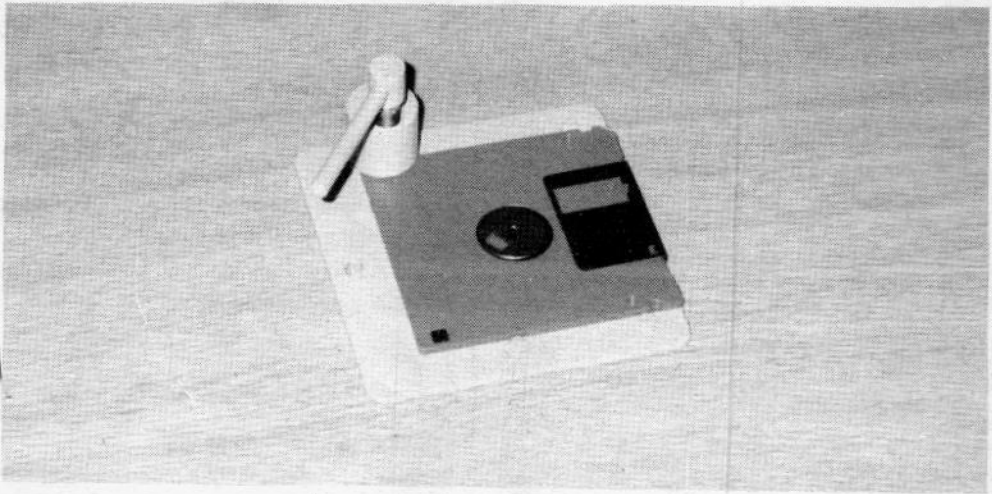
There are four types of density ratings for floppy disks: single, double, high and extra-high density. Single density disks, hark back to the early 160K days of PCs. As well, high density disks can store up to l.44megs and more of data on a 3 1/2" micro-floppy (provided you have a high-density drive in your computer). This is compared to 720K of storage on a 3 1/2" double-density disk. Extra-high density disks can hold as much as 40MB of data.

Density ratings are backward-compatible: a high density floppy can be used in a double-density disk drive. You should, however, avoid formatting a double-density disk for high-density operations. You might lose or damage your data. ❑



Disk Punchers: are they safe?

by Graeme Bennett



If you use an AT-class machine with a 3.5" drive, or a SuperDrive-equipped Mac, you may have wondered what the difference between Double Density (720k for PC and 800k for Mac respectively) and High Density (1.44MB) disks is. Most people think that there are only two significant differences: price, and that extra little hole opposite the write protect hole. Now on the market are devices that promise to save you money by allowing you to use regular double density disks in HD drives. These products, essentially specialized hole-punchers, are available by the brand names Disk Wizard (see figure 1) and Double Disk Converter. To use a regular disk in an HD drive, just cut an extra hole in the upper left corner, and initialize it with double storage capacity. Hmm. What's the catch?

There is an additional difference between regular and high density disks in the coating that magnetically stores your documents and programs on that disk. The magnetic bits in the coating of a 1.44 MB disk resists demagnetization more strongly than the magnetic bits on a 720k disk do.

changed. Recent versions of the 2-D section of some low-end CAD packages have menus and commands that rival their more expensive counterparts, although without many of the more advanced features. They can, however, still produce nearly the same end result. Learning curves tend to be shorter so you can be producing professional drawings in very short order. But instead of an advanced programing language, most low-end packages make do with macros, which allow you to string together a series of commands which can then be initiated with a single keystroke.

Low-end CAD companies are also starting to offer some fairly advanced 3-D packages that, although they can't emulate high-end CAD, are very capable of producing professional looking models.

Hardware

Hardware needs will also dictate which CAD program you will end up buying. Some low-end CAD packages will work on an inexpensive 286 with 640k memory and gray-scale monitor. The more costly high-end CAD systems need a fast 386 with lots of RAM to run properly. You will also have to consider buying a color monitor so that you can apply different colors to layers or line thicknesses to be able to differentiate between them on your monitor.

Most CAD programs also need a math co-processor without which the program would simply be too slow to use. This is because CAD stores

Scientists measure this coercivity, or resistance to demagnetization,. in *oersteds.* As it turns out, the coercivity of a 720k disk is 600 oersteds, whereas the coercivity of a 1.44MB disk is 720 oersteds. Because the higher density disk must pack the magnetic bits together much more closely, its resistance to demagnetization must be higher so that they don't demagnetize each other. Experts warn that hopped-up disks are more susceptible to data loss, a month or more down the road.

In *Chicago Computing,* George Demos writes that "for coercivity, the ANSI standard requires a minimum of 600 oersteds for high density drives. All major disk manufacturers produce their double density disks at no less than 600 oersteds. Therefore, while this more-or-less proves that the disk-punching technique works, the fact remains tha the high density disks are rated at higher coercivity level, hence, may expected to suffer less long-ter magnetic data corruption. Further evidence that the magnetic media is not, as some advertisements assert, "essentially the same" is the fact that I have personally tried to format name brand high density disks on regular-density drives without success. Whether bulk "no-name brand" high density disks are truly high density media is anybody's guess.

In our own tests, we had no trouble with disks hopped-up with Disk Wizard (aside from putting the disk into the device sideways instead of upside-down on the first try, leaving us with a useless but harmless hole in the wrong place). If you are feeling the bite of HD disk costs, perhaps one of these products is for you. Caveat Emptor.

Incidentally, disk punchers for single-sided disks (used by earlier computers such as the Commodore 64, Apple II, 8-bit Atari and other machines with single-sided disk drives), suffer from a different problem. Because they buy double-sided 5.25" floppy diskettes, the owners reason, why not use both sides? For that matter, even if a disk is only certified as single-sided, generally both sides are perfectly usable, with no difference in density, or coercivity.

To use the "other side" of a single or double-sided disk in their single-sided drive, budget-minded computerists simply take a hole punch or any number of handy gadgets that can cut a notch in the thin diskette material. The trouble is, inside a floppy disk's vinyl jacket, the actual magnetic diskette is sandwiched between two pieces of fuzzy material, similar to the tiny bristles of a Universal Lint Removing Fantastic Brush, or whatever those things they sell at K-Mart are called. The tiny bristles catch the dirt, dust and stray magnetic oxide particles and sweep them in the direction of the spinning disk. Unfortunately, when the would-be thriftster flips the disk over, the brushes are suddenly sweeping in the opposite direction, and all this debris becomes dislodged, and ends up you-know-where. Whups.

ADDENDUM TO CARING FOR DISKETTES

In preparing for publication the article "How to Care for Diskettes," in the November 1978 issue, one page of the original manuscript was inadvertently omitted. As a result, some additional information is necessary to clear up some misconceptions that may have been created due to the omission.

In small diskette systems, the type most popular with computer hobbyists, the actual diskette rotates within a protective jacket. After the diskette is loaded and the loading door closed, the internal mechanical arrangement forces a pressure pad to "squeeze" the flexible diskette to the head. In a sense, this produces a "dimple" in the relatively soft diskette at the point of contact.

Depending on the diskette and drive used, the relative head-to-diskette speed can reach about 8 mph. Thus, if there are any scratches on the head or if any foreign substance gets on the diskette so that it is forced between the head and the soft diskette surface, minute physical grooves can be cut creating data dropout. Figure 2, shown for what is called a "flying head" disk system, dramatically illustrates how foreign matter on the surface can create data loss on the disk.

During diskette operation, the pressure pad on the other side of the diskette "scours" the surface. It is possible for the pad to accumulate a layer of relatively hard dust, or even minute (metal) oxide particles scraped from the diskette—in most cases, even though only one side of a diskette is used, both sides are coated with magnetic oxide.

After some hours of use, the tiny hard particles adhering to the pressure pad can scratch the diskette surface. If the other side of the diskette is to be used, the rotation is then "backwards," which can cause surface damage and result in loss of data. It is probably for this reason that no small diskette drives use both sides of the diskette.

It should have been stated at the beginning of the "Foreign Matter" section that the mechanical data was for a large disk system whose diameter and drive speed are much higher than those of a small diskette. Thus the rpm is much higher. However, the information on the damage that can be caused by foreign matter—including smoke particles, dust, and grease—holds true for all diskettes.—*Les Solomon, Technical Director.*