

# Memory and Hard Disk: What's the Difference?

A COMPUTER IS A MACHINE that can manipulate information (called *data*) according to a prepared set of instructions called a *program*. In order to do this, it has to have a place to store both the data and the program. There are two places to store things in a computer: *memory* and *hard disk*. If you use a computer, you've probably heard these two terms from time to time; but unless you're a computer specialist, you've probably never encountered a clear explanation of the difference between them. This paper describes what both of these parts of a computer are in physical terms, how they differ, and what they do.

## The Central Processing Unit

The heart of your computer is called the *central processing unit*, or CPU. The CPU does the actual work of the computer. Specifically, it is designed to carry out various simple operations on blobs of data, in accordance with a sequence of instructions contained in a program. Another name for the CPU is the *microprocessor*.

In physical terms, the CPU is a tiny, flat, rectangular *chip* of silicon, and is somewhat smaller than a postage stamp. The chip contains nearly a hundred million microscopic transistors. It is enclosed in a matching flat ceramic box bristling with gold-plated connecting pins that lives deep inside the case of your computer. The box is hidden beneath the fins of a metal radiator and fan that are necessary just to keep the CPU from melting (the CPU consumes about as much electricity as a light bulb—which is a lot for something smaller than a postage stamp).

The data manipulated by the CPU, as well as the program that provides it with instructions on which manipulations to perform, are stored in the computer's electronic memory.

## About Memory

Memory is a part of your computer that temporarily stores information needed by the CPU. The CPU cannot do its job without it. Physically, memory consists of tiny flat boxes that look like cyber-centipedes, arranged on rigid flat sticks that are installed inside the computer. These boxes contain computer chips similar to the chip that forms the CPU, except that these chips contain memory devices instead of CPU circuits. Virtually all computers come with one or more memory sticks pre-installed at the factory, but most computers let you add more, if you wish.

Memory is just what its name implies: it is a part of your computer that “remembers” things for the CPU. The CPU needs something to work on while it is running, including both the information it is supposed to be manipulating (a business letter or spreadsheet, for example) and instructions telling the CPU what to do with that information (usually referred to as a program or software). The memory of your computer holds these things, and provides them to the CPU (at blazing speed, of course) whenever the CPU asks for them. In addition, when the CPU calculates something new (such as the result of some calculation in a spreadsheet), it immediately stores it in the computer's memory.

The memory of your computer has one annoying characteristic: everything stored in that memory is forgotten when you turn the computer off. This characteristic makes a computer with just a CPU and memory pretty useless, because it is impossible to keep anything permanently (unless you never, ever turn the computer off). Fortunately, there is a remedy for this problem, and that remedy is the hard disk.

## About the Hard Disk

A hard disk is a part of every modern computer that allows the computer to store information permanently. A hard disk is like a tape recorder or dic-

tating machine: you can store information on your hard disk, and then get it back later, at any time. You can also erase things on the hard disk and replace them with something else.

The hard disk is essential to every computer nowadays because of the above-mentioned nasty little drawback of computer memory, namely, the fact that computer memory is forgotten when the computer is turned off. By recording things on the hard disk before turning the computer off, it is possible to retain them safely until the next time the computer is turned on.

You might wonder why a computer even bothers with memory if it can store things permanently on the hard disk. The problem is speed, and space. The computer's memory isn't very permanent and doesn't hold very much information, but it is blazingly fast, and that's what the CPU needs if it is going to operate at anywhere near its maximum speed. This being so, every computer uses memory to remember things rapidly and temporarily, and then puts them on the hard disk if they have to be kept around permanently.

## How They All Fit Together

The best way to describe how the CPU, memory, and the hard disk work together is by way of analogy with your own brain (which is a kind of computer, although comparing a computer to a human brain is rather like comparing a sleeping bag to New York City). Think of the CPU as your own brain, think of the computer memory as your own memory, and think of the hard disk as a huge card file on your desk.

Now, in order to think about anything, you need to know about it first. This means that you have to put some kind of information in your memory, just like a computer. Similarly, whenever you do any kind of calculation or solve any kind of problem, the results of your efforts are in your memory.

Of course, your memory is neither infinitely large nor perfect, so you need something to help you keep track of things permanently. The card file on your desk can serve this purpose. The card file is your own "hard disk," if you will.

Suppose you need to add a column of numbers together, and suppose that these numbers are in your card file. The first thing you need to do is search through the card file and look up the num-

bers. Next, you need to add the numbers together using your head. Finally, you need to write the results down somewhere (such as back in your card file again) in case you forget them.

This process has an exact analogy inside your computer. Looking up the numbers to be added together is the equivalent of the computer looking for something on the hard disk and putting it into its memory. Adding the numbers together is the equivalent of the computer's CPU adding the numbers in memory together and saving the result in memory. Finally, writing the answers in the card file is the equivalent of the computer writing the results of its calculations onto the hard disk.

You may have realized by now that you have an important advantage over the computer, in that you are never "turned off" at the end of the day. This means that your memory is never completely erased. You can memorize some things permanently as a result. However, a computer doesn't have this option; every time it is shut off, it forgets everything in its memory, and so anything that it hasn't saved on its hard disk at that point is lost forever. Thus, computers are much more diligent about writing information on their hard disks than you are about writing things in your card file. You'll probably never experience total amnesia, but a computer experiences this every time you flip the power switch (in fact, just pressing the reset button on the computer, if there is one, will also produce total amnesia in the computer's memory). If your own brain and body worked like a computer, you'd have to learn how to walk and talk all over again every morning after waking up.

By now it should be clear that memory and the hard disk each have their places. Memory is essential in order to allow the computer to "think"; and the hard disk is essential if the computer is to recall what it was doing the last time it was used.

The functioning of your computer's memory is invisible to you; the computer can manage that all on its own. However, you do have to advise the computer about what information to save permanently on the hard disk, and you also have to decide how you want things organized on the hard disk. This is what we will discuss next.

## Organizing Your Hard Disk

Now that we've covered the details of both memory and the hard disk, it should be easier to understand how it is possible to save your work for later, and how it is possible to accidentally lose your work, if you aren't careful.

Whenever you open a document or start a new document or project on your computer, the computer will automatically set up all the necessary things in memory, without any help from you. While you are working on your document, all the changes, deletions, and additions you make are stored in the computer's memory automatically. You don't have to worry about any of this. However, at some point, you'll usually want to save all your work somewhere so that you can return to it hours, days, or even years later. At that point, then, you need to know how to tell the computer to save your work permanently on the hard disk. If you just turn the computer off without saving your work, it's gone—you'll have to start everything over from scratch the next time you use it. But if you tell the computer to save your work on the hard disk, it will be there the next time you need it, and you can just tell the computer to open it again.

The magic concepts you need to remember when saving and looking for things on your hard disk are those of *files* and *folders*.

Everything on your computer's hard disk is organized in files. Files are so called because they are very much like electronic versions of the paper files you keep in your file cabinet. For example, a hand-typed annual report might be stored in a file in your file cabinet, whereas an annual report that you prepare with a word-processing program in your computer will be stored as a file on the computer's hard disk.

Unlike memory, the hard disk isn't automatically managed by the computer. It's up to you to decide how you want to organize things on your hard disk. When you create a document and save it on your hard disk, you save it as a file, and you give the file a name (which you choose), so that the computer can identify it later on. You also need to tell the computer where to put the file on the hard disk. This latter task involves the concept of folders, so we need to explain those.

A folder on your hard disk is very much like a folder in your file cabinet. It can hold one or more

files. Every folder has a name (which you choose yourself). You can have as many folders and files as you want, as long as you have space left on your hard disk. You can create folders (and files, for that matter) whenever you want, and you can erase them, too, at your discretion. If you erase a folder, though, everything inside of it disappears as well. (If you erase a file, that file disappears, but other files in the same folder are unaffected.)

Folders on the hard disk of your computer are a little fancier than folders in a file cabinet, because, unlike a file cabinet, a hard disk can hold folders inside folders. In other words, you can create a folder and put a couple of files in it, but you can also create another folder inside the first folder, and put more files inside of that. This is a bit like putting a manila folder inside another manila folder, except that it's hard to fit manila folders inside each other, whereas putting folders inside other folders on a computer is easy. In fact, you can create as many levels of folders as you want on your computer. How you organize the folders is up to you.

As an example, you might create a folder called Payroll, and put spreadsheets or other documents related to payroll inside of it (see Figure 1). However, if you had twenty employees, you could also create a subfolder for each employee within the Payroll folder, and give each folder the name of the employee. So, inside the Payroll folder, you'd not only have documents related to payroll, but you'd also have more folders called John Smith, Jane Doe, etc., for each employee, in which you could save other files on a per-employee basis. Of course, this is just an example, but you get the idea. How you actually set up folders on your hard disk is entirely up to you. The computer doesn't really care.

There is one folder, called the *root folder*, that exists on every hard disk. The computer creates this for you. It doesn't have a name. You create all your folders and files inside this root folder. You can also create additional levels of folders inside folders, if you wish. You can delete all the folders and files you create yourself, but you cannot delete the root folder. The computer needs that folder so that it can find all the other folders and files that you create.

## Using and Saving Files

Now that you understand how things are organized on the hard disk, it's important to understand what causes things to be saved in files, and what doesn't. Remember, when something is saved in a file on the hard disk, it's safe—it won't be lost when the power is turned off. Conversely, anything that hasn't been saved will disappear as soon as you shut off or reset your computer. This is why it is very important that you know what causes things to be saved on the hard disk.

When you open a new document (a letter, a spreadsheet, whatever) it is stored in your computer's memory. It stays in the computer's memory until you tell the computer to save the document in a file, at which point the computer copies the document in memory to the hard disk, with the file name that you specify, in the folder that you select. At that point, you have a copy of the document open in memory, and a copy saved on your hard disk. If you don't ever save the document in a file, it will never exist outside of the computer's memory, so it will disappear as soon as you turn the computer off.

If you make changes or additions or any kind of modification to an open document, those changes are made to the copy in memory only, and they are not saved to the hard disk until you tell the computer to save the document. Furthermore, after you've saved the document, any additional changes are still kept in memory only, so each time you make new changes to a document, you need to save it again when you are finished with the changes, or they will be lost when you turn off the machine. If you make changes to an open document after saving it, and you then close the document, and you say "no" when the computer asks if you want to save the document, the changes you made after the last time you saved the document will be lost.

When you first create a new document, there is no file on the hard disk to hold it. When you try to save the new document for the first time, the computer will ask you to tell it what file name you want to use to create a file on the hard disk to hold it, and it will give you the opportunity to select the folder in which you want to create the file. Thereafter, the computer will know where the file is, and when you save the document again, it will automatically save the document in the same file.

When you open an existing document, the computer reads the document from the file that contains it on the hard disk, and puts a copy of the document in memory so that you can view it and change it (remember that the computer's CPU can't do anything with a document unless it is in memory). Any changes you make are made in memory only; you must tell the computer to save the changes if you want them to become permanently recorded in the document's file on the hard disk.

When you close a document, if you have made any changes to the document since you last told the computer to save it to the hard disk, the computer will ask you if you want to save the changes. If you say "yes," the changes will be recorded in the document on the hard disk; if you say "no," the changes you made since the last save will disappear. If you haven't made any changes since the last save, the computer won't ask anything, since there is nothing new that has to be permanently recorded. If you close a brand new document that you have never saved before, the computer will not only ask if you want to save the changes, but it will also ask you to select the file name and folder in which you want to save your document (if you answer "yes" to the computer's question).

## Deleting Files and Folders

Just as you can create and modify files, you can delete them, erasing them forever from the hard disk of your computer. If you delete a file, its contents are gone forever; you cannot bring the folder back into existence once it is gone. Furthermore, if you delete a folder, not only is the folder erased, but so are any files or folders it contains. Because of this, you should never delete a file or folder unless you are absolutely certain that you never want to see it again.

## Preventing Disasters

Hard disks are extremely reliable, but not perfect. Every once in a while, they fail. If they fail, all the information you have stored on them is lost. For this reason, you really need to take backups of the files on your hard disk if you want to be completely protected.

A backup is simply a copy of important information on your hard disk. For example, you can copy a file that contains an important document from the

hard disk to a floppy disk inserted into your computer; in this way, if the hard disk ever breaks, you'll still have a copy of the document on the diskette.

In practice, most backups involve lots of files, not just one. For example, you could create a folder on your hard disk in which you store your most important documents. At regular intervals, you could copy all the files in the folder to diskettes, and put the diskettes in a safe place. In this way, if your computer were ever to burn down or explode or something, you'd still have safe copies of all your most important documents. It's really no different from making photocopies of important paper documents and putting them in a safe place.

In its most advanced form, a backup involves copying the entire contents of the hard disk to some other place, such as diskettes, a cassette tape, or something similar. Since modern hard disks hold the equivalent of hundreds or thousands of diskettes, most backups of this kind are carried out with a special program that writes all the information to a cassette tape, a CD, a special kind of optical diskette, or something similar.

The details of backup methods are outside the scope of this paper; however, backups are very important, and they are your only protection against a failure of your hard disk. If you are a home user, it may be sufficient to just back up the most important files you have on a few diskettes. If you are an office user in a large company, your local computer support group may be able to back up your machine automatically for you at regular intervals, or they may be able to advise you on the best way to perform a backup. Finally, some people prefer to take their chances and never back up anything, but we cannot recommend this approach.

One final note: If you are running your own small business and your computer is important to that business, you must take backups regularly. Many small businesses (and not-so-small businesses) have failed only months after a computer failure, simply because they never bothered to back up the essential data they kept on their computers. If you are running a small business, back up everything on your computer frequently—you will never regret it. 