THE COMPUTER CORNER

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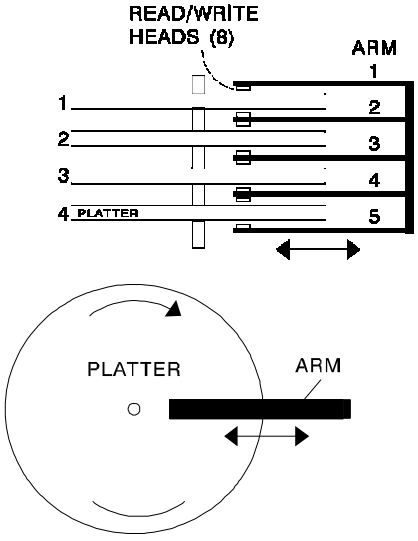
Well, it is 2014. Exactly 20 years ago, I wrote “A GOOD ONE IS NOT HARD TO FIND”, about the workings of hard drives. Interestingly, it is still accurate, though a few of the details relating to differences in size of modern drives have changed and it does not describe today’s SSD drives (solid state drives with no mechanical parts). But the article does accurately describe how a hard drive works. I thought it might be interesting for folks who did not see the original article (some were not yet born!), so here it is, exactly as printed in 1994.

No. 14, September 1994 **A GOOD ONE IS NOT HARD TO FIND**

Of course, this title's twist on Mae West's famous comment describes that marvel of modern technology, the hard drive, also known as a fixed disk or Winchester drive (the latter title was given to it when the first model, a 3030, reminded someone of the famous 30-30 rifle of the early west). Although these gadgets are simple in concept, they just have to be about the most complex mass-produced mechanical/electronic device in history. I am truly amazed that they even work, let alone reliably. But they do work, and very reliably, too (unless you have failed to back up your data, in which case the gremlin that lives in each hard drive notices that fact and quickly causes a non-recoverable crash). Let's see if I can tell you how they work, for those who have never opened the case of a defunct hard drive. (You should, if you get the opportunity; it is a good learning experience. But make sure it is really no good. If in doubt, give it to me to check out; I will be glad to trade you a junker to open!)

Imagine an old jukebox that plays records. Remember those antiques? There was a stack of records in view, and when you put in your coin, a mechanical arm would remove your selection from the stack and drop it on the turntable. Another mechanical arm holding a needle would then move over the rotating platter and gently lower itself until the needle settled into the groove. Voile, music!

The hard drive is not too much different. A stack of several platters, each about the size of a 45 rpm record or a little smaller and each separated from its neighbor by perhaps 1/4 inch, spin constantly (but at around 3,600 rpm). A mechanical arm moves between each pair of platters. Each arm holds two tiny read/write heads, one of which floats near the platter above the arm, and the other of which floats near the platter below the arm. That means, if your hard drive has four platters, there are 5 arms holding 8 heads, as is shown in the diagram.



Sometimes the published drive specifications show it has one less head than it should (7 heads for four platters, for example). That is because one platter surface is sometimes set aside to hold head positioning data that the controller uses to move around the drive. So, the head is really there, but it is not usable by you to hold your data.

There are marked differences, though, between the way the needle gets "data" from a phonograph record and the way the read/write heads get data from (or write data to) the hard drive. First, the read/write heads do not normally contact the platters. If they do, it is called a "head crash" and the platter surface is most certainly damaged where contact was made. Normally, the heads float on a cushion of air a few micrometers above the platter. I have seen the analogy that the spaces involved are akin to a 747-jet plane flying 6 inches off the ground! That is why the smallest speck of dust inside a hard drive housing can wreak havoc if it comes between a head and a platter; the speck of dust is like a 3 foot boulder lying on the ground when the 747 goes by. It can simultaneously damage both the head (the 747) and the platter (the ground below). Hard drive housings must never be opened, or the "ground" will be strewn with boulders. They are manufactured in a special clean room where dust particles are not present.

Another difference concerns the tracks of data on a hard drive platter and a phonograph record's groove. A phonograph track is spiral; that is why the arm and needle wind up near the center of the record when it has finished playing. On a hard drive, the tracks are not spiral; they are circular. The word "track" has even fallen out of use when referring to hard drives, probably partly because it might be taken to mean a spiral pattern (though the term is still in use when referring to floppies). The newer (and more descriptive) word is cylinder. A typical 20-megabyte hard drive will have two platters, four heads (held by 3 arms) and 615 cylinders. I just checked a large hard drive database and found 41 different drives with those specifications, including the famous Seagate ST225.

Each cylinder is further subdivided into short arc-shaped sectors. A 20 meg drive will typically have 17 sectors per cylinder. Each sector holds 512 bytes of data. Now lets do some arithmetic: 4 heads X 615 cylinders X 17 sectors X 512 bytes. My calculator comes up with 21,411,840. If I divide that number by 1024 (there are 1,024 bytes in a kilobyte, not an even 1,000), my calculator says 20,910k. That translates into 20.910 Mbytes, rounded to 21 Mbytes. Yep, it works out just right.

There you have it. From a mechanical standpoint, a hard drive is a glorified stack of phonograph records, with circular (not spiral) magnetic "grooves". Ah, but the electronics to read from, write to, and control the drive - that's another matter and very complex, indeed. Amazing that it all works so well! Happy computing.

"Drill for oil? You mean drill into the ground to try and find oil? You're crazy!"

Response from drillers that Edwin L. Drake tried to enlist for his project to drill for oil in 1859.