MAGNETIC STORAGE OF INFORMATION

Many machine tools, entertainment devices, and information-processing devices require the storage of information. Sets of operating instructions for modern drill presses and lathes are frequently stored with the machine in order to repeat operations over and over again. For decades, computers have used external storage devices to hold data and control programs for later use or to interact with specific processing operations. The most flexible and cost-effective medium to store large amounts of information for these applications is by magnetic tape or magnetic disc.

After studying this unit you will be able to:

- Describe the process of storing information on a magnetic medium.
- Identify characteristics of magnetic tape and disc storage systems used with machine tools and computing devices.
- Trace the history of magnetic storage devices used with machine tools and computing devices.

The story begins . . .

External storage mediums for machine tools and computers have gone through a number of evolutionary changes since punched cards and paper tapes were used to store simple codes. During the late 1950s, a fast and efficient storage medium that could be reused was found in magnetic tape. A number of years later, the magnetic medium was placed on a disc to overcome some disadvantages of the tape. Basically, the storage of data and control information on a magnetic surface for machine tools and computers work on the same principle as storing music on a cassette tape. There are, however, enough critical variations in the storage and retrieval process and the equipment to warrant a look at contemporary techniques and devices.

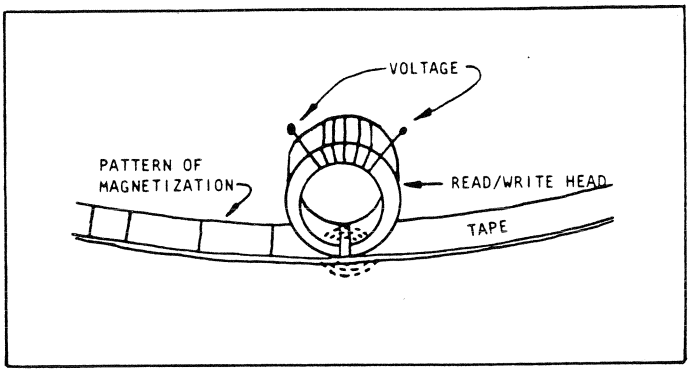
MAGNETIC TAPE

Early tape storage systems were reel-to-reel. If you have ever seen a reel-to-reel tape recorder begin to spill tape in ever-increasing lengths across a room before someone could turn it off, you can appreciate one of the dangers of this format. As machine tools and computers became smaller and smaller, this means of storage did not seem to be very practical. The reel-to-reel format was also too large and expensive. Thus, the tape format that evolved was the cassette or cartridge.

The cassette is distinguished from the cartridge tape format by the manner of tape movement within the case. The cassette permits tape to be driven in either direction with tape taken up or removed from both reels. The cartridge requires tape to be driven in one direction only. Because the cartridge tape is an endless loop, there is no need for rewinding.

The flexible magnetic tape used in cartridges and cassettes is inexpensive and durable. The tape consists of a base material of polyester. This is a relatively stable medium because it has good tensile strength and can stop and start repeatedly without breaking. The polyester also reduces the tendency to shrink or stretch when tension is applied. The polyester is made in wide ribbons coated with an iron oxide surface that is very sensitive to magnetic fields. The polyester base with the magnetically sensitive coating is then slit into tape widths and applied to take-up reels. The cassette drive is the most important element of the mass storage capability of microcomputer systems that use magnetic tape.

The two critical functions of the cassette tape drive are the reading and writing of information onto the tape and the tape transport mechanism. The magnetic head in a cassette tape drive is the device that actually records and retrieves information from the magnetic tape. The iron oxide on the surface of the tape comprises many needle-like magnetic particles. The particles are not aligned in any particular order when the iron oxide coating is applied to the tape's base material.



Let's take a close look at what occurs when information is recorded onto a cassette tape. In order to store information on the magnetic surface, it is necessary to align the magnetic particles into a pattern. The magnetic head aligns the magnetic particles to represent zeros and ones by using a tiny electromagnet to create a magnetic field.

The conventional magnetic head consists of a split ring-like substance, wound like a coil. The gap on the front of the head is where the magnetic field is generated when current is applied to the winding.

When the cassette drive is in the record mode and information is being stored on tape, data in the form of binary signals are sent to the windings around the core. As the signals activate the magnetic core, a magnetic field is generated at the gap of the core. As the magnetic tape presses the head, this magnetic field aligns the particles on the tape in a form that can later be distinguished as the binary code.

STANDARD SIZES OF MAGNETIC STORAGE MEDIUMS FOR SMALL COMPUTER SYSTEMS

DISCS		TAPE	
Rigid	8"	Cassette	1/8"
Floppy	8"	Cartridge	1/4"
Rigid	5-1/4"	Cartridge	1/2"
Minifloppy	5-1/4"		
Semirigid	3-1/2"		

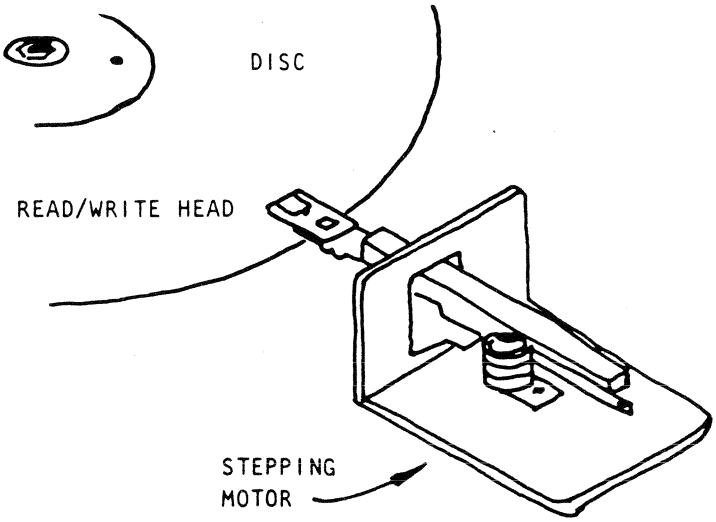
Each character, such as the character "A" followed by the character "B," followed by the character "C," and so on, follows an order indicating that a character serial technique is used. It is this very recording technique of bit serial, character serial, that the magnetic tape cassette drive storage system uses to record each track of the tape. This method ensures more accurate information retrieval because the alignment of read-write heads is not critical. This tolerance is the reason why cassette tape drivers are so useful as an inexpensive storage medium.

MAGNETIC DISC

The physical characteristics of the magnetic disc medium, as well as the characteristics of the disc drive, are engineered to provide efficient information storage and transfer. To understand how data are stored and retrieved on a magnetic disc, it is necessary to investigate what the read/write head is and how it works.

The reading and writing of data on discs are accomplished by a small, cylindrical device similar in principle to a tape recorder. The head is at the end of a movable arm. The arm, powered by an electric motor, slides in and out along the same axis. This permits the head to be positioned above any of the tracks of stored data that are on the surface of the disc. The movement of the head is controlled by the disc controller card or circuit. Accurate positioning of the head, in relation to specific tracks of data, is extremely important.

Once in position to read or write data, the head is activated. To read data, the head must be able to discriminate between patterns of magnetic fields represented by the arrangement of magnetic particles. The head of a floppy-disc storage system actually makes contact with the surface of the disc. This is necessary because the flexible nature of the disc would create uneven distances between the head and the disc as it rotated. The head moves up and down with the disc to maintain accurate data transfer.



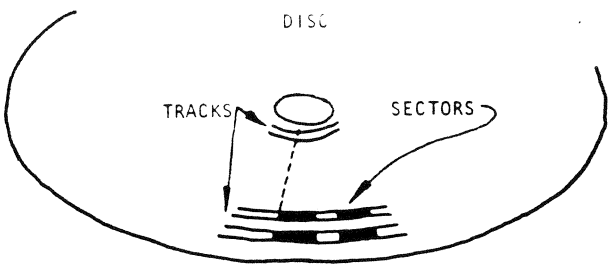
The more traditional rigid disc is stable enough to maintain a uniform rotational distance from the head. This enables the head to float on a cushion of air between the head and the disc surface. This type of head configuration is commonly referred to as a "Winchester" head. The Winchester-type head design has been manufactured by many firms since its introduction in 1973.

Disc storage systems differ from manufacturer to manufacturer. During the early 1980s, the Apple II microcomputer system recorded data onto 5¼ inch floppy diskettes which contained 35 concentric bands called "tracks." These tracks were numbered from the outermost to the innermost track. When the read/write head needs access to a certain track on the diskette, the head moves back and forth into position. Each track is divided into numerous sectors.

Now back to the rotating disc. As the sectors pass beneath the head, one after another, the head fills each sector with information by alternating the arrangement of magnetic particles. If a sector can hold up to 256 bytes of information, then 256 bytes are stored at one time exactly filling one sector.

Because the disc is spinning when the disc drive is activated, the head will store information in the first vacant sector it finds. This frees the head from having to search for a particular starting point and track through sectors until it finds an empty one. That process would have to be repeated each time storage occurs. As the method of random storage continues, the head may search for empty sectors on any track to continue to store information. This process continues until all sectors have been filled.

The disc operating system records the location of each data file according to the track and sector it is stored in while it stores the information. This creates something of a directory of tracks and sectors. This track sector directory is also stored in an empty sector, usually located in one of three tracks reserved for use by the disc operating system. These procedures enable the random storage and access of information to occur very quickly—a major characteristic of disc storage mediums.



Now, try a SELF-QUIZ

On your own sheet of paper, write your answers to these questions.

1. What were the major disadvantages of reel-to-reel magnetic tape storage units for machine tools and computers?
2. The characteristic of magnetic tape to store information one character/bit after another is referred to as _____.
3. Magnetic disc mediums are considered to be random access in terms of storage and retrieval of information. This is because the format of most discs includes some type of _____ and _____.
4. What happens to a magnetic surface when information is stored?
5. What are the two physical forms of magnetic discs for machine tools and small computers?

Turn this page upside down and you will find the answers. Go back and read again about the ones you missed.

THINGS TO DO

- Create a "click" track on a reel-to-reel magnetic tape by laying out the tape and passing a magnet across the width of the tape at different lengths (2, 3, 6 . . . inches).
- Using a specific microcomputer, determine the format of the external storage medium including tape or disc tracks, sectors, or channels. Try to create a program that will store your name in a given location only.
- Using paper/tape from a desk-top calculator, design and construct a device that will control a low-voltage electrical circuit. Consider using punched holes in the tape as a machine code. Can you make your device automatically turn on and off a power tool?

FOR FURTHER STUDY

Bethune, R. W. Getting along with cassette storage. *Popular Computing*, 1983, 2(8), 190–192.
Waite, M., & Pardee, M. *Your own computer*. Indianapolis, Ind.: Howard W. Sams, 1981.
White, R. M. Disk-storage technology. *Scientific American*. 1980, *243*(2), 138–148.

ANSWERS
1. too large and expensive
2. bit serial, character serial
3. track, sector
4. an alignment of magnetic particles into specific patterns represents information
5. rigid and floppy