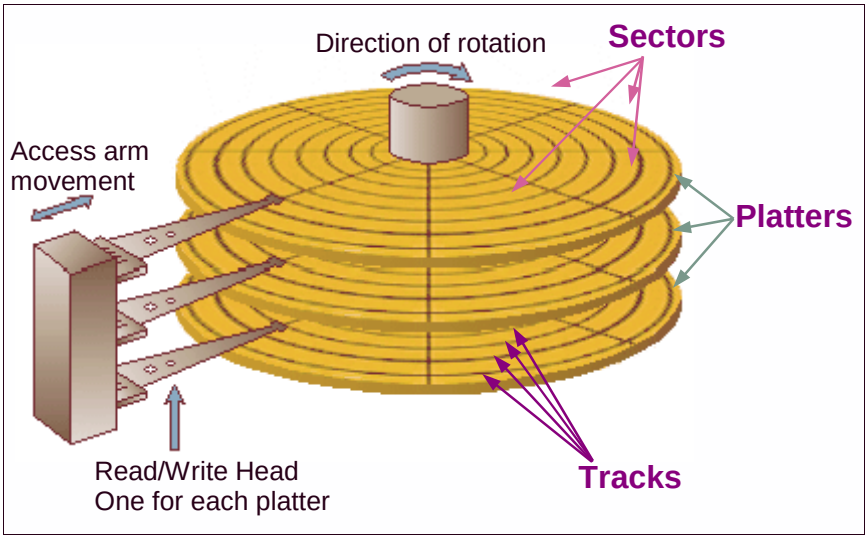
Secondary Storage

Goals and Objectives

The course module provides a summary of secondary storage devices. Students are introduced to the mechanisms and use of some of the secondary storage devices available today for microcomputers.

Hard Disk.

Technically microcomputer hard disks are called Winchester disks (from the origins when the first hard disks were termed Winchester) or *fixed disks* as they are a pack of disks permanently sealed inside the drive.



A hard disk is composed of platters which have a surface coated with metallic oxides spinning constantly. Read/Write heads move over the platters similar to the old vinyl records reading and recording data on the surface of the disk platter. The read/write heads do not actually touch the platters but float above the surface and magnetically read and write data to the platter.

Because of the microscopic size of elements being dealt with, the Hard Disk is sealed in a case to minimise intrusions of dust and the effects atmospheric changes have on the internal components. The improved materials, sealing of hard disks contributes to their higher reliability than floppy diskettes.

The faster the platter spins, and the read/write heads move in and out, the more data can be read and written to/from the disk platter. Increased volume of data and the higher speed of retrieving information from the hard disk gives hard disks an advantage of floppy diskettes.

Hard Disk Advantages: Speed, Size, Security/Integrity.
Hard Disk Disadvantages: Higher Cost

The disadvantage of storing everything on a hard (fixed) disk is the need to share data/programs. A network allows for sharing files within the network but transferring data/programs between unconnected machines is difficult if it requires you to take the hard disk out and put it onto the other machine.

A Name - by any other name

Each disk drive on an IBM PC Compatible computer is assigned (or given) a letter ('drive letter'). Historically the first two letters (A and B) have been used for the only disk drives available for IBM PC microcomputers at the time, floppy disk

drives. Drive letter C, later became the first letter used by the Hard Disk Drive. Additional Hard Disk drives added to a microcomputer gain, or get the next drive letter, and so on.

Floppy Disks.

Diskettes, often called *floppy disks*, are single platter plastic disks in a plastic jacket. The plastic jacket is quite hard on modern 3½" diskettes, but they are nevertheless still classified as floppy disks, not hard disks as some people think.

Floppy diskettes are usually inserted into a floppy disk drive with the label face-up. For 3.5” floppy diskettes this side of the floppy diskette is usually marked with a HD symbol.

Floppy disks are characterised by several parameters:

Size, the diameter of the disk.

Floppy diskettes were originally developed along with the USA computer industry and the US influence continues in the imperial measurements for floppy disks.

Early machines using floppy diskettes for file storage used 8” disks but there were so many different 8” disks, and different ways of recording onto the disks that few machines having 8” disk drives could read disks used by another manufacturer’s computer.

5¼" floppy diskettes.

The first widely used disk size was the 5¼" diskette. The drives and controllers for 5¼" diskettes were cheaper than the 8” drives and more reliable so the fledgling (young) microcomputer industry standardised on 5¼" disks.

Initially each manufacturer developed their own ‘standard’ for how information is layed out, or stored on the floppy disk. Unfortunately this meant that disks used by different computers had the same problem that 8” drives had, not being compatible between different machines.

When IBM released their IBM PC they popularised PC-DOS an operating system licensed from Microsoft. Microsoft had created their own disk layout which they licensed to other computer manufacturers and subsequently became the standard format for laying out information on floppy disks. As companies such as Compaq, Digital, Philips developed their own computers they licensed Microsoft’s operating system and in so doing they adopted Microsoft’s design for using floppy disks.

3½” micro-floppies

In 1987 IBM standardised its new IBM PS/2 range of computers on the newer 3½” micro-floppy developed by Sony Corporation. The floppy disk and disk drive were originally introduced into the microcomputer market by Apple’s Lisa and Macintosh computers, Atari ST’s and Commodore Amigas, but it was IBM’s introduction of machines with 3½" disks that sent software suppliers to providing programs on 3½” disks.

The standard MSDOS format was now available on 3½” disks and the manufacturers copying IBM’s design also used the MS-DOS disk layout. The prolif-

eration and importance of the MS-DOS format is evident with most microcomputer operating systems supporting 3½” also providing direct support for MS-DOS 3½ disk format.

The 3½" floppy disks higher capacity (than the 5¼”) and the greater durability of the 3½" casing was adopted by hardware and software suppliers. Today, the standard size of floppies is the 3½".

Single or double-sided.

Floppy disk drives available today read and write data on both sides of the diskette with read/write heads on each surface of the disk. The first designs of disk drives only supported reading one side of a disk at a time.

Density - the number of bytes that can be stored on each track.

As technologies improved, more and more magnetic particles could be packed onto the same area of space on the floppy diskette and correspondingly read by the disk drive. This increase in density changed the amount of data a diskette could contain.

Size	Density	Tracks per Side	Sectors	K per Inch of Track	Total K
5¼"	Double	40	9	2.5	360
5¼"	High	80	15	5	1,200
3½"	Double	80	9	2.5	720
3½"	High	80	18	5	1,440

The density of floppy diskettes for IBM PC Compatibles allowed 1.25 kilobytes of data to be stored per inch of track. As disk drives and disk technologies were improved disks that could hold 2.5 kilobytes per inch were released and called (logically) *double density* disks.

Technology improvements continued and soon *quad density*, later called *high density* disks and drives were released. The original low density disks have now disappeared, leaving only double and high density disks. This results in some confusion for new users as the name double density seems to imply it holds more than the other current type - high density.

High density disks are usually labelled HD. 3½" high-density disks and can hold up to 2.00MB of data but are formatted on IBM Compatible computers to store 1.44MB of data. Continuing developments in floppy diskettes have released newer, higher density floppies and disk drives, such as the 2.88MB floppy disk, but the lack of support from a major hardware supplier and its relative small incremental value to customers and suppliers has seen it languish.

The total capacity of a floppy disk is a multiplication of surfaces by tracks by sectors. So, a 3½" high density disk can hold 2 surfaces x 80 tracks x 18 sectors x 512 bytes = 1,474,560 bytes (1,024 = 1,440K).

Densities are an issue when using older computers that only have double density disk drives. High density disk drives will read and use lower density disk, but unfortunately older computers with only double density disk drives cannot read high density diskettes.

Diskettes rotate within their permanent jacket at either 300 or 600rpm. The jacket is lined with a fabric to clean the disk as it spins and to prevent the friction of the plastic platter rubbing against plastic casing.

Access slots for read/write heads are located on either side and allow touching the surfaces. On 5¼" disks the slots are protected when the disk is not in use by storing the disks in paper envelopes. 3½" disks have a spring-loaded metal shutter that closes and protects the access slots (the disk drive opens this shutter automatically as the disk is inserted).

All PC disk drives have indicator lights that show when the disk is actually being used, either being written to or being read from. Removing a diskette while the computer is writing data to the diskette may cause file information to be partially written which may corrupt the data and other files on the diskette.

A diskette should never be removed while this light is on. You should always look at this light before removing a diskette. Apple computers have a software eject facility for removing diskettes to ensure data is saved properly before the floppy disk is ejected.

Advantages of using floppy disks:

- copy files from one computer to another;
- Easy to move floppies from place to place (machine to machine)
- cheap.

Disadvantages of using floppy disks:

- limited capacity
- relatively slow;
- less reliable than hard disks so proper care should be taken to prevent loss of data.

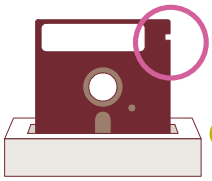
It is important to take proper care of your diskettes to minimise the danger of losing data.

Looking after that Floppy Diskette

Protecting information on a floppy disk

Floppy disks, like audio and video cassettes, can be delete protected. On diskettes it is called *write protection*. It protects data from deletion and alteration. If the diskette is never to be altered or contains important data this is a useful facility. If you are attempting to save onto a diskette and the computer responds with a message "*Write Protect Error*", this indicates the diskette has been write protected.

To write protect a 3½" disk, slide the plastic that covers the top right notch so the notch is open.



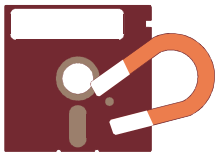
To write protect a 5¼" disks, cover the notch in the top right corner with a simple tape over the notch. To remove write protection take the tape off.

Care for the Diskette

Floppy diskettes are magnetic recording devices so when using floppy disks, here

are some things to avoid:

- magnetic fields (such as televisions, speakers, and computer monitors)
- dust
- moisture
- extreme temperatures



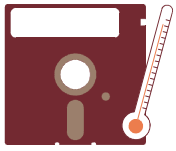
Magnetic Fields: The floppy diskette is a piece of plastic carrying tiny particles which are organised by changes in magnetic polarity by the floppy disk drive. Since magnetic forces are used to change the location and meaning of the particles on a floppy diskette then a strong magnetic field, such as sticking a magnet on a floppy diskette will change the behaviour of the little particles, changing the meaning of their location and in many cases make it so the computer will no longer read the diskette.

It is important to avoid, not put, strong magnetic fields. Things at home that generate electro-magnetic fields that can cause problems with floppy diskettes include the television, and radio.

Dust particles are very big compared to the size of the particles used on floppy diskettes. Dust on the diskette media can damage the diskette and/or cause errors in the floppy disk-drive's attempts to read data. Since a single misplaced 0 or 1 can cause a computer to radically misinterpret information, dust can be a very big program.

Moisture: High Humidity in Tonga allows mold to develop on floppy diskettes and pouring water, coffee on floppy diskettes will not do it good either.

Extreme Temperatures: Extremes in temperature effect the floppy diskette media, which can cause problems with the particles. Extreme heat can also cause the plastic to deform, change shape, which effects the ability of the diskette drive to find the correct physical location, since the diskette is now physically changed. **Do not** leave floppy diskettes in the car, on the dashboard in the car, or beside a window where the glass magnifies the heat and rays of the sun.



It is possible to bend the floppy diskettes, but just because you can do it, is not a good reason to do it. Bending a floppy diskette can cause tiny wrinkles in the floppy media which may not be noticeable to the human eye but cause problems for the floppy disk drive. When the problem is big enough for the floppy disk drive to not read the diskette properly than it has become a big problem.

Labelling

Labels help computer users identify what they have on the floppy diskette. Like labels used on books, the more meaningful the label the easier it is to understand what is inside the floppy diskette. Place the label on the front of the diskette, at the top, so that the label does not stick to any exposed areas on the diskette.

Connecting to the Computer

Hard Disks are connected to the microcomputer bus through an interface. On older machines a hard disk controller card is often required, while on newer ma-

chines (since it is commonly understood that everyone will need a hard-disk) the controller interface is built onto the motherboard. The controller card, interface, includes the circuitry that serves as an interface between the motherboard and the hard disk.

Two major standards for Secondary Storage interfaces have been adopted. The most common is the **Integrated Drive Electronics (IDE)** with an increasing number of machines now supporting a second standard due to its greater flexibility (the **Small Computer System Interface, SCSI**).

Integrated Drive Electronics

When IBM released its IBM PC AT with an IDE controller card, this defined for copiers the standard interface for hard disks. At first, the electronics was built onto an interface card that was plugged onto the motherboard, and with the increasing use of hard disks most new machines now have the IDE electronics built into the motherboard. Continuing improvements to the IDE interface standard has seen IDE improve to support increasing capabilities of hard disk drives. These improvements have meant changing the IDE acronym to EIDE (Enhanced IDE), IDE Mode 4, etc.

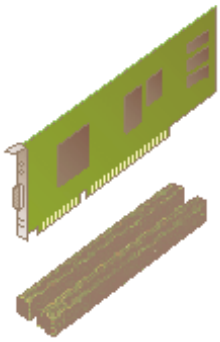
An important limitation in the IDE design is the limit of allowing only two devices per interface. A microcomputer with one IDE interface can have at most two hard disks. A microcomputer with two IDE interfaces can have at most four hard disks. In general only two IDE interfaces can be used in a microcomputer.

Small Computer System Interface (SCSI)

Small Computer System Interface (SCSI) is an adaptation of older technology than IDE but was only previously available on more expensive computer systems. SCSI's major advantages over IDE include the ability to transfer data from the computer to the hard disk at a much faster speed, the ability to connect more devices per interface, and the ability to connect to input devices other than hard disks (such as scanners).

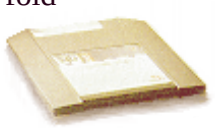
SCSI interfaces can support up to seven devices each, and as many SCSI interfaces that can fit on the motherboard can be supported. An important development for the SCSI interface is the increasing popularity of scanners (input devices that can grab images from paper documents) and CD-ROMs. Scanners require an interface to the computer that can cope with the large amount of data being sent very quickly. SCSI copes with scanners very well without the limiting constraints IDE places on the number of devices that can be connected.

SCSI has become an important standard for connecting devices for transferring large volumes of data to the computer.



Iomega ZIP Drive

Iomega Corporation released a new disk storage product they called the ZIP drive in 1994. The distinct advantage of the ZIP Drive was its portability, similar to floppy diskettes, and its storage capacity similar to a hard disk. The ZIP disk increased the storage capacity for a removable storage device 100 fold (from 1.44MB to 100MB) while at the same time controlling costs and maintaining the reliability attributed to hard disks.



The ZIP drive unit is 18 x 13 x 4 cm and weighs about half-a kilo. It has rubber feet to stabilise the unit in either vertical or horizontal positions. There are two indicator lights: green for power and amber for disk access. It has an eject button, but no on/off switch.

Three models, a SCSI model, an IDE and a parallel port model, provide customers with the option for speed (SCSI), cost-effective speed (IDE) and extreme portability. The portability of the SCSI drive model includes the ability to be moved between Macintosh and IBM PCs. Due to the greater transfer rate of SCSI devices, the SCSI model is about 2 to 5 times faster than the parallel port model.

The parallel port model can only be used with a PC and connects to the computer's parallel port. Since all PCs have printer ports, the parallel port model is extremely transportable between PCs. The drive also offers a printer pass-though feature so you can still use your printer while the ZIP drive is connected.

The IDE model can only be used with a PC and connects to the IDE connector, similar to most PC Hard Disks, with a door similar to the floppy disk for the ZIP to be put into the drive (computer) and taken out with ease.

Jaz Drives.

Iomega also introduced the market to a higher capacity removable storage device called the Jaz drive. The Jaz drive can pack up to 2G on each disk , and there is no limit to the number of disks you can use. An older version is available with support for only 1G disks.

Because Jaz drives are only available as SCSI devices they are faster than most hard drives.

Like Zip drives, Jaz Drives are portable and make transporting large amounts of information easier. It weighs less than 1 kilogram.

Jaz drives come as external (portable) and internal. A Jaz insider drive fits into any available 3.5" drive bay, the same space reserved for adding new Hard Disks into most computers.

With the Jaz drive's speed and the Jaz disk's capacity and price, the Jaz is a useful large system backup device. In environments where large amounts of data are manipulated a Jaz drive is a good supplement to the existing hard disk.
Jaz Disks.

Compact Disks and Digital Versatile Disks (DVD)

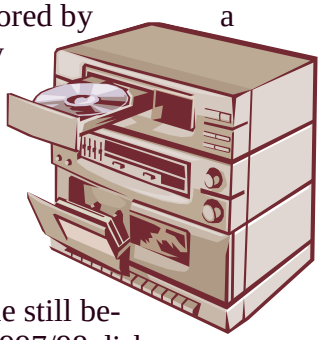
Our discussion so far on secondary storage has focussed on magnetic media devices. With the increased requirement for larger datafiles by multi-media applications the high cost of magnetic medias has increased the research and availability of optical (laser) based storage devices.

CD-ROM Drives are an old technology but their popularity has increased with the corresponding requirement by programs with animated pictures, video, and sound for more storage space. Products such as encyclopedias and Windows 95 applications with animated tutorials require far more space than is practical with floppy diskettes. For example, the CD-ROM version of Windows 95 would require over 24 floppy diskettes to store; each diskette would cost approximately USD 50¢ to put together for the manufacturer whereas the complete CD-ROM would cost the manufacturer approximately USD$1.00.

With the increasing number of computers with CDROMs, a market has grown for CD Writers (Drives which can write onto CDs). With a much lower cost of media (the CDs themselves) and a more permanent record of what has been written, CDs have become an important tool for people distributing software tools, data within an organisation due to the large capacity and ready availability of CDROM readers. For data that does not change, such as the national Census records, or Court Records, Parliamentary Records, CD Writers are an effective tool.

Standard computer CDs suffer from the problem of being slow compared to magnetic disks and the CDs being read-only.

To help alleviate, solve the speed and read-only problem, a number of optical products have been introduced with little market success. Digital Versatile Disks (DVD), a new optical drive and CD format, is being sponsored by a number of the large technology manufacturers to hopefully provide a solution for the increasing need for large storage, speed, and lower costs.



DVD is promoted as the successor to CD-ROMs, laser disks, audio CDs, and VHS video cassettes. With an expected capacity of 17 Gigabytes, DVDs should be able to store full movies, audio CDs, and high quality images while still being the same physical size as today's CDs. Although the 1997/98 disk drives and DVDs are read-only the writable variations should appear on the market by late 1998 or in 1999.

Terms and Definitions

Term	Description
CMOS	
NVRAM	Non-volatile Random Access Memory
RAM	Random Access Memory
ROM	Read Only Memory

Review Questions

1. A disk which is write protected means that:
a) the write protect notch is covered
b) existing files cannot be erased from the disk
c) new files cannot be written on the disk.
d) all of the above
e) none of the above

2. A computer has two types of storage. Describe at least one difference between primary storage and secondary storage.

3. Examples of Primary storage are RAM and ROM, describe one difference and one similarity between them.
a) Similarity:
b) Difference:

4. Disks (hard and floppy) are examples of secondary storage devices, and are very popular. Give 2 reasons why disks are popular.

5. Describe one difference between a floppy disk and a hard disk

6. The way data is stored in main memory and disks differ in many ways. Describe one difference and give one disadvantage and one disadvantage for each.
a) Memory:
i) method:
ii) advantage
iii) disadvantage

b) Disk:
i) method:
ii) advantage
iii) disadvantage

7. Floppy disks are available in various types and thus differ in capacity. See if you can write up the table and capacities relative to the disk size and density.

Sources and References

http://www.tongatapu.net.to/compstud/ - Computer Studies Course Notes
http://www.tongatapu.net.to - **Tonga** on the **'NET**

http://www.tongatapu.net.to is available on all networked computers at Queen Salote College.