Option 4: Multimedia Systems

Outcomes - on completing this topic a student should be able to -
- H1.1 apply an understanding of the nature and function of information technologies to a specific practical situation
- H1.2 explain and justify the way in which information systems relate to information processes in a specific context
- H2.1 analyse and describe a system in terms of the information processes involved
- H2.2 develop solutions for an identified need which address all of the information processes
- H3.1 evaluate the effect of information systems on the individual, society and the environment
- H3.2 demonstrate ethical practice in the use of information systems, technologies and processes
- H4.1 propose ways in which information systems will meet emerging needs
- H5.2 assess the ethical implications of selecting and using specific resources and tools

Multimedia systems are information systems that combine the different types of media. Professional multimedia systems, especially when being created, involve many participants with a wide breadth of experience. Multimedia systems encompass the entire information process, though this topic emphasises the displaying part of the process. This is usually a combination from television, film, graphics, animation, books and radio to produce a multimedia presentation. The range of programs used to combine these aspects is termed authoring or presentation software.

The term Multimedia refers to the use of ‘multiple and different media’ to present a message or to entertain. A dictionary meaning for Multimedia would be - the presentation of information in a variety of forms.

The Purpose
Multimedia attempts to actively engage a user in the presentation of a message. Interactive multimedia extends the presentation options so that the viewer becomes a user who can directly control the flow and/or direction of the presentation.

The Requirements
Multimedia is both processor intensive (fast processing speed) and memory hungry (both RAM and hard drive space). Thus for better presentations, a CD - ROM or DVD drive, fast processor, quality colour monitor and lots of RAM are required. Thus hardware and software costs are quite high and time requirements are considerable for the production of quality multimedia productions.
**Exercise 1**

1. What is multimedia, from your *personal experience*?
   Discuss this question with reference to where you have seen multimedia, what types, what variety of things were presented, and how successful you consider it was and why.

2. Why is multimedia being used more each year and for a greater range of tasks?

3. Which presentation areas most successfully use multimedia? Why? Why not all presentation areas?

4. View several of the presentations produced by previous Year 12 students. Comment on several of these, including the Golf Stack - looking at ease of navigation, good and bad features, interactivity, etc.

To be completed and handed in by - ..................................................

**Examples of Multimedia Systems**

The main areas for multimedia use include -

1. **Education and Training**
   Over recent years multimedia has become much more important in the areas of education and training and the variety of presentation techniques and forms has proven very successful at assisting people to learn. Multimedia has allowed people to learn at their own rate, jumping to more advanced areas if needed or going slowly over basic concepts. For all, multimedia has generally allowed learning to become more interesting and enjoyable.

   **Computer- based Training** is used in interactive multimedia products in -
   - homes
   - libraries and museums
   - schools, colleges and universities

   In educational settings users get to spend a lot more time to explore as well as find information, and are thus designed differently to say shopping centre presentations. There is more content in the displays, generally more navigation options and greater depth and flexibility to cope with expertise levels. Typing programs are one example of such training products.

2. **Leisure and Entertainment**
   Multimedia provides a great form of entertainment, with video games arcades (e.g. Intencity) and home system games very interactive in nature. High quality graphics, stereo sound and animation (increasingly including video) are all vital in enhancing the action of the game.

   The storage demands of these make CD-ROM distribution a must, and since few players want to read written instructions and background details, the characters have voices. Interaction is through mouse, joystick, trackball or other specialised add on (e.g. steering wheel, rudder pedals,
The emphasis is on fast action and the ability of the user to explore and discover - with navigation buttons often hidden in the graphics or scenes.

3. Information
We are living in the Information age, being inundated with more data than most of us can handle every day. Multimedia provides an effective method of distributing and storing some of this information.

Presentations may be found in -

- information kiosks at tourist centres
- department store enquiries desks or location guides
- shopping complexes to give advertising for tenants

Many of the presentations are non-interactive, with the presentation recorded onto video and simply being replayed continuously. The interactive ones rely on touch sensitive screens as the only input device, to allow navigation - and hypertext (in normal sized print at least) is not possible. Museums, exhibitions, shop sales areas and libraries are some such locations. Since many of these are often in noisy or very quiet environments, audio may either a minor part or omitted completely. These presentations are to provide basic information quickly to users with often little computer experience.

Many business presentations have utilised multimedia to raise the interest of the audience and increase the effectiveness of the communication. For example, sales organisations generate enthusiasm for their sales staff, or a kitchen design company may demonstrate a range of ‘dream kitchens’ to potential buyers.

4. Virtual Reality and Simulations
Virtual reality utilises multimedia to allow a person to interact with an artificial environment. Commonly the user has goggles, glove(s) or body suit to interact.

**Power Glove** - this input device, is associated mainly with computer games, but is being applied to a variety of other uses. It uses a keypad on the outer forearm, as well as sensors in the hand portion that detect movement in the fingers, hand and wrist. Such movements, either individually or in combination, can be used to control on-screen actions. The power glove’s greatest application may be in the work on virtual reality, where it may be the forerunner of a sensory ‘suit’ worn by the user.

The user of VR can pick up and manipulate objects, move through rooms, etc. and is quite interactive.
Flight Simulators - have been used for many years to train pilots for a wide range of situations, places, etc. without risking both their lives and millions of dollars worth of aircraft. Both normal and emergency simulations (weather, breakdowns, etc.) can be run to fully prepare the pilot for any foreseeable eventuality. These are expensive to construct and set up with the software and hardware needs, but much cheaper than replacing planes.

Advances in Technology

Obviously multimedia development is constantly being influenced by technology advances, such as processor speed, hard drive sizes and other secondary storage methods, as well as those in communication technology for the widespread display of multimedia. We will look at each of the following areas -

1. World Wide Web - the WWW or ‘Web’ is the Internet network which is used by millions of people throughout the world to access information and communicate with each other. Web sites contain data and information on almost every imaginable topic and interest area, as well as chat areas, etc. Web pages are documents stored on the many servers located around the world. As seen earlier, Web pages generally have active links (termed hyperlinks) to other documents in this interactive environment allowing users to browse from page to page and site to site.

2. Communication Speed and Capacity - with the upgrading of Internet bandwidth, the amount and range of multimedia resources has expanded enormously and made the Internet a valuable source of material. ISP’s can now provide fast service and large download capacities at more reasonable cost and this has allowed people to access graphics, music, videos, etc. to use in multimedia presentations.

3. CD-ROM speed - CD-ROMS to play CD’s have increased in speed from 2X to 52X in only a few years, and this means that the information on them (up to 650 Mb) can now be accessed faster by computers. This means that multimedia presentations containing video, audio and animations in particular, can now be stored on CD’s and played at the same speed as from a hard drive.

4. Digital Video Disk - DVD is a disk format that allows for large data storage capacity, along with high quality replay for video and audio - thus possibly replacing CD’s, videotapes, etc. DVD can be used for video to play through the television via a DVD player, and even with compression (MPG-2 format) to fit whole movies, the replay quality is high. Capacity for a DVD-ROM disk is the same physical size as a CD-ROM but ranges from 4.7 Gb to 17 Gb for storage capacity. For multimedia purposes, the other big advantage of DVD’s is that text, graphics, audio and video all have the same file structure (called Universal Disc Format - UDF) which overcomes all incompatibility problems.
Integrity of the Source Data
In educational and other multimedia systems the integrity - that is the completeness and accuracy of the contained information, must be considered. In entertainment multimedia we rarely worry about the accuracy or completeness of the facts, but for information and educational purposes, the authors must ensure that viewers are not given incorrect or incomplete data during presentations.

Exercise 2

1. Describe the location and purpose of an information kiosk you have seen and hopefully used. What other type of information devices would have been replaced by such a kiosk?
2. In what year was the WWW first available for use by the public? What came before the WWW, and how useful was it?
3. On DVD’s movies have to be compressed to fit them on the disk, with the type of compression termed ‘lossy’. Find out what ‘lossy’ compression is and how it actually works.

To be completed by - ..............................................................

Characteristics of Multimedia Systems
The media which are combined to produce a presentation include -

- text, hypertext and numbers
- audio
- images and/or animations
- video

1. Text, Hypertext and Numbers
Text is the main information format used in word processing and in many multimedia programs. Early multimedia programs were basically conversions of conventional books into computer format - and did not allow for jumping back and forth between sections of text. Even in most modern multimedia presentation software, text screens, text boxes and text windows are important methods of providing information.

While it is possible to design a presentation which contains no text at all, allowing users to navigate with graphical and auditory information using icons and other clues, they would soon tire of the experience. It takes a lot more concentration to keep up with spoken words and animations than reading the directions at the user’s own pace.

Hypertext is the term generally given to a method of linking one piece of information to another. This comes from the area of hypermedia - the linking of data types to give pop up windows or jumps to other sections of text or videos, etc. Hypertext, hypergraphics and hypersound are terms used for hypermedia. The text that is linked is often highlighted in red and hence the term hotword is used.
Effective use of hypertext means that information can be accessed in a non-linear manner. This is quite different to traditional books which are normally read from cover to cover with each page read from top to bottom. However, the placing of hypertext links within the text (hotwords) will allow the user to choose the order in which they access the information.

Hypertext links allow access of information in a non-linear method

Hypertext links are defined by specifying the source (the hotword) and then specifying the destination text that is ‘jumped to’ when the hotword is selected. Therefore hypertext is built up progressively by establishing one link at a time. The link may be to text, an image, an animation, audio or video - as specified by the creator of the presentation.

Numbers are normally numerals used to perform calculations, such as cost of a number of items, often linked together in some form of chart.

2. Audio

Audio can be stored in a digital format after being recorded from natural or humanly produced sources (e.g. voices and musical instruments), or produced artificially (e.g. using a synthesiser). Digitised sound is created by sampling the characteristics of a sound source and converting them to numerical values for storage as a waveform file. A waveform is a sequence of samples that is played back at a certain rate to create a sound. A waveform is frequently displayed on a monitor in the shape of a wave, allowing the user to alter the characteristics of the sound.
A multimedia presentation can use sounds played by external devices (e.g. CD’s) and MIDI (musical instrument digital interface) equipment. For CD’s, the computer can directly select the particular track, the sequence of tracks and duration of each track to be played by an external CD player. The sound is normally played through the speakers attached to the CD player. A CD-ROM also can contain audio CD tracks and these can be played directly through speakers attached to a computer system.

For a MIDI instrument, the computer can store and replay instructions that allow an instrument to play a particular sequence of notes. The MIDI file contains the instructions to control the musical instruments and make them reproduce the music. A MIDI file is not a digitised sound file and cannot be played through speakers or displayed and altered in the same way as a waveform file. See the main differences below -

**MIDI files**

*Advantages* - Small file size, only a low powered computer needed, all aspects editable, playback speed can be altered without changing sound quality or pitch.

*Disadvantages* - sound quality depends on attached musical instruments, cannot reproduce speech and requires some musical knowledge.

**Digital Waveform files**

*Advantages* - more reliable playback, sound quality can be higher, no expensive instruments needed.

*Disadvantages* - huge files and considerable CPU processing time, not possible to edit all aspects of digitised sound.

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**Exercise 3**

Investigate how sounds, such as music, can be varied using the following shareware audio programs found on the Multimedia CD -
Use each one for up to 10 minutes only.

To be completed by - ....................................................

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**3. Images**

In general, graphics are static images (single screen image) and therefore pictures, charts, drawings, mathematical graphs and icons are all conveying graphical information.

Graphics are vitally important for multimedia presentations, as they provide the initial visual impact, as well as the background and foreground for menu or selection screens, as well as providing non-textual information. If we consider memory requirements, text occupies about 2K per page while a 256 colour full screen graphic may range from 500K to 2000K commonly.

The type of video display used (that is the type and size of monitor) is usually very important -
with resolution being most critical. A minimum of 640 X 480 pixels is needed for multimedia presentations - usually termed a super VGA monitor. The current minimum standard is 256 colours, and the number of colours which can be displayed on screen at any time is referred to as the palette.

The palette is usually stored as a colour table which describes the exact colour combination of red, green and blue video signals needed to make a particular colour. The colour table value of every pixel on the screen is usually stored as a bit map in the VRAM (video RAM or frame buffer). The size of the available VRAM will determine both the number of pixels on the screen (screen resolution) and the number of available colours for each pixel (bits of VRAM per pixel).

<table>
<thead>
<tr>
<th>Bits per pixel</th>
<th>Size of palette</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>16 colours/greys</td>
<td>Windows 16-colour VGA standard</td>
</tr>
<tr>
<td>6</td>
<td>64 colours/greys</td>
<td>Limit of visible grey scales</td>
</tr>
<tr>
<td>8</td>
<td>256 colours</td>
<td>MPC and SVGA standards</td>
</tr>
<tr>
<td>24</td>
<td>16.7 million colours</td>
<td>Limit of visible colours</td>
</tr>
</tbody>
</table>

Real world images obviously contain millions of colours, but this is impractical for multimedia presentations (both from VRAM and resolution aspects) and so the palette will have to be reduced (to 256 colours generally).

**Animation**

The basic principle behind animation in any form is the persistence of vision. The light-detecting cells in the retina in the back of your eyes work relatively slowly and are still sending the image they received in the previous frame (while the screen is blank before the next frame is present) and therefore the rate of frames per second does not have to be too great to achieve the illusion of continuous motion.

In the early days each graphic image had to be drawn by hand, with only the background having to be completed once. With computer animation, only the main frames have to be created while the software creates the frames in between. Each image frame for a computer animation is stored, in sequence, as a graphic bit map in normal RAM. The images are then copied into the VRAM one after another - and if this is fast enough, an illusion of smooth motion is created.

The computer’s refresh rate is 30 times per second, and thus the computer system changes the image in VRAM during the brief pause between times when the contents of the screen are being redrawn.
Frames per second (fps) | Examples
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30 | Animation speed matching the refresh rate used on many VDU’s
25 | Normal video speed for the PAL television system
24 | Standard speed for movies and the minimum speed for smooth, continuous motion illusion
12 | Traditional speed for cartoon animation
8 | Minimum working speed for the illusion of motion

Typical animation speeds and their uses

**Exercise 4**

1. Explore the software Powerpoint, for use as an authoring tool - particularly importing files (graphics, text, etc.)
2. For your assigned area, find and save a folder of likely graphics - note the best graphic format(s) to save them in.
3. Try importing some of them into Powerpoint and create a presentation called Trials - which should contain several screens with text and selected graphics.

To be completed by - ..............................................

**4. Video**

Despite the power of modern computers to handle full motion video replays, two major limitations still exist -

1. a single full screen colour (24-bit) video image needs one megabyte of memory. Thus ten seconds of video images at 30 frames per second, would need 300 megabytes of storage space.
2. to create realistic motion with full screen, full colour images, a disk to RAM transfer speed of 30 megabytes per second would be needed - well beyond the capabilities of currently available hard disk drives.

To overcome these problems, the video images must be compressed for storage and decompressed before display. This needs special hardware and software - the decompression technology is available, but the compression technology is expensive and thus has been previously limited to high end amateurs and professional users.

Without the hardware and software, a video replay must be limited to a small screen area or black and white, or with no realistic motion. Even using compression techniques, large disk storage is needed, so CD-ROM’s (over 4 speed) provide suitable storage media and capacity.
Video digitisers work by sampling each of the horizontal lines in every video frame - enough times to produce the screen resolution required by the display system e.g. for 640 X 480 pixels, each line must be sampled 640 times. The horizontal lines of video in the signal are reduced to 480 lines of pixels by software algorithms or the digitising hardware.

**Exercise 5**

1. Describe the term *digitising* as it refers to a video signal. How is it actually achieved?
2. What do JPEG and MPEG represent? How are these used in multimedia?
3. View several movies in the resource file - add several to your Trial presentation.

To be completed by - ..............................................

**Multimedia versus Print Media**

The differences between print and multimedia for similar content are based on the mode of display (monitor compared to printout on paper) and interactivity (some for paper compared to considerable for multimedia).

**Display** - multimedia is normally displayed on a computer screen, allowing all 4 forms of data display, with a variety of resolutions to choose from in a number of sizes. Touch screens are often used for public input for choices and selections.

Speakers also allow instructions to be given as well as music, commentaries, etc. to accompany the text, animations, videos, etc.

**Interactivity** - is normally included in most multimedia presentations, so that the user is able to alter the sequence and often the content. Hypertext and hypermedia allow the user to jump from page to page, begin videos, music or animations, see pictures, etc.

On paper, the user may choose to go to a particular chapter or use the index to locate a particular section, though considerably less than ‘surfing the Internet’ for example.

**Exercise 6**

1. Produce a 1 page summary of the 4 media types listed on page 5, ready to print out.
2. Copy and paste the same data in a limited multimedia presentation - take up to **30 minutes** only.

To be completed by - ..............................................
Organising Presentations

A navigation map of the presentation must be constructed - to show the pathways that a user may follow. This map takes the form of a storyboard and in the early stages of the project may be quite general in nature. Its purpose is to show the structure of the presentation and how its components will be co-ordinated.

There are four basic types of storyboard layouts used in multimedia projects -

1. Linear

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   ———— ———— ———— ———— ————
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Here the user moves through a simple sequence of presented information.

2. Hierarchical

Here a number of choices are available to the user at each part, with the information still in a sequence but the user has control of the direction of the presentation.

3. Non-linear

Here the user can move freely through the presentation, not restricted to a linear pathway, and the information is presented in an unstructured manner.

4. Composite

Here the movement in some parts of the presentation may be linear or hierarchical, and non-linear in other parts.
Each box in a storyboard may represent a single process or a complex set of steps to be later expanded into a separate storyboard for each one. Links may be either one-way or two-way, allowing users to backtrack over a previous section if necessary.

If using a hierarchical layout care should be taken as to how many times the user will have to ‘reverse out’ to get back to the starting point. Allowing branching out from boxes lower down will ease this problem of a quicker return path.

**Design and Screen Layout For Multimedia Presentations**

The screen design is the scene the user sees and the controls they use to interact with the program. The screen design is an important factor in delivering content. Screen design is a highly creative art form which can enrich a presentation. It requires thought from designers and artists, who should take into consideration the content and the users. It should also suit the audience at which the presentation is pitched, and thus designers should consider the colours used, backgrounds and complementary graphics. You would not use a screen design that has a border made up of pink teddy bears if you were presenting to a group of footballers or lawyers.

**Points to Consider -**

- Consistency is one of the most important things to consider, as inconsistency will often confuse the user and detract from the presentation.
- Backgrounds should be attractive and appealing with the colours being soft and relaxing or enhance the content.
- Fonts use no more than 2 or 3 different fonts in your presentation.
- Confining text to specific parts of the screen and keep consistency through the presentation, and keep text to a minimum. Large amounts of reading text are best delivered on paper rather than on a video screen. Multimedia can deliver content in more ways than just reading, and these other ways should be exploited.
- HyperText often is a different colour than the surrounding text or in bold or italic form.
- Plan your artwork so that it presents the message you wish to deliver.
- Leave sufficient margins around the edges of the screen so the users can focus on the text and artwork being displayed.
- Simple cartoon artwork works well and can be animated with little application of talent. A simple animation or movie with less detail can deliver more information than detailed stationary artwork.
- The interface should be easy enough for the user to grasp.

**Collecting the Media**

Once a plan has been made for moving around in the presentation, the type of media, how it is to be collected and in what format, must be planned.

- text may be typed, scanned, etc.
- images may be drawn, imported, downloaded, etc.
- audio may be played and recorded, imported, downloaded, etc.
- video may be recorded, downloaded, etc.

To achieve all of these for all media types a range of devices may be used, to either create the media from scratch (e.g. graphics tablet for drawing) to such digitising devices as scanners, cameras, microphones, etc. Converting analog media to digital using an interface card is another method (e.g. video capture card).

**Digitising** methods -

- **Scanners** - are of 3 types - hand held, flatbed and overhead and depending on the software, capture either images or text. The scanning process involves shining a light on the picture or text and catching the reflected light and converting it to a digital form - which can then be used in the multimedia product. Resolutions between 2400 and 9600 are normal maximums these days, generally using the TWAIN (Technology Without An Interesting Name) standard, allowing use in a range of applications.

- **Digital Still Cameras** - capture and store digital images, rather than on film. The image is transferred to the computer where it can be manipulated using software, before being added to the presentation.

- **Digital Video Cameras** - capture video in a compressed digital format e.g. MPEG and can be transferred directly to the computer. *Analog video cameras* can have their signal converted into digital form using a video capture card - this interprets each frame as a bit-map image. These cards compress the video clip which works on an analyses of the changes from frame to frame (so new frames are stored along with just the changes, rather than all of the data from every frame).

A **frame grabber** captures and digitises images from a video, with the rate varying - but since they are displayed at 30 frames per second, the rate must be close to this for capture.

- **Microphones** - capture sound (analog data which travel as waves) to convert it to audio. A **sound card** performs the conversion e.g. Sound Blaster, which are capable of recording and playing audio at 44.1 kHz in stereo (CD quality).
Displaying in Multimedia Systems

A range of hardware is used for the display of multimedia products, along with a range of software to manipulate the media.

Hardware

For creating and displaying multimedia products, the following devices are used -

Screens - The monitor is also known as the video display unit (VDU) and is the main output device of the computer.

Most consist of a grid of 25 rows by 80 columns and each of these can display one alphabetical character - made up of little dots called pixels - the letter B is seen from the pixels turned on. The most common type of monitor screen is the Cathode Ray Tube which is the same type as used by a TV.

As shown in the diagram, the CRT creates an image on a phosphorus coated screen by bombarding it with a controlled beam of electrons. To determine the intensity of the beam, a negatively charged grid allows through only the required amount of electrons. This concentrated beam is directed at the individual dots on the screen (pixels). When an electron strikes a phosphor atom on the surface of the screen it releases its energy in the form of light, though since this only lasts a short time, it needs to be struck regularly to maintain the picture - this is termed the refresh rate. This refreshing generally needs to be done at least 30 times per second, and if it is not quick enough will cause flickering and the image will begin to fade.

Most CRT displays use a raster scan, (allowing text and graphics to be displayed) with a series of zig zag lines creating the image - and these may be either interlaced (odd and even lines refreshed separately) or non-interlaced (where all 72 lines are refreshed every second). Whereas a monochrome screen has a uniform coating of a single colour phosphor, a colour screen has a matrix of pixels, where each pixel is a triad of a dot of red, green and blue phosphors. With a colour display three electron beams are used, one for red, green and blue. The intensity of each beam is controlled individually, however each group of red, green and blue elements combine together to produce an area of colour (a pixel of colour). Given the size of each colour element, electron beams must be accurately aligned to strike the corresponding phosphor dot in a triad of red, green and...
blue dots for each pixel.

In **vector display systems**, the electron beam is directed to draw the lines required for the image by joining two endpoints, turning off between each line. Vector display operation is shown in the diagram.

Vector display systems can only be used to display vector-based graphics and cannot display bit-mapped graphics as these are not represented by lines. Shading of areas can only be drawn as a series of lines.

With vector refresh scan displays, the lines are drawn directly onto the phosphorus screen, continuously refreshing the lines at a fast rate. Vector refresh scan displays are capable of displaying animation only where this involves wire models. With vector storage displays, the images are first drawn onto a storage grid just before the main phosphorus coating. When the images have been built up, another electron gun floods the entire screen causing the images to glow brighter than the surrounding screen. As the whole screen needs to be redrawn before changes can be seen, this system is not capable of animation. Both vector display systems are expensive and are used only in high-end CAD systems.

The **touch sensitive screen** allows the human hand to select items from menus on special screens. The finger tip pushes one layer of the screen onto a grid which locates the point and decide which command is required. Like the mouse, this eliminates the need to use a keyboard to enter commands. Such screens are often used in museums like the Powerhouse.

**Liquid crystal displays (LCDs)** use similar technology to the displays used in digital watches and calculators, though computer displays provide higher resolution than displays used in calculators and watches. They are usually used with notebook, laptop and portable computers, although they are becoming available for desktop computer systems. The LCD display is controlled by a video controller that switches the appropriate pixels on or off to create a matrix of pixels much like a CRT display. To make the display easier to read some manufacturers have installed lighting behind the pixels, called back lighting.

Monochrome LCD displays have a restricted viewing angle (cannot be seen easily from the side) and displays that do not have back lighting are even harder to read in poor light conditions. Typical LCD displays also respond slowly, for example, when scrolling though a text document.
the display tends to blur. At present colour LCDs are more expensive than monochrome LCDs, however colour LCDs have a faster screen refresh rate (less blurring when scrolling) and a wider viewing angle than monochrome LCDs. LCD panels also have the disadvantage that they do not function when too hot or too cold.

Currently colour LCDs cannot yet display as many colours as a CRT display however some observers predict that colour LCDs may replace CRT’s because they:
- consume less electrical power and hence less demand on fossil fuel reserves
- are thinner and lighter making them suitable for portable computing or even mounting on the wall
- do not emit large amounts of electromagnetic radiation (which some observers suspect may be harmful to people).

Projection devices - these are of two types -

- **data projection panels** have now become commonplace in training and business presentations, being placed on top of an overhead projector to project up onto a screen or wall - this type uses LCD technology with the light passing through it to project onto the screen.
- **data projectors** take the video signal directly from the computer and project it onto the screen with more adjustments possible, but are also more expensive (commonly $2000 to $10000).

Speakers - audio signals from the computer are translated into analog sound waves for transmission through the speakers, with the sound being generated electromagnetically. A wire coil is attached to the speaker cone and this is positioned around a permanent magnet, so that an electronic signal passing through the coil magnetises it. This magnetising pulls and pushes against the magnet, causing the cone to vibrate along with the strength of the electronic signal - thus setting the air vibrating with the sound, so we hear it.

CD-ROM - (Compact Disk - Read Only Memory) - are similar to the 12 cm music CD’s. However, they are able to store over 600 megabytes of computer data - text, graphics, music or even video. This means that an entire encyclopaedia including pictures can be stored on a single CD - some are read only, they cannot be used to record information from the computer, while others are rewritable.

Video - is displayed via the monitor (in various sizes), by data projector or onto video tape for TV display.

Head-up displays - these are devices worn on the head (sometimes termed head-sets) to originally use virtual reality. The earlier helmets have been replaced by glasses sized displays for the projection area for the overlay of the multimedia presentation.
Software

For creating and displaying multimedia products, the following programs are used -

**Presentation software** - this is used to present to groups of people, generally as a some form of a set of slides (which are screens or pages which may include text, graphics, animation, audio and video). Programs for this include PowerPoint, Freelance and Persuasion.

This type of software produces on-screen presentations (timed or manual, with or without special transitions), printed handouts, overhead transparencies (in colour or black and white) and speaker notes.

**Application software** - this is a program designed for a specific purpose, to create or adapt the various types of media for a multimedia presentation. Examples include -

- word processor - mainly for text creation and editing, formatting and in some cases, limited control over images and sound.
- spreadsheet - puts text and numbers into a grid, also allows charts or graphs to be produced.
- graphics - for creation and editing of images, either as paint (bit-mapped graphics) or draw (vector graphics).
- audio - for creation and editing of audio (sounds deleted, have speed changed, echoed, mixing and altering of sound qualities.
- video - for creation and editing of video footage, adding text, audio and images to the video clip. Combining video segments, cutting, cropping and pasting - such as in the program Premiere.

**Authoring software** - The software which attaches the components of the multimedia project together is generally called an **authoring package** and these can be found for all major computer systems e.g. Macromedia, Hypercard, HyperStudio, Visual Basic and Toolbox.

Such software allows all of the media types to be combined along with the interactivity of the user, generally using a type of scripting language.

**Animation software** - this allows individual images to be made to appear to move, either as 2-D or 3-D, sometimes including warping and morphing (see later notes for these). Two dimensional animation involves flat images in altered positions, while three dimensional animation requires the use of mathematical models to realistically portray the depth of objects.

**Web browsers** - these are programs stored on the computer to be able to access the Internet websites (when the address is given). They allow the downloading of multimedia files (animations, audio, videos, etc.) located on Web pages. Examples of these programs are Netscape Navigator and Microsoft Explorer, and both can play audio and video with the addition of additional software termed ‘plug-ins’.

**HTML editors** - these are programs which alter the HTML language which is used to create Web pages by controlling how that parts of the document are to be displayed. The editors specialise in writing HTML code, using tags (which are metadata or information about data), as shown by the angled brackets e.g. `<TITLE>`
Exercise 7

1. Using PowerPoint, complete each of the following (making note of successful methods used and also what this software will not allow you to do) -
   (i) try importing a range of sounds (and playing them)
   (ii) try importing several animations
   (iii) try importing some video clips

2. Make a summary for each media type as to how to get each of them to operate correctly.

To be completed by - ..............................................................

Demands on Hardware for Multimedia

Both Primary and Secondary storage capacities have to be large to meet the size and quality requirements of multimedia presentations. Most presentations will quickly grow into megabytes of graphics, animations and especially video - so -

• 256 Mb of RAM (or even larger) will normally be a minimum
• a large hard disk, CD, etc. will be needed to store the presentation
• a fast processor is essential (particularly for video rates and larger screen size displays)
• high resolution monitors allow improved display
• good quality speakers enhance the audio output

The two main areas of concern for hardware are -

• representing colour images
• sampling rates of audio data

Colour Images - the need for colour images usually between 8 and 24 bit depth (see page 8) means that each image displayed will have to be stored in the part of memory termed the frame buffer or video RAM.

As the resolution (as given by bit depth) of the image increases, so each pixel requires more memory, and we sometimes need to look at the bit map (or memory map) to check on this relationship.

Bit Depth for an image is the number of bits of memory needed to contain the details for each pixel in that image.

Images on screen are composed of tiny dots called pixels or picture elements.

    PIXEL = derived from PICture ELelement

The screen is made up of a grid composed of columns and rows - with the intersection of a column
and a row forming the pixel. Both text and graphics are made up of pixels, with the computer hardware and software controlling the number, size, tone and colour of each pixel. These characteristics determine the quality of the image and the amount of memory required to store it.

The image on screen is composed of individual pixels that are either on or off (in a monochrome display) or of various colours (in a colour display). Bit-mapping actually refers to the relationship between the bits that represent the image in memory and the image displayed on the screen. One or more bits must be used to store each pixel on the screen - at the simplest level, one bit can represent one pixel, and so a 0 would mean that pixel is off, and a 1 that it is on. Thus the ‘bit-map’ is a continuous section of RAM which reflects or maps the pattern on the screen.

For a monochrome monitor, of 640 pixels horizontally and 400 pixels vertically, this means 256 000 pixels - at one bit per pixel this would be 32K of memory (256 000 / 8 / 1024 = 32 000 bytes). Thus that to store the image for that display would require 32K of memory. Greater detail and colour would greatly increase this memory size.

### Tones
- or shades of grey, are needed for most graphics
  - and this requires more memory, based on -
    - one pixel uses 2 bits - allowing 4 shades (00, 01, 10 and 11)
    - one pixel uses 3 bits - allowing 8 shades (000, 001, 010, etc.)

If a monochrome monitor (640 X 400 pixels) displayed an image with 64 tones, or shades, it would need each pixel to use 6 bits - thus requiring 6 times the amount of memory or 192K.

### Colour
- the number of bits controlling each pixel depends on the number of tones and colours. If one pixel represents 8 bits, then the display will be 256 tones and / or colours - which could be 256 colours, or 64 colours with 4 tones, or 16 colours with 16 tones. Thus a colour monitor with 640 X 400 pixels with 256 colours would require 250K of memory to store the image.

<table>
<thead>
<tr>
<th>No. of bits</th>
<th>Tones or colours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td>7</td>
<td>128</td>
</tr>
<tr>
<td>8</td>
<td>256</td>
</tr>
</tbody>
</table>

### Working

- Horizontal X Vertical X Bit Depth

File size = 640 X 400 x 8 (pixels times number of bits for colours/tones)
= 2048000 bits
= 2048000 / 8 (converts from bits to bytes)
= 256000 / 1024 (converts from bytes to kilobytes)
= 250 K

### Audio Storage
requires analog sound to be digitised, and this is achieved by a process called **sampling** (see page 225 of Power’s text for a diagram) and this is made up of 3 characteristics -
- **sampling rate** - is simply the number of times the sample is taken of the sound wave, where the higher the number of samples the better the quality.
The common rates are 22.05 kHz (22050 samples per second - music playback rate) and 44.1 kHz (44100 samples per second - CD playback rate).

- **sampling size** - is the number of bits used per sample (or bit resolution), where the more bits the better. The common sampling sizes used are 8-bit (good for voices) and 16-bit (good for CD stereo sound).

- **mono or stereo sound** - mono uses one channel, while stereo uses two - thus doubling the file size.

**Audio file size** is calculated by - **Sample rate x Sample size x Time in seconds x 2 (if stereo)**

Example - for a 2 1/2 minute stereo song with a sample rate of 44.1 kHz and 16-bit sample size

\[
\text{File size} = \text{Sample rate} \times \text{Sample size} \times \text{Time in seconds} \times 2
\]

\[
= 44100 \times 16 \times 150 \times 2 \text{ bits}
\]

\[
= \frac{211680000}{8} \text{ bits to bytes}
\]

\[
= 2646000 \text{ bytes to megabytes}
\]

\[
= 1048576
\]

\[
= 25.23 \text{ Mb}
\]

**Exercise 8**

1. Compare the relationships between the following terms - frame buffer, bit depth, bit map, and resolution.

2. (i) For an 8 bit graphic, with 8 tones, how many colours can you have?
   (ii) For a 5 bit graphic, with 16 tones, how many colours can you have?
   (iii) For a 4 bit graphic, with 4 tones, how many colours can you have?

3. How much memory would -
   (i) 640 X 400 pixel screen with 64 colours need?
   (ii) 1024 X 1024 pixel screen with 128 colours need?
   (iii) 720 X 640 pixel screen with 256 colours need?

4. Calculate the file size for -
   (i) 10 minutes of mono sound sampled at 22kHz with a 8-bit sample size
   (ii) 6 minutes of stereo sound sampled at 44kHz with a 16-bit sample size

   To be completed by - .................................
Obviously the file size for CD quality generates very large files, creating storage problems, and therefore the compressed **MP3 format** is able to reduce this problem by filtering out extraneous noises from the original source - resulting in around one minute of music equalling 1 Mb of MP3 file.

**Video Data Processing**

Video can provide some of the most interesting and exciting aspects of multimedia, but is the most demanding on both the hardware and software. A video camera, whether it be digital or analog, is used to collect a video clip, and then either -

- a video capture card is used to convert the analog signal into a digital format - which can then be worked on in a program e.g. Avid Cinema on the Mac 6500 with the video in/out card
- digital video straight from the camera goes into the computer e.g. an eMac with iMovie or other software.

The software allows editing, addition of text, audio or images to the video clip so as to create the multimedia presentation. The size of the files created means that a number of considerations must be made, including the **frame rate** (the speed at which the frames appear on screen per second) - see the page 6 table.

The faster the frame rate (frames per second), the smoother the video - but the greater the processor and memory requirements - as shown below -

For a 30 minute video, at 24 fps and 2048 x 872 pixels at 32 bits - the calculations are -

\[
\text{Total frames} = 24 \times 30 \times 60 \quad (\text{frames times seconds}) \\
= 43200
\]

\[
\text{File size per frame} = \frac{2048 \times 872 \times 32}{8 \times 1024} \quad (\text{horizontal x vertical x bit depth - in Kb}) \\
= 6976
\]

\[
\text{Movie file size} = 43200 \times 6976 \\
= 301363200 \text{ Kb} \\
= 287.4 \text{ Gb}
\]

**Image and Animation Processing**

As a series of images are moved at a sufficient rate so animation occurs. With our eye taking about 25 images per second, smooth movement appears at the 30 frames per second, the refresh rate of computer monitors. However, just a 5 minute animation produces 9000 frames (30 x 5 x 60) and this is a considerable task of drawing - animators for cartoons used to spend hundreds of hours producing each short cartoon. These days animation software makes this process much easier - using either -
• **cell based animation** - or cel animation (in the old cartoons, the individual drawings for each frame were painted onto clear sheets of celluloid - hence each frame on a transparent sheet was termed a cel), which involves the drawing and displaying of individual cells or frames.

Each frame is stored and loaded into a graphics page in the primary memory, which is displayed while the next frame is loaded, and so on. Animation is achieved by alternating the display of these graphics pages. This is highly memory intensive, with up to 10 or even 15 million calculations required per second to maintain high quality fast animation.

• **path based animation** - this involves moving objects onto a fixed background in a selected sequence or path, with the pixels of the background remaining the same while those of the moving objects only having to be changed. Thus many animated objects can be moved across a fixed background, and by drawing the object on the background, then wiping out the object, then drawing the object in a new position, the impression of movement is achieved. If necessary, the background can also gradually be moved in a similar fashion.

Animation process = DRAW . . . REMOVE . . . MOVE . . . DRAW . . .

In - betweening (or tweening)
This is where the computer animator creates key positions (normally initial and final) for the characters and the software calculates the distances between corresponding points (e.g. hands, feet, head, etc.) and produces frames to fit in-between the key frames. So long as enough in-between positions are produced, the motion will be smooth and saves the animator from having to do all of the intermediate steps.

**Morphing** (from polymorphic tweening)
This is a similar but more sophisticated technique to tweening, for use with bit-mapped graphics. It is the process by which one shape is turned into another shape gradually e.g. person into tiger - two images.
In morphing, the computer has to calculate the changes that will occur to every individual pixel in all the frames. This requires quite a powerful computer for high resolution graphics - as seen on TV commercials, video clips and movies (Who Killed Roger Rabbit?).

Thus a person can be morphed into a car, or hairstyles can be drastically alternated - but it takes hours to generate several minutes worth of video, as most frames generally need to be retouched using a paint program. Many of the TV commercials are a good example of this.

![Circle to Square](image)

**Warping** is different to morphing in that warping is the distorting of a single graphic (stretching, twisting, etc.) rather than changing from one graphic into another. For example, the mouths of people or animals can be made to alter using this method (appear to say things, grow very large, etc.).

### Exercise 9

1. Use the Animation program Amazing Animation to produce a short animation- 15 minutes only please.

   #### Questions
   
   (i) What type of animation is this program using? Give reasons for your answer.
   
   (ii) What are the strengths and weaknesses of this particular program, from a multimedia point of view?

To be completed by - ........................................

### Issues Related To Multimedia Systems

1. **Copyright** - since all kinds of media are needed for multimedia products to be produced, so this area is of major concern for copyright, since too many people simply copy text, graphics, animations, audio and video clips and add it to their presentation - without a thought for the real ownership of that material. Obviously someone (the author or artist) must create each graphic, each minute of audio, etc. and by law you are not allowed to use the work of another person without their permission. If permission is difficult to get, then at least the source of the material must be acknowledged.

   The **Copyright Act** does allow students to use information for research purposes, allowing the use of a reasonable portion of the original work if it is cited correctly. For an Internet source, this will
Copyright is a moral issue, in that most people will not be caught copying that music CD from a friend, or copying a graphic or animation from the Web, and it is therefore on your conscience rather than the police knocking on your door that stops people from ‘ripping off’ the work of others. Digital data is so easy to alter that an piece of work could easily be modified and called someone else’s.

If you had spent hundreds of hours producing an original piece of work, and someone else copies it (and says it is theirs maybe) then how would you feel? Also, would you bother producing more work if everyone just takes it and you receive no money or recognition for your efforts?

2. Appropriate Use of the Internet
The recent appearance of live video and live performances has created greater concerns over privacy issues, where the individual may no longer be able to control personal data. With streaming of video from mobile cameras or those located in the street, people are being filmed without either their knowledge or permission. If this trend continues, and people have their rights infringed on, then questions will have to be answered on access to our lives.

3. Merging Technologies
The merging of radio, television, communications and the Internet have, along with computer improvements, merged these once separate technologies. For example, phones can be data entry devices for computer systems (using the keypad on the phone), while some Web sites are providing radio and video broadcasts. Will the Internet one day replace radio and television?

Digital data is simply that, whether it be audio, text or video and the widespread use of multimedia is now relatively inexpensive for all. Digital television is now with us, and this allows the user to view different aspects and choices, with higher resolution and greater control over what is being viewed e.g. a racing car can be in view all the time of the race.

Other Information Processes

Processing
The manipulation of data during processing involves the integration of data types, the compression of the data into manageable amounts and the linking of data with hypermedia.

(i) Integration of Data - having been imported into a multimedia program, the various media types need to integrated with their different formats which need to be organised and normally linked interactively.

(ii) Data Compression - the large file sizes associated with multimedia mean that compression and decompression of data files is essential - large graphics, animations, audio and video files easily
extend to gigabytes. Compression is used to reduce the number of bits required to represent the
data, thus allowing greater data storage and allows faster data transfer. Most of this must be
decompressed ‘on the fly’ so that the action and audio go on uninterrupted as the presentation
proceeds. There are standard compressed file formats such as MPEG for video and JPEG or GIF
for graphic images. Conversion programs (such as Graphic Converter) can be used to convert
graphics into one of these formats so they may be easily imported into the authoring program.
Note - GIF’s are limited to 256 colours, while JPEG’s can have up to 16.7 million colours.

A CODEC (from COder-DECoder) is used to encode and decode the various types of data, such as
sound and video files. CODEC’s convert analog video signals into compressed video files (such as
MPEG) or analog audio signals into digitised sound (such as RealAudio). The compression
technique is based on only small differences occurring between successive frames of a video, for
example, so all of the starting frame is stored then just the sequence of changes to successive
frames.

(iii) Hypermedia - as previously covered, the linking of information via hypertext allows the
creator to have a varying degree of interactivity with the user of the product. The information can
be accessed and combined in any number of novel and interesting ways - with the navigation and
options planned for the user. The Internet is the largest example of the use of hypermedia so far.

Storing and Retrieving
Due to the size and complexity of multimedia products, people must have efficient methods for
both the storage and retrieval of the information from that product. Compression types and file
formats combine to provide that efficiency.

(i) Compression techniques - as mentioned above, compression of files is necessary, and the
greater the compression the smaller the files become (though quality is lost if this process goes too
far).
The compression ratio shows the relative size of the compressed to uncompressed file size
e.g. (2:1) means that the file is half its former size, and (3:1) is one third of the original
The two main compression types are termed -

- **lossy compression** - this method removes some data bytes from the file to reduce its size, with
some loss of quality as a result. However video files can be highly compressed without any
detectable change to our eye, while audio files can also be quite compressed without the human
ear detecting a change.
e.g. MPEG files can be compressed up to 200:1

- **lossless compression** - allows the original file to be decompressed in full, by replacing the
repeated data with a symbol that occupies less room - such as replacing often used words - like
‘the’ or ‘and’ with single character symbols and saving 2 characters of space every time. This
method is mainly used with text files (word processor and spreadsheet) generally with a 3:1
compression ratio.
(ii) **File Formats** - the correct file format choice is critical for each media type used in a multimedia presentation. The application software, data quality, type of multimedia presentation and authoring software for the product will all need to be considered. For example, for a Web browser, the images would normally be in GIF or JPEG format. There are many file formats, some old while others have only recently been developed, and these include -

- AIFF
- ASCII
- CGM
- GIF
- JPEG
- PICT
- RealAudio
- TIFF
- WMF
- Animated GIF
- BMP
- EPS
- HTML
- MPEG
- Quicktime
- RTF
- WAV

**Exercise 10**

For the above file formats, construct a table with the following headings and fill it in - Format, Expanded name, Media type, Used to, Strengths/Restrictions

To be completed by - ........................................

**Fields of Expertise for Multimedia**

Normally groups of people produce multimedia productions, with a range of skills and expertise over the group. Depending on the size of the project and the budget, these people may fill multiple roles or each may be separate people. These include -

- content providers - people who provide the text, graphics, video, audio tracks, etc.
- system designer - person who plans and organises the required hardware and software (may also be the project manager)
- project manager - person who organises the scheduling of each of the parts and supervises the delivery of all of the components on time.
- technical staff - people with the artistic and technical skills to edit, format and design all of the content for the final product.