Chapter 2
Multimedia hardware

Chapter summary

This chapter provides an overview of the hardware required for multimedia development and delivery. Studying this chapter will help you to understand all the various issues related to multimedia hardware and be able to compare the differences between hardware for multimedia development and delivery.

Learning outcomes

After studying this chapter you should aim to achieve these targets by answering the questions at the end of the chapter. You should be able to:

Outcome 1: Compare and contrast different types of computer used for multimedia development.

Outcome 2: Describe the main input and output devices used in multimedia development and delivery.

Outcome 3: Outline the role of networks in multimedia development and delivery.

Outcome 4: Summarise the main end user hardware issues.

How will you be assessed on this?

In an exam you might have to suggest what hardware would be appropriate for multimedia development and be able to roughly describe the specification of a suitable computer system for a given scenario. In course work you might have to explain what hardware you used to complete a project or explain for what end user hardware you have designed your application.

Section 1

Computers

In this section you will learn about the specification of computers and their use in multimedia development and delivery.

The two types of **desktop computer** used for multimedia development are the **Apple Mac** and the Microsoft Windows based **personal computer** or **PC.** Both platforms share these common components as do most types of computer:

• **Processor**	The processor or central processing unit is the key component and controls the rest of the computer and executes programs.
• **Cache**	Cache is a small amount of very high speed memory built into the processor for doing immediate calculations.
• **RAM memory**	RAM (random access memory) is the working memory where the current application program resides.
• **System bus**	The system bus connects all the necessary devices to the processor. There are other buses that connect to the system bus like SCSI for hard drives.
• **Motherboard**	The processor, cache, RAM and system bus all reside on a main printed circuit board called the motherboard.
• **Operating system**	The operating system manages the loading and unloading of applications and files and the communication with other peripheral devices like printers.
• **Storage devices**	Application programs and working files are saved longer term on different kinds of storage device. Storage devices include hard disk drives, CD-ROMs and floppy drives.
• **Input/output devices**	Connected to the system bus are a number of other devices that control the other essential components of a desk top computer including the monitor, mouse, keyboard, speakers, printer, scanner.
• **Expansion bus**	Most desktops should include 'slots' into which other non-standard devices can be installed.

The latest specification Macs and PCs are capable of running the application tools necessary for developing standard multimedia applications. The standard applications are image, sound and video editing, animation and multimedia integration. Comparisons of the performance of the latest generation of PCs and Macs are hotly contested but in general they are now roughly the same with each type of computer performing better on some tasks than others. Apple Macs have, in the past, been more associated with the multimedia industry, however PCs are increasingly being used since they are now capable of undertaking the same processor intensive tasks like video compression equally well. High specification computers are required to undertake some of the tasks required in multimedia development and Figure 2.1 shows the specification of a recent PC and Mac base unit that are appropriate.

PC	**Mac**
Based on an Intel Pentium P3 processor running at a clockspeed of 1GHz or the AMD Athlon at 1.4GHz	Based on two Motorola PowerPC G4 processors running at clockspeed of 1 Ghz
128Kbyte L1 and 256Kbyte L2 cache	32Kbyte L1 Kbyte L2 and 2Mbyte L3 cache
512Mbyte Ram expandable to 2Gbyte	512Mbyte Ram expandable to 2Gbyte
System bus is the peripheral components interface or PCI	System bus is the peripheral components interface or PCI
Microsoft Windows XP operating system	Apple MacOS X operating system
Storage devices: 1. 60Gbyte hard drive connected via a SCSI or Ultra ATA/100 interface. 2. CD-ROM writer	Storage devices: 1. 60Gbyte hard drive connected via an Ultra ATA/100 interface 2. CD-ROM writer
4 PCI expansion slots	4 PCI expansion slots

Figure 2.1 Specification of the base unit of recent PCs and Macs suitable for multimedia development

There are other types of computer used in multimedia developed particularly for graphics processing, video capture, and editing and 3D modelling. For example, the **SGI Silicon Graphics Octane2** computer is specifically designed for visualisation, 3D modelling and other graphical applications and is based on SGI's own R14000A processor and a version of the UNIX operating system. 300 SGI Octane2 computers were used to create the 3D animated characters for Disney and Pixar's *Toy Story 2* film.

There are a number of storage devices used in multimedia development, the key one being the **hard disk drive**. It is important to have a large hard disk drive to undertake some tasks like video and sound editing, however the latest desktop computers come with a minimum of 60Gbyte of capacity which is enough for most standard tasks. Currently, hard disk drives have capacities up to 120Gbytes and data transfer rates of 160Mbits per second. There two standard types of hard drive used in desktop computers – enhanced integrated drive electronics (EIDE) or Ultra ATA based drives and small computer system interface (SCSI) based drives.

Optical disk drives including the **compact disk-ROM** (**CD-ROM**), **CD-Recordable (CR-R)**, **CD-Rewriteable** (**CD-RW**) and the **digital versatile disk drives (DVD)** are also key storage devices. The CD-ROM was the standard medium for delivering multimedia throughout much of the 1990s but is being superseded by the rapid development of the Web. Computers used for multimedia development should include a CD-RW drive for reading and writing CD-ROMs disks. CD-R drives, sometimes called WORM (write once read many) drives, are used for backup purposes and also for creating master copies of multimedia applications. For batch production purposes CD-Copiers are used for copying and labelling 50 CDs at once. CD-ROM drives store up to 660Mbyte at access speeds of up to 7200Kbits per second. Currently CD-RW drives work at lower access speeds but are becoming standard since they are re-recordable and are making the 3.5'' floppy drive redundant. CDs are all based on a particular **CD standard** named after the colour of its covers. The original audio CD was based on the yellow book standard, the CD-ROM on the red book but is also compatible with the yellow book standard so you can listen to audio CDs on your computer. CD-R and CD-RW are based on the orange book standard. It is likely that DVD drives and in particular DVD rewriteable drives will eventually supersede CD-ROM technology with storage capacities up to 17Gbyte and faster transfer speeds.

CRUCIAL CONCEPTS

Desktop computer: a computer that sits on desktops and that contains a processor, RAM, system bus, motherboard, operating system, storage devices and input and output devices. Multimedia desktop computers must be of a high specification. **CD standards** are the yellow, red and orange books which specify the audio, CD-ROM and CD-RW formats for optical disk technology.

CRUCIAL TIP

Search the Web sites of computer manufacturers like Apple and Dell and find out what are the latest specifications of desktop computers. Then search the Web to find out about what the specifications listed mean, e.g. what is a RAID drive?

Quick test

What are the main storage devices used in multimedia development?

Section 2

Input devices

The last section discussed the key specifications of computers used in multimedia development. In this section we consider the various input devices which are attached to a computer for multimedia development and delivery.

Keyboards

Input devices enable users to input different kinds of data from text through to video into a computer. **Keyboards** have not changed in layout since the QWERTY arrangement of the nineteenth century although there have been several attempts at improving its layout. The design of the keyboards has improved with cordless and ergonomically contoured keyboards like that shown in Figure 2.2.

Figure 2.2 Ergonomically contoured keyboard

Pointing devices

There are a range of **pointing devices** used in multimedia development and delivery. The classic pointing device is the mouse which is now available cordless and is based on an optical sensor rather than a rolling ball. Multimedia developers who are engaged in image or video editing may wish to use more sophisticated pointing devices like a trackerball or tablet. Figure 2.3 shows a state of the art trackerball which gives developers finer control over the position of the pointer without moving their hands.

Figure 2.3 State of the art trackerball

The other pointing device used by developers is the **digitising tablet** as shown in Figure 2.4. Either a special pen or a mouse is used as the pointing device allowing developers to map the dimensions of the tablet to the dimensions of the screen so that extreme points of the tablet match the extreme points of the screen. Multimedia developers can place pictures onto the digitising tablet and 'trace' them if they need to.

Figure 2.4 Digitising tablet with mouse and pen

Sound recording equipment

The use of sound in its various forms is a component of a multimedia application and the quality of the recording equipment is important in determining the final quality of the sound. **Sound recording equipment** ranges from a simple tape cassette recorder for low budget amateur sound productions to a fully equipped professional recording studio. The essential pieces of hardware for recording sound are microphones or musical instruments for creating the sound source, portable recording equipment like a digital audio tape (DAT) recorder for use outside a studio, a multitrack **mixing console** for editing and mixing various sources of sound and another storage device like a DAT recorder. **DAT recorders** enable sound to be recorded at sampling rates up to 96KHz and 16 bits per sample. The medium for the recording, editing and capture of music is generally undertaken using the MIDI data format and today most electronic instruments and equipment associated with music support it. Chapter 10 explains how MIDI works.

Once the sound has been recorded it must be input into a computer for further editing and integration into a multimedia application. Output from digital sources like a DAT recorder can be input directly into a computer without conversion, however analogue sources need to be captured, i.e. converted from analogue to digital. Standard **sound cards** installed in most desktop computers can receive and convert analogue sound sources. Sound cards have a number of different input sockets for various sound sources and can support sample frequencies up to 192KHz at 24 bits per sample. Sound cards also convert sound from digital to analogue for output to speakers.

Video recording equipment

The hardware used in professional video production is beyond the scope of this book so we focus on the kind of equipment that could be used by a small independent multimedia design company or home users. Basic **video recording equipment** includes either an analogue or **digital video camera** and a **video capture card** installed in a desktop computer. Video capture cards are different to graphic display cards which are not capable of video capture. Although many video experts still prefer using analogue cameras, digital video cameras are becoming more standard offering 6Mb/s data rate or up to 30 frames per second at a resolution of 720 by 480 pixels. Once a piece of video has been recorded it needs to be captured; digital video cameras can be connected directly to one of the USB or serial ports on the desktop computer but analogue video needs to be captured via a video capture card. Video capture cards receive analogue video signals through one of their ports and sample it at a frequency up to 30 frames per second, a resolution of 768 by 576 pixels and a sample size of 24 bits per pixel. Video capture requires high specification desktop computers with a fast, high capacity hard disk drive to cope with the input video data.

Image scanners

The last type of input device used in multimedia development which you should be aware of are **image scanners**. Scanners enable developers to digitise hard copies of pictures and photographs ready for editing and inclusion in multimedia projects. Standard flatbed scanners (see Figure 2.5) are available in up to A3 size and scan up to 2400 dots per inch (dpi) with a colour depth of up to 48 bits per pixel.

Figure 2.5 UMAX Astra 4700 Flatbed Scanner

CRUCIAL CONCEPTS

Pointing device: a range of devices used with PCs and Macs that include mouse, trackerballs and digitising tablets.
Sound recording equipment includes sound recorders like DAT or tape cassette, various microphones, mixing consoles that are used to create sound for multimedia applications.
Video recording equipment includes the various hardware used to create digital video, including analogue and digital video cameras, analogue and digital editing studios, video cassette players and video capture cards.

CRUCIAL TIP

Visit www.pctechguide.com to learn about input devices in detail.

Quick test

What kind of pointing devices do multimedia developers use and why?

Section 3

Output devices

In this section we consider the various output devices which are attached to a computer for multimedia development and delivery.

Monitors

The most important output device for multimedia development and delivery is the **monitor**. Thus the quality of monitors and the **graphic display cards** that drive them are important considerations for multimedia developers. Multimedia developers need to use large 17'' or 19'' (measured diagonally across the screen) monitors in order to have room to display the multimedia application under development and the various dialogue boxes of the authoring tools. Some multimedia developers use two monitors that are driven using special graphics cards so that they can see the multimedia application on one screen and have the tools displayed on the other.

Large monitors do not necessarily mean that more information can be displayed. The amount of detail displayed on a monitor is dictated by its screen resolution and the resolution that the graphics display card is capable of delivering. See Chapter 8 for an explanation of the meaning of resolution. Multimedia development needs large monitors that support high screen resolutions and a large number of colours. Currently, the most common standard for graphic display cards on PCs used for multimedia development is the **Ultra Extended Graphics Array** or UXGA which enables a monitor to display 1600 by 1200 pixels and up to 16.7 million colours. There are a number of other competing standards. Graphic display cards have their own special RAM which contains the current screen display pixel by pixel. Some multimedia tasks, like video and image editing and displaying 3D graphics, require between 4 and 8Mbytes of graphic display RAM.

An important type of monitor for use in point of information applications are **touch screens** which are both input and output devices. Touch screens are an intuitive way for users to interact with a multimedia application by allowing them to touch buttons and links directly rather than indirectly via a mouse or other pointing device. Touch screens include three key components:

- a touch screen sensor panel that generates a voltage to indicate where the screen was touched;
- a controller that converts the voltage into a digital signal and transmits it to the processor; and
- a software driver to translate the digital signal into data that emulates the mouse.

There is one other type of monitor which is used in public multimedia presentations called a **data projector.** Data projectors enable the normal output from a computer to be projected onto a large screen so that a larger audience can see. Some data projectors include special display screens which act like enormous digitising tablets so the display can be used as if it were a touch screen.

Speakers

Another crucial output device for multimedia applications are the **speakers** which provide the sound outputs. Speakers are driven by sound cards as explained in the last section. Most sound cards support the **SoundBlaster** standard developed by Creative Labs and the General MIDI standard (see Chapter 10 for an explanation of MIDI) for sound reproduction. Speakers used with desktop computers usually require their own power source and have built-in amplifiers.

Printers

The last type of output device used in multimedia is the **printer**. For multimedia development it is important to have a high quality colour printer to show screen shots to clients and for discussing particular elements of a multimedia project. It is impossible for a printer to exactly match the on-screen colours, however they are helpful in seeing the general look and feel of an application. There are two types of colour printer - laser and inkjet. Currently a top of the range inkjet printer is capable of outputing about 1.5 pages per minute at a quality of 1200 by 600 dpi and a similar priced colour laser can output four pages per minute at a quality of 600 by 600 dpi. The new inkjet and colour laser printers allow you to change each of the colour cartridges (cyan, magenta, yellow and black) separately. The latest inkjet printers also allow you to purchase each of the colour print heads and associated ink cartridges separately hence reducing the cost of printing. Currently colour laser printers have a lower cost per page than an equivalent inkjet printer.

CRUCIAL CONCEPT

Graphics display cards are installed in desktop computers and drive the monitor. The most up to date standard is the ultra extended graphics array.

Quick test

What kinds of monitors are used for multimedia development?

Section 4

Networks

In most multimedia design studios computers and peripheral devices are generally networked together. Therefore you should have some understanding of the principles of local area networks. Also the Web has become an important medium for delivering multimedia so you should have some understanding of the hardware used in the Web and the Internet.

Computers and other devices in multimedia design studios are often networked together to enable people to share files and devices. A **network** simply means that a group of computers and other devices like printers are linked together, usually by cable which allows people to send files of data to each other and to share devices. A network that only extends to a room or single building is referred to as a **local area network** or **LAN**. Typically, each computer in a network has a **network interface card** (NIC) installed in one of their expansion slots to which a network cable is attached. The most common type of network is based on the Ethernet protocol which defines the rules by which each computer can use the network to avoid more than one computer trying to use the network simultaneously. Figure 2.6 shows a typical network used in a multimedia design studio and includes a file server, scanner and several printers. A **file server** is a special computer with a large storage capacity where designers usually save their work rather than on their local computer so that they can be available to everyone else in the studio. The hard disk drives of file servers need to be fast so they tend use a different type of bus like SCSI or RAID. Often one or two of the computers in a design studio serve a dedicated purpose so for example, one of the computers in Figure 2.6 is a dedicated video editing suite which can be used when needed and enabling any files produced to be placed on the file server.

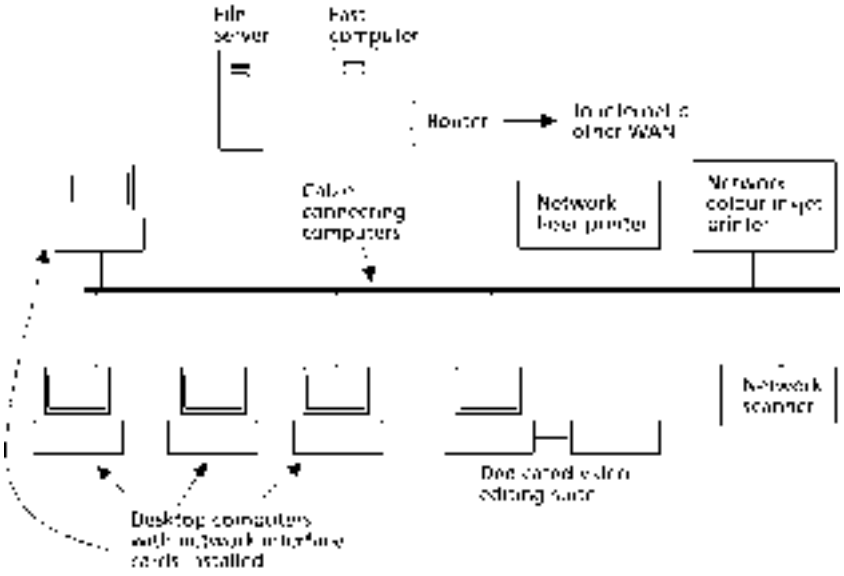

Figure 2.6 A multimedia design studio network

A network which extends over a broader geographic area is referred to as **wide area network** (WAN), a good example being the Internet. Chapter 12 explains what hardware is involved in the Internet and the Web. To enable designers to connect to a WAN, particularly the Internet, a **router** is included in the LAN configuration as shown in Figure 2.6. A router is usually a fast computer with at least one network interface card and at least one WAN interface card.

CRUCIAL CONCEPTS

Network: An arrangement of computers and other devices linked together via a cable enabling files and devices to be shared.
Local area network (LAN): A network limited to one room or building.
Wide area network (WAN): a network which extends over a large geographic area.

Quick test

What are the benefits of a local area network in a multimedia design studio?

CRUCIAL TIP

Practise drawing the diagram of a network in Figure 2.6.

Section 5

End user hardware issues

So far we have focused on hardware designed for multimedia development. However there are a number of important end user hardware considerations of which a multimedia designer should be aware.

Multimedia designers will be using high specification computers with large, high quality monitors. However the end users' hardware will most probably be of lower specification and use different input and output devices. It is therefore important that designers define the **minimum specification** they are designing for. Ideally a minimum specification computer is set up somewhere in the design studio to check the performance of an application. Figure 2.7 gives a breakdown of the **end user hardware issues** of the various elements of hardware.

So far, we have been assuming the end user will have a desktop computer. However many multimedia applications are often placed in public spaces like museums, libraries or airports. A multimedia application that is found in a public space is referred to as a **multimedia kiosk** or **point of information terminal** (POI). The important hardware issue to consider when designing a multimedia kiosk is the higher levels of usage and therefore the need for more durable hardware. Generally kiosks are enclosed in a cabinet so end users cannot interfere with the computer. However the output devices (monitor, speakers) and the input devices (pointing devices) could be. So the monitors, keyboards, speakers and pointing devices must be robust to cope with heavy usage. Since mice require some maintenance touch screens (see Section 2) are often used as the pointing device. If the application requires the end user to carry out drag and drop actions a trackerball might be embedded in the kiosk cabinet. Purpose built keyboards are sometimes used with a limited number of keys to provide for the actions used in the application like navigation buttons.

Element	Issues
• **Processor**	The developers' computers will be using high specification processors. The end users' computers will use processors from different manufacturers running at different speeds. Developers should therefore be careful not to optimise their applications for a particular processor or chipset.
• **RAM memory**	Developers must make sure their applications do not require an unreasonable amount of RAM to run efficiently.
• **Operating system**	Differences in operating system are very problematic for developers and could mean producing more than one version of an application.
• **Storage devices**	Recent hard disk drives of at least 10Gb are generally of sufficient capacity to cope with typical multimedia applications. However many end users will have relatively low speed CD-ROM drives so developers must make sure that their applications will run adequately on low specification CD-ROM drives or arrange for the install program to copy files which require fast access on to the end users' hard disk drives.
• **Monitor**	This is one of the most important considerations for designers. Designers will be working with large 19'' or dual monitors at high screen resolutions supporting 24 bit colour. A significant proportion of end users will have a 15'' monitors, running at lower screen resolution and maybe only 8 bit colour depth. It is imperative designers test out their materials with a low specification monitor and declare a minimum standard for end users.
• **Pointing devices**	As noted developers tend to use digitising tablets or trackerballs for extra precision. End users will in general be using mice. Applications should be tested out using mice.

Figure 2.7 End user hardware issues

CRUCIAL CONCEPTS

Minimum specification is a list of the hardware requirements that a particular application needs to run properly.
End user delivery issues are the list of issues designers must consider when designing their applications, perhaps the key one is the resolution and colour depth of the monitor.
Multimedia kiosk/point of information terminal are multimedia applications placed in public spaces. The hardware used must be robust to withstand heavy usage.

Quick test

What should multimedia designers be aware of when designing for end users?

Section 6

End of chapter assessment

Multiple choice questions

1. Which of the following is true about desktop computers?

   a) The SGI Octane2 is the most commonly used multimedia computer.
   b) 32Mb of RAM is sufficient for most multimedia development work.
   c) Multimedia development computers should include an expansion bus.
   d) Multimedia development computers do not need an operating system.

2. Which of the following statements is true about storage devices?
   a) Hard disk drive capacity should be at least 60Gb for multimedia development.
   b) There are two standard types of hard disk drive – PCI and SCSI.
   c) CD-Rs are based on the yellow book standard.
   d) CD-ROM technology is superior to DVD technology.

3. Which of the following statements is true about input devices used for multimedia development?
   a) Image scanners are used for displaying images.
   b) Graphic display cards are capable of video capture.
   c) Sound cards are capable of sound capture and output.
   d) Multimedia designers only use mice as pointing devices.

4. Which of the following statements is true of display devices used in multimedia development?
   a) Developers generally use touch screens.
   b) The screen resolution dictates the number of displayable colours.
   c) Graphic display cards have their own RAM.
   d) Large monitors are required to displayed more information.

5. Which of the following is true about a networked multimedia studio?
   a) Each computer needs a network interface card.
   b) Each computer needs a file server.
   c) The Internet is an example of a LAN.
   d) Generally each computer on a network has its own printer and scanner.

6. Which of the following statements is true of end user's hardware:
   a) The end user's specification will not be the same as the designer's.
   b) Designers should decide on a minimum specification.
   c) Most end users have 19'' monitors.
   d) Multimedia kiosks use standard desktop input and output devices.

Multiple choice answers

1. c)
2. a)
3. c)
4. c)
5. a)
6. b)

Exercises

1. You have been asked to come up with the specification of a new design studio for a large company who want to produce multimedia training applications for their staff. Write down and explain your choices of hardware.

2. You are designing an interactive multimedia application that will be made available over the Web. Write down the kinds of issues you need to consider about the end users' hardware.

3. What extra hardware or equipment is required to produce digital sound and video?

Answers

1. This question gives you a lot of scope to explain what you know about the hardware required to undertake development work. You could start by considering whether to choose Apple or PC based computers and their respective specifications. Once you have considered this you can write down the choices of input and output devices, especially sound and video recording and editing equipment. A set-up like this would require a network so you should reproduce and explain a diagram similar to that in Figure 2.6. If this design studio is producing training materials for its staff it will need to make its materials available. This will either by via the Web, in which case they will need a HTTP server, on the network (see Chapter 12) or a multiple CD copier.

2. You should start your answer by explaining the issues of bandwidth (see Chapter 12) and the problems of knowing what are the end users' computer configurations. If the application is going to be interactive, the end user must have computer hardware that can cope with the (i) the time to download interactive applications (ii) running the application. You should suggest the need to stipulate a minimum specification for running the application. Now you can consider what that minimum specification should be so you can discuss the screen resolution, processor, amount of RAM, hard disk drive and variations in operating system and browser.

3. To answer this question fully it is helpful to have read and understood Chapters 10 and 11 on sound and video. To produce digital sound you need to consider the equipment used to record the required sound – e.g. DAT recorder, sound studio setup and the issue of MIDI or digital audio; the equipment used to edit the sound either digital or analogue including a mixing desk; and the hardware required to capture the sound track – sound card, reproduction equipment to connect up to the sound card and a desktop computer capable of capturing and storing sound. A better answer would include a brief overview of the process of editing digital sound found in Chapter 10. The situation for digital video is similar. Explain what equipment is used to record video and capture video. Video capture is one of the most demanding tasks for a desktop computer so you should explain that a high specification computer is required and suggest a suitable specification. Unlike sound capture, where the sound card can both output and receive sound, video capture generally requires a dedicated card separate to the display card which has a significant amount of on board memory.

Section 7

Further reading

Buchanan, W. (1999) *Mastering Networks*, Macmillan.
Englander, I. (2000) *Architecture of Computer Hardware and Systems Software: An IT Approach (2nd edition)*, John Wiley and Sons.