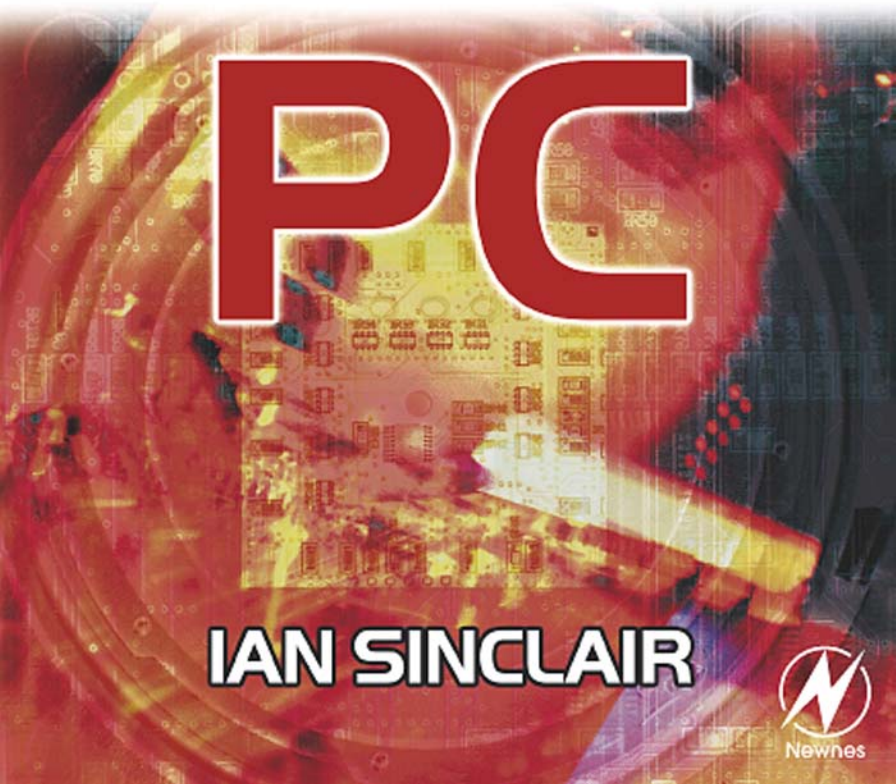
FOURTH EDITION

BUILD & UPGRADE YOUR OWN PC



IAN SINCLAIR

Newnes

Build and Upgrade Your Own PC

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Fourth edition

Ian Sinclair

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Preface to fourth edition

The mass production of PC chips, circuit boards and accessories of all types has led to the growth of a thriving assembly industry in PC machines. The result is that it has for many years been possible for anyone with facilities for assembling circuit boards into cases to put together PCs with capabilities equal to all but a few modern designs. The sheer number of small-scale suppliers, and the standardization of design, indicates how easy this work can be, using plug-in boards from the lowest cost sources. Construction, in this sense, can mean assembly, and not necessarily much assembly in some examples.

The small-scale assemblers, most of whom can offer machines with high specifications, cannot necessarily offer much more than hardware. In particular, they cannot offer a manual that makes much sense to the first-time user, and even an experienced PC user can be baffled by a new machine if little or no information is available.

This book is a form of manual that will cover the construction of a PC, either from scratch or following the much more common (and more rational) method of buying a low-cost machine from a local assembler, or from other sources such as auctions, and improving it as required. It also covers upgrading, ranging from simple plug-in additions that do not require the casing of the computer to be opened, to radical upgrading of the interior.

This book will also be a useful reference text for users of all the machines that can be described as generic, machines which are very closely compatible with standard PC/AT design but with enhanced facilities. If your low-cost PC comes provided with a manual that can be politely described as rudimentary, this book is one that will be useful to you. To avoid making this book unnecessarily long, the construction of machines to older specifications has been relegated to the last chapter because the parts are now quite difficult to obtain, and such machines can be obtained ready-made at very low prices if you shop around. The emphasis in this edition will be on the construction of a machine to modern standards (typically at least an 850 MHz clock speed) or updating a machine of close to this standard to a higher standard (more than 2 GHz clock speed).

To clarify terms, the first IBM desktop machines were known as PC, meaning personal computer. AT means *Advanced Technology*, and the PC/AT type of machine set the standard that is still followed (with many improvements) today. This type of machine is also referred to as ISA, meaning *Industry Standard Architecture,* and the letters EISA (E meaning *Extended* or Enhanced) are also used of the later versions such as the MMX types (the use of the term MMX is now discontinued, since all processor chips for PCs are of this type). We are concerned in this book with EISA machines using processors of the Pentium 3/4, Celeron, AMD Duron and Athlon (with a mention of the later Opteron) types.

One point that often worries prospective DIY builders is that their machine will be non-standard. The fact is that a home constructed machine is likely to be totally standard, more so than some big-name varieties, and more adaptable to upgrading. Another worry is that some inadvertent action will destroy the whole machine, and this also is a myth unless you make a habit of dropping hammers into equipment. Perhaps we should add the worry that the machine will be damaged in some way by unsuitable software or when a program locks up. As this book points out, the computer clears its memory when it is switched off, and a fault in a program cannot affect any other program that is run after restarting like this. Unless a runaway program has, by a most unusual fluke, altered the contents of the hard drive, no harm will be done. By contrast, the type of program that we class as a virus will often alter the hard drive contents – careless use of the Internet is much more dangerous than building your own computer.

- The most dangerous action, as far as a computer is concerned, is a hard knock on the casing while the hard drive is working.

Two new chapters, one on computer security and one on common problems regarding hardware and software, have been added to this book to make it more useful to buyers who are concerned about such points.

As it happens, building a PC totally from scratch is usually **more** expensive than buying a machine from some of the small-scale firms, and most private owners take the course of buying only as much as they need of an assembled machine – often a case, PSU, and motherboard only. Many suppliers specialize in this type of *bare-bones* machine, and because the parts are usually standardized, such machines are easy to work with and to upgrade. By far the easiest of these bare-bones machines to assemble are the new small-form factor types such as the well-known Shuttle. By starting in this way you can gain a price advantage, because there is no way that you can buy components cheaper than an assembler who can buy in bulk. The casing, for example, that costs you £55 may have been bought for less than £10 each, but only in container loads. You may, however, feel that you can use the monitor, casing, keyboard and some other parts from an older machine that you are currently using, but only if the machine is not **too** old. The point of assembling your PC in this way is that you can also upgrade for yourself, avoiding the high costs that are so often associated with changing hardware. A second-hand computer, after all, depreciates like a second-hand car.

Once again, though, you need to know a fair bit about PCs to know what can, and can not, be upgraded. Since the actions of upgrading are almost identical to those of constructing from scratch, the snags of upgrading are discussed in a separate chapter.

Another route which is now significant is to buy machines that have been discarded by local authorities and other corporate users. The more a local authority or nationalized service complains about lack of money the more computers they appear to scrap (not sell), simply because they are not the most recent models. These machines are found at auctions and at car-boot sales, often at very low prices. Some are older 80486 types which are almost useless, others are almost new Pentium machines which have been used in networks and which may lack a hard drive. Prices of £50 to £100 make this a very encouraging start and one which is much cheaper than buying all parts separately.

Another possible reason for building your own is to make a machine to a high specification but without items that are irrelevant to your needs. You might, for example, want to build a machine with the fastest processing speed attainable, but without the DVD drive, scanner, CD-R/RW, Webcam and other accessories that would almost certainly be loaded on to such a machine if you bought it ready-made.

The aim of the book is to provide information for anyone taking any of these routes, because no manuals will be available. Since many readers of this book are likely to be experienced in electronics, some aspects of computer circuitry and disk recording are explained in more detail than would be relevant to the reader with no electronics background. Other than these paragraphs, the book is intended to be used by newcomers and experienced users alike, either in computing or in electronics.

- Other new topics that have been covered in this edition are the use of DVD recording drives, sound and video editing, and broadband Internet access.
- Since the effects of construction and upgrading cannot be judged without the essential software, the essentials of installing Windows *Me*, and Windows XP, the operating systems that are most suited to the home constructor, are also included, along with a section on printers. For details of how to use Windows, see the various *Pocket Books* and *Made Simple* books from Newnes.

I am most grateful to August One Communications Ltd. for Windows *Me* and Windows XP discs for evaluation. I am also grateful to AMD Inc. for permission to use some images from their excellent website devoted to the construction of a PC using the Athlon processor.

Ian Sinclair
May, 2004

Part I

Planning

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Chapter 1

Initial planning

Planning is the most important, and most neglected, aspect of building your own computer. It is particularly important if this is your first building project, but it still needs to be done thoroughly and carefully even if you have built a machine previously. There are two particularly useful resources for planning: one is the availability of magazines aimed at computer users, the other is availability of information over the Internet. You can get by with just one of these, but your planning will not be well guided if you have neither.

There are four main parts to a plan for a self-build project. They can be listed as:

- What do you want a computer to do?
- What do you need to build?
- What components do you need?
- What buying options are available?

We'll look at each one of these in turn in the course of this chapter.

Because of the importance of planning, it can't be done in a hurry. This means that you should not be looking for the latest and flashiest trends in machine design or components. For one thing, the rate at which things change in the computing world means that you can never be fully up to date in anything unless you're prepared to spend a very large amount and work very quickly. In addition, computer manufacturers will always be able to purchase the latest bits and pieces long before you can get your hands on them, and put them into heavily advertised machines at low prices, lower than it would cost you to buy the same parts.

The other point is that the latest and most fashionable items are often the ones with which you are most likely to meet trouble, and with the least prospect of any help because they will be unfamiliar to many other users. If you are building for yourself you can't afford to be a guinea-pig – you won't have a large stock of components you can use as substitutes if something doesn't work. Keep to well-tried components, and you have a much greater chance of success as well as spending less. At the time of writing, the design standards are changing again, but you will be better off keeping to the older standards for some time to come.

Do your planning in an unhurried way. Once you know what you want your computer to do and what you need to build, that's the time to start looking for all the advice you can get in magazines and over the Internet. In particular, this is how you know if what you want to do is feasible. For example, you might want to build a machine for which all the components are now out of date and difficult to find. You might find that some of your favourite programs cannot be used on the most recent version of Microsoft Windows, and you would need to be sure that if you bought an older version of Windows you could still use these programs. Most important of all, you might find that your choice of components would cause problems of incompatibility, something we'll come back to several times in this book.

- This is not exactly a comfort if you are building for the first time, but you will find the construction of your second machine much easier than the first unless techniques have changed totally in the time between the two. That's another way of saying that if you don't read the instructions, you might find that the way you did it last time is totally inappropriate to the way you need to work for another later machine. That's particularly important if you want to build a Shuttle or other small-format machine.

Remember too that planning does not stop when you buy your components. You need to read all documentation thoroughly, because that can often be where you find that problems of compatibility are noted and (sometimes!) solutions also. You also need to get a good idea of what you are going to do before you are in the middle of construction. This is particularly important if you will be without any Internet connection while you are constructing a machine.

- An important part of planning is keeping a log of what you want to do and to buy, with reasons for each choice. When you are about to start construction you should make lists of your components and of the order of actions, and when you are going to install software you should also list the order in which you install. This may all sound rather bureaucratic, but it can save a lot of time in the long run (when you buy a heavily-advertised component and remember why you had originally rejected it, or when you find that one program you have installed conflicts with another and you cannot remember in which order you installed them).

Cherished hardware can be a problem also. As we'll point out later, all hardware items such as printers and scanners depend on the use of short programs called *drivers*. These drivers are a link between the computer's operating system (Windows) and the hardware, and they are frequently changed and updated. Changing to a new version of Windows may require new drivers, and some of the older and/or more exotic hardware items may not have drivers for the most recent versions of Windows. This could have the effect of making the hardware unusable. The later versions of Windows, such as XP, will carry out a hardware and software scan for you before you install Windows so that you can find out if there is likely to be any problem with your hardware. Older versions of Windows are not so obliging in this respect, but, as a compensation, are less likely to be fussy about your hardware drivers.

- Don't be tempted by alternatives to Windows. Building your own computer is not so very difficult, but installing it with software that is not a majority preference can triple your troubles, because you are very much on your own, despite the help on the net for users of systems such as Linux. The trouble with alternative operating systems is that they are designed for enthusiasts and professionals, and the help that you can get is often couched in very technical terms. By contrast, almost everyone is familiar with Windows, its way of doing things and its problems, and you can always get solutions in everyday language. If you are likely to be bitten by the Linux bug, make sure first that your computer can be used with Windows as well until you eventually opt for one rather than the other.

Compatibility

Another important point concerns the compatibility of components. This is something that is a major problem for the home constructor, because you have such a bewildering range of components to choose from. Even with considerable experience of home construction, you can still be caught out by things that you take for granted. You might think, for example, that if a specification for a motherboard states that it will take very fast processors, then it would be an advantage to buy a fast processor. You might find, however, that no matter how fast your processor could run, it will be set at a low speed by the motherboard. Most motherboards will allow you to set speeds almost at will (sometimes fast enough to fry the processor); a few run only at a set speed that you change only with difficulty and at your own risk.

The worst compatibility problems concern the processor, the power supply, the motherboard, the memory, and the video card. You might think that by buying a motherboard with built-in video (and often sound also), one source of incompatibility might be eliminated, but in my experience this is not entirely true, as I have had more problems with built-in video and sound than with the use of separate plug-in cards.

- These last two paragraphs have started to mention items of hardware, and there will be explanations of these items and how they contribute to the working of the computer later on in this section.
- By contrast, you can add peripherals such as printers and scanners with very little fear that they might cause incompatibility problems. I have, however, been very disappointed with one brand of combination printer/scanner/copier which I had to ditch when I found that it could not print label sheets that presented no problem to other printers.
- Your planning should concentrate initially on constructing a no-frills machine with the minimum of components, no peripherals (other than mouse, monitor and keyboard) that need drivers, and

no software other than Windows (apart from video and port drivers). Once you have this up and running satisfactorily you can then plan for adding further software and hardware.

Before you start planning to build your own computer, you need to know a few facts, and the answers to what we call FAQs (meaning frequently asked questions).

The first point that you need to be clear on is that there are limits to DIY. You are not expected to build a monitor, keyboard, mouse or printer, and there are no kits of parts available for constructing these items. Assembly work is limited to the main processing unit, and one good reason for this is safety. There are no exposed high-voltage points in the main processing unit, and assembly is limited to plugging and fastening circuit boards and other units into place. The other main reason is that standardized parts are readily available only for the main processing unit.

If you intend to assemble the whole computer system, including keyboard, mouse, monitor, printer, Windows software, and other accessories such as scanner or digital camera, you will pay much more for the privilege of doing it all yourself than you would if you bought a package from Dabs, Evesham, PC World, Mesh, Time Computing, to give just a few well-known sources. This should not come as a surprise because the same applies to many other DIY projects, particularly cars. You will never have the advantage of getting the low prices on single components that can be obtained by someone who can order in thousands.

You might, of course, already have a keyboard, mouse, monitor and printer and possibly other devices as well, and want only to build the main processing unit. In this case, because there are few suppliers of this item of hardware by itself, you might very well make a cash saving. You might want a machine that is not so elaborately specified as the models that are on sale, or one that incorporates items that are not usually part of a ready-made machine.

- Many modern packages that are sold at prices of around £300–£1000 are intended for a user who has nothing or is replacing a very old system, and who needs a fast complete machine, often for games use, with printer, scanner, digital camera and all sorts of other accessories. If this applies to you, then such a package is your easiest route into computing. If you don't need all the bells and whistles, or if you have items such as a monitor and keyboard already, then the advice in this book will save you money and time.

- The other side of this sort of thing is that a package may not contain precisely what you want, and to get exactly what you want might cost considerably more than you want to spend.

Selling an old computer to help finance a new one is seldom economic, because a second-hand computer, unless it is a very recent model, is difficult to sell, and prices are low despite the overblown values some sellers hopefully put on their old machines. If your 'old' computer is not too old you are always likely to be better off by upgrading it rather than selling it and building a new machine.

- You can sometimes find that a beginner would welcome an old machine at a low price just as a learning experience and an introduction to computing. If you know someone in this category then by all means offer them your old machine, but remember that this may put you in the position of being consulted each time the beginner encounters something that he/she cannot understand.
- If you also want a better keyboard, a larger monitor, and possibly a better printer as well as the main processing unit, then forget the idea of doing any construction for yourself unless you really want to get into construction, and buy a package at the best combination of specification and price that you can find.

Words and meanings

If a self-build computer is to be your first computer, or the first you have encountered for some time, then you need to know some of the language of today's computers and the way that these words are used. If you are already using a reasonably up-to-date PC, then you can skip over this part.

To start with, the type of machine that we now describe as a PC is one that is modelled on the IBM PC type of machine that first appeared in 1980. The reason that this type of machine has become dominant is the simple one of continuity – programs (also called *software applications*) that will work on the original IBM PC machine will work on later versions and will still work on most of today's PC machines using Windows *Me* or Windows XP Home (possibly using the *Accessories – Command Prompt* menu item for running pre-Windows programs).

By maintaining compatibility, the designers have ensured that when you change computer, keeping to a PC type of machine, you do not necessarily need to change all of your software (programs). Since the value of your software is much greater than the value of the hardware (the computer itself) this has ensured that the PC type of machine has become dominant in business and other serious applications. Other machines that are not compatible with the PC (or with each other) have a monopoly manufacturer, less choice of software, more expensive components, and self-building or self-upgrading is actively discouraged.

- It is very difficult now to build a PC machine to an older specification because the parts are simply not available except by dismantling older machines. You cannot, for example, easily find a hard drive smaller than 20 Gbytes now. Do not be tempted to build using second-hand hard drives (or any other mechanical component) because the life of such items might be short. Even purely electronic components can be so out of date that a modern version of Windows cannot make use of them.

A modern PC type of machine is currently identified by the following points:

1. It uses a microprocessor which is an Intel Pentium, Intel Celeron, AMD Duron, AMD Athlon, AMD Opteron, or a compatible chip from these or other manufacturers.
2. It has enough hard drive and memory space to run Windows 98, Windows *Me* or Windows XP.
3. It has a large number of input and output sockets, and provision for expanding its capabilities by adding circuit boards or cards.

Explaining the bits

If you have become familiar with computer hardware or, at least, keeping up with the magazines, the following will not really be applicable to you, and you can skip the explanations. On the other hand, if it is all rather a mystery and you feel that the magazines are aimed at experts rather than at beginners then you might find this section of explanations useful.

The CPU (processor). First of all, the actions of a computer are all regulated by the *processor* or *CPU*, a microchip (Figure 1.1) with several hundred connecting pins which is mounted on a quite large casing and is usually cooled by a block of finned metal (a *heatsink*) with a clip-on fan. The speed at which this processor works is important and is controlled by its clock pulses, electrical impulses that repeat at a very high speed. The fan is essential because a processor gives out at least as much heat as a 60 W lamp bulb and if this heat is not removed the rise in temperature will be enough to melt the processor, something that cannot be repaired. A few computers, notably the Shuttle, use a vapour-cooling system that operates rather like the cooling system of a car, with a radiator at the back of the computer. All nowadays are designed to be used in a *motherboard* that provides methods of checking the temperature and other running conditions of the processor and shutting down the system if temperature or voltage settings are exceeded. Many systems have variable-speed fans so that the fan runs slowly (with less noise) when the processor is idling, and increase speed as more power is used.

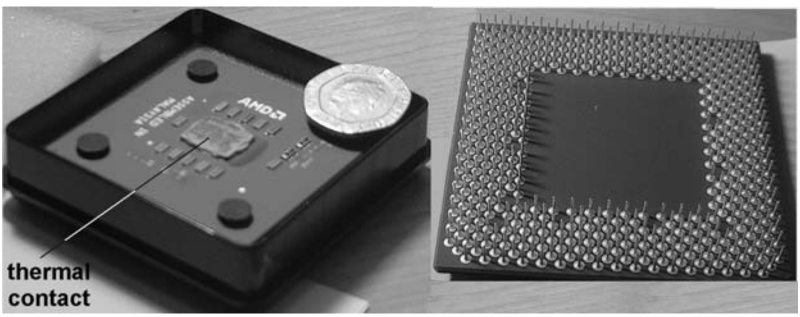

Figure 1.1 Top and underside views of a Socket-A CPU with a 20 p coin to show scale. The central portion on the top side view is the thermal contact for the chip and is tightly clamped on to a heatsink

Clock rate. The *clock rate* of a processor is the rate at which the CPU receives timing signals. This is measured now in gigahertz (GHz), meaning thousands of millions of clock pulses per second, and you can expect to use clock rates of 1 to 3 GHz or more for modern machines. Units of megahertz (MHz), millions of clock pulses per second, are used for specifying slower rates, like the clock rates that are used in the linking connections (buses) between the CPU and other chips. Typical bus clock rates are 100 MHz for the older chips, 133 MHz for average machines, faster (266 MHz; 400 MHz, or more) for more recent designs. The term ‘front-side bus’ (FSB) is often used now to mean this clock rate.

Motherboard. The processor is mounted, along with other important chips, on a mainboard or *motherboard*. This motherboard (Figure 1.2) has slots to hold other boards, variously described as *daughterboards*, or simply as boards or cards, that add other actions to the computing actions of the motherboard. There are also slots to hold memory units (DIMMs), and there is the all-important socket for the CPU. The motherboard with all of its slot-fitting cards is mounted in a case that contains also the sealed power supply unit (PSU). Several different varieties of motherboard were in use at one time, but all home-assembled machines now make use of the type of motherboard referred to as ATX. Compact machines (referred to as SFF – small form factor) that use a miniature form of ATX board will be mentioned later.

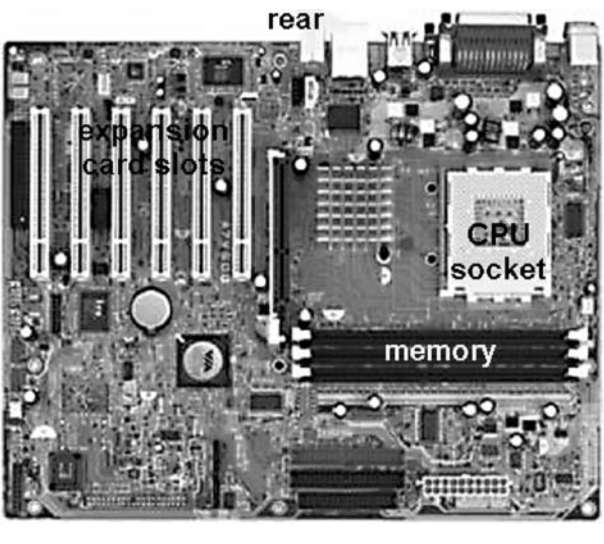

Figure 1.2 The shape and layout of a typical motherboard

At the time of writing, a new standard called BTX is evolving so that all future machines will be of a more compact pattern – more of that later.

Chipset. The processor is a very important chip, but it can't do everything. On the motherboard you will find a set of other chips that control how data signals flow to and from the processor. The performance of your computer depends as much on this chipset as it does on the processor. There are several such chipsets, but your choice is limited because the chipset that you get is fixed by the type of motherboard you buy – there is no option for changing the chipset the way that you can change the processor because these chips are soldered into place, not inserted in sockets.

Sockets. All modern processors fit into a socket (a ZIF socket, meaning zero insertion force) that accommodates several hundred pins, and though sockets for different types of processors may look identical they are not electrically compatible so that you have to take care that you are fitting the correct type of processor into the socket on the motherboard, even if the number and layout of the pins is the same. The socket types you are most likely to use are Socket-A (Figure 1.3) for AMD CPUs or Socket 478 for Intel CPUs.

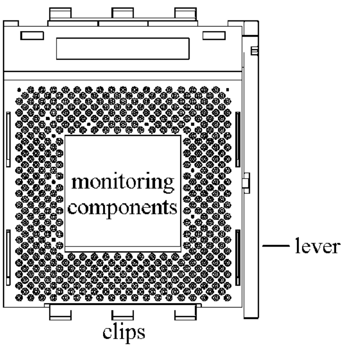

Figure 1.3 A CPU socket, Socket-A in this example, showing the lever at the side that clamps or releases the chip

OS. The processor actions are controlled by the *operating system* (OS), a program that is responsible for the whole system, ensuring that memory, disk drives, monitor, sound card, keyboard, mouse, etc., all act together. For most readers, this OS will be some version of

Microsoft Windows. Strictly speaking, Windows is a GUI (see later) that provides a convenient way of controlling the MS-DOS operating system, but the two are now so entwined that there's not much point in being pedantic about the difference.

Applications. The *applications software* items are the programs that you make use of. These programs will call on the operating system whenever they need to use any routine actions such as working with disk files, printer, keyboard, monitor, mouse, and so on.

GUI. At one time, an operating system required you to type in commands, and though you can still use such systems (such MS-DOS and Linux) all modern PCs provide a *graphical user interface* (*GUI*) which almost eliminates typing commands in favour of using the *mouse* to select images (icons) or menu items and clicking a button to start an action. The GUI for the PC is *Microsoft Windows*, and the most recent version for the home user at the time of writing is Windows XP Home Edition, though Windows *Me*, Windows 98 and even the older Windows 95 are still in use. Windows 2000 is not really intended for the home user and is not a natural upgrade from Windows 98 in the sense that it will not necessarily work with the hardware/software that you use with Windows 98. Windows *Me*, first demonstrated to the public in April, 2000, is the best option for any PC user who is likely to make large changes in a machine subsequent to installing Windows (such as frequent upgrading). Windows XP Home version is a natural upgrade from Windows *Me*, but it requires the user to activate it by contacting Microsoft. An unactivated copy can be used for only 30 days, and once activated, the Windows XP cannot be installed on another computer. The advantages, however, outweigh the inconvenience, and XP has a lot to recommend it as compared to the older versions. We'll look at all that later.

Memory. All programs, whether operating system or applications, need *memory* to work. The program instruction codes are stored in memory while a program is running, and memory is also used to store the data of a program and also temporary items (such as words you have cut from a word-processor document, or the carry-over in a piece of arithmetic). Memory is supplied in small daughterboards (strips) that fit into slots on the motherboard. Compatibility is a very important point as regards memory, because a motherboard will usually be designed to take just one type of variety of memory.

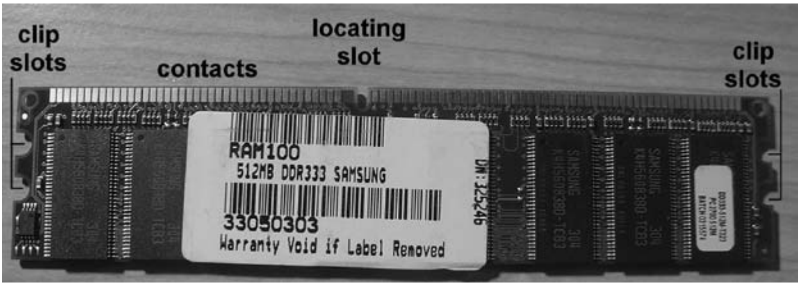

Figure 1.4 A typical DDR DIMM memory strip, 512 Mbyte in this example

The dominant variety at the time of writing is referred to as DDR DIMM, meaning double data-rate dual inline memory (so be thankful for the abbreviation).

Bytes. The unit of data size is the *byte*, which is eight bits, with each *bit* being either 1 or 0. This allows a single byte to store a code number that can be between 0 and 255. This range is enough to allocate a number code to each letter of the alphabet, each digit (0 to 9) and each punctuation mark, so that word processing can be carried out using a byte for each letter. A more complicated system, using up to 8 bytes per number, is used for working with numbers in arithmetic.

The byte is a small unit of data (corresponding to the storage space for one typed character) and for practical purposes we use the larger units of Kbyte (kilobyte, meaning 1024 bytes), Mbyte (megabyte, meaning 1024 Kbyte or 1 048 576 bytes) and Gbyte (gigabyte, meaning 1024 Mbyte). The reason for using the factor 1024 rather than 1000 is that 1024 is an exact power of 2 (it's 2^{10}), and the whole scheme of counting digitally is based on powers of two.

- Be careful of abbreviations. Mbyte is often abbreviated further to MB (and Kbyte to KB), but you need to distinguish MB from Mb (meaning megabit) and KB from Kb (kilobit). I have used the longer abbreviations throughout this book to avoid confusion.
- Memory for a modern PC is measured in Mbytes (megabytes) and typical values nowadays are 128 Mbyte to 1024 Mbyte (1 Gbyte). Though adding memory enhances performance, machines that use the older versions of Windows cannot use more than 512 Mbyte of memory, though XP will allow much more to be fitted and used.

Modern machines will require at least 256 Mbyte of memory, and many are now supplied with 512 Mbyte or 1024 Mbyte (1 Gbyte). Do not assume that because you could fit more than 1 Gbyte of memory on a motherboard that the power supply would be capable of coping, because memory uses a lot of power, second only to the consumption of the CPU. Some machines now fit cooling fans over the memory.

RAM. The memory in a PC is usually called RAM (random-access memory), to distinguish it from other types. All memory allows random-access, meaning that you can get at a byte anywhere in the memory without needing to read every byte from the start. The name is an old one that has been retained (because everyone uses it) to mean memory that can be written, read and rewritten. The important distinction is that the main RAM that we use in a computer (classed as *dynamic RAM*) is cheap and easy to make in large sizes, but it does not retain information when the computer is switched off. There are many different varieties of RAM and it's essential to buy RAM that matches the motherboard and processor that you will use. At the time of writing the flavour of the month was the variety of RAM described as DDR (double data-rate), and the quoted speed of this memory must match the capabilities of your processor and motherboard.

ROM and CMOS-RAM. There are two types of memory that are used to hold information when the computer is off because they are able to retain data. These are *ROM* (read-only memory) and *CMOS-RAM.* ROM does not need a power supply to retain data and is used for the programs that the computer needs to get started; programs such as a keyboard driver and monitor driver. The set of programs on the ROM is collectively called the BIOS, meaning Basic Input Output System. The CMOS-RAM is a piece of memory that holds changing or changeable data, such as the date and information on the hard drive, and it uses a small battery on the motherboard to keep the data memorized. Both ROM and CMOS-RAM are small sizes of memory, very much smaller than the main RAM, and they come as part of the motherboard.

Hard drive. The *hard drive* is another essential part of a modern computer, and is used to store large amounts of data such as the operating system and all your applications. The main memory of a PC operates only while power is applied, and some method of storage is needed to store the bytes while the machine is switched off. The hard drive uses magnetic storage, which does not depend on a power supply, but which is much slower to use than the electronic memory.

- The word drive is used as a reminder that this is a mechanical component that uses an electric motor to spin a disk. All drives are liable to mechanical wear and tear, and their life is inevitably shorter than that of purely electronic components.

When hard drives first became available for small computers, a storage capacity of 32 Mbyte was a luxury, but the normal size nowadays is 80 Gbyte or more. Prices have now fallen to such a level that it is not a real economy to buy a small hard drive even if you can find one. Large-capacity hard drives cannot be used by old PC machines. Despite the capacity differences, hard drives are nowadays all the same *physical* size so that they can all fit in a standard 3½-inch holder (bay).

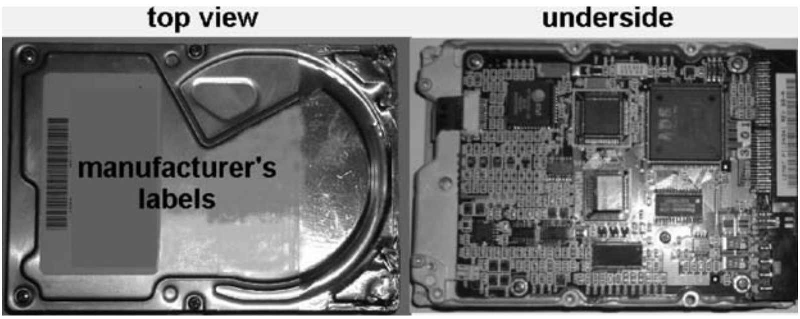

Figure 1.5 A typical hard drive

Floppy drive. The *floppy drive*, Figure 1.6, uses removable magnetic disks which can hold up to 1.4 Mbyte each. These are used for short applications programs and for small amounts of data. Some machines now, particularly laptops, do not use a floppy drive and for smaller-scale storage they use memory sticks that plug into the USB socket on the computer. The floppy disks themselves, Figure 1.7, can be inserted only one way round, top side up and arrowhead to the left, and are pushed into the drive slot until they click into place. A disk is removed by pressing the button next to the slot in the drive. The standard type of floppy disk has a small sliding shutter on the left-hand side (top view)

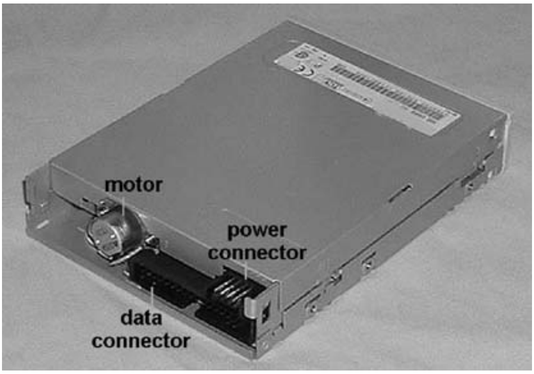

Figure 1.6 A typical floppy drive, showing the rear view

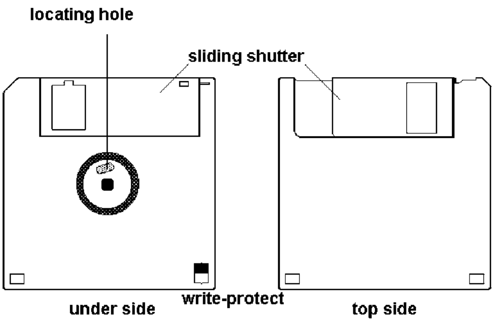

Figure 1.7 Front and back views of a floppy disk

which is used as a write protection device. When this shutter is slid so as to cover the square hole, the disk cannot be written and any data on it is safe. This ability to protect data using a mechanical system is unique to floppy drive and tape drives, though a CD-ROM is also protected against being written in drives that can write to CD-R/RW discs.

CD-ROM. Larger amounts of data are catered for using the *CD-ROM drive* (Figure 1.8), together with CDs that can store up to 700 Mbyte. The CDs that are used for a PC employ exactly the same methods as the music type, so that you can play a music CD on a PC that has a sound card and loudspeakers. You can also fit a *CD-R/RW* drive that will create CDs, so that you can hold large amounts of data or music

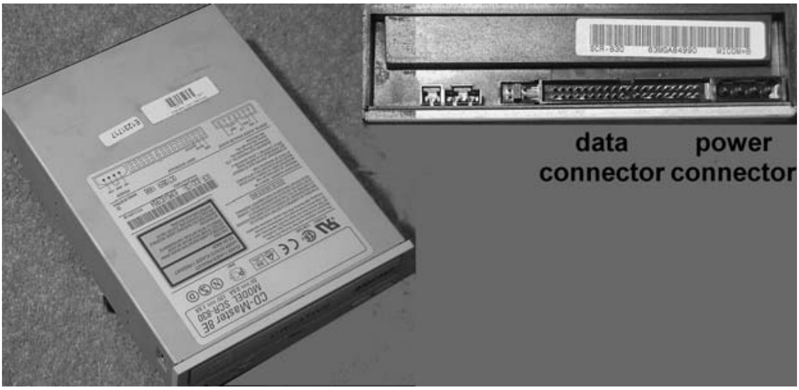

Figure 1.8 A CD-ROM drive as seen from above – the casing covers all of the internal structure so that there is no risk of laser light emerging

on a disc that you have created for yourself. CD-R/RW drives are now so inexpensive that it is unusual to fine a modern machine that still uses a simple CD-ROM drive; and many now fit a DVD writing drive as standard. Figure 1.9 shows a typical front panel and the appearance of the drawer that is used to hold the disc.

- A few music CDs are now being produced that are deliberately designed so that they will not play in the CD drive of a computer. If you buy such a CD, return it and ask for a refund, so that the music industry will (eventually) understand that they have no right to choose how you want to play CDs.

DVD. A more recent development is the *digital versatile drive* (*DVD*). This uses the same disc size as the CD drive, and can read existing CDs. The difference is that the DVD can use more closely packed data and also use both sides of the disc, so that it can, in theory, cope with up to 17 Gbyte of data (recording two layers of data on each side). The more usual size for a computer drive is around 4.7 Gbyte, and at the time of writing this is the maximum size that can be recorded on a DVD recordable drive. DVD reader drives, with software for displaying movies, are reasonably priced, and the DVD recordable drives (which write as well as read) are now at attractive prices. There are three competing formats (like the early VCR days with Beta and VHS), see later, but only two of these are commonly fitted in computers.

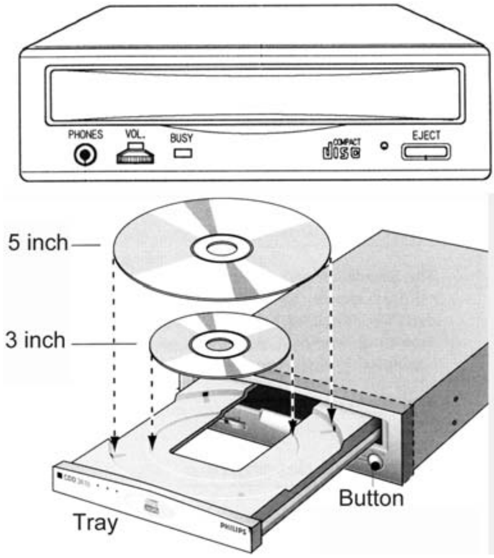

Figure 1.9 A typical front panel of a CD-ROM drive, and the provision, seldom used, for different disc sizes

Sound. Modern PCs come with a *sound card* (Figure 1.10), either as a separate item or built into the motherboard, whether you want one or not. Sound is useful if you want it, annoying if you don't, but there is no obligation to use a sound card if it is fitted (or to have the volume control turned up). Sound in digital form uses a large amount of memory and hard drive space, so that your computer will be considerably less cluttered if you don't use sound. On the other hand, you will miss the full impact of *multimedia* programs (using text, sound and pictures) if you omit it. A sound card is essential if you wish to work with sound inputs from old recordings, transcribing the music on to CDs, or if you wish to work with the modern MP3 music files or edit digital movies. To avoid the use of a separate sound card, these sound facilities are often provided built into the motherboard, and some monitors are provided with loudspeakers (not always very loud) to avoid the need for more clutter on your desk.

Peripherals. The main casing of your computer contains many sections that deal with the data. There must still, however, be other units that cannot be contained inside the computer. Three obvious examples are

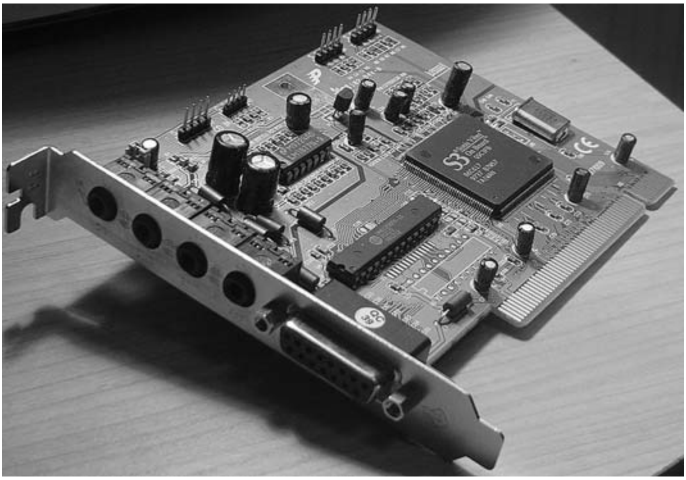

Figure 1.10 A typical sound card – most other expansion cards are of roughly this shape

the keyboard, the mouse, and the monitor. These devices are *peripherals*, something outside the main casing, and other peripherals are the printer, the scanner, the loudspeakers, and possibly devices such as a network, Webcam or a digital camera. These peripherals have to be connected to the computer by cables that run from connectors called *ports*.

Ports. *Ports* are the connections between the main section of the computer and the other units (the *peripherals*). Strictly speaking, a port is a circuit that allows signals to be transferred and (if necessary) changed in form, but the name is just as often used for the connectors themselves. The usual basic set of ports consists of a single parallel port for a printer, two serial ports (for modem or mouse), a keyboard port, a mouse port and a monitor port. A separate mouse port is omitted if the serial port is to be used for the mouse. All modern computers use in addition a more recent type of port, the universal serial bus (USB) that can replace all of the other types, and some machines now are omitting older types of ports, such as the parallel printer port, in favour of USB, particularly now that the later version (USB-2) is becoming commonplace, Figure 1.11. In addition, many computers now come with several fast ports of the 'Firewire' (or IEEE 1394) type for connecting with peripherals that require fast data flow, such as digital video cameras or

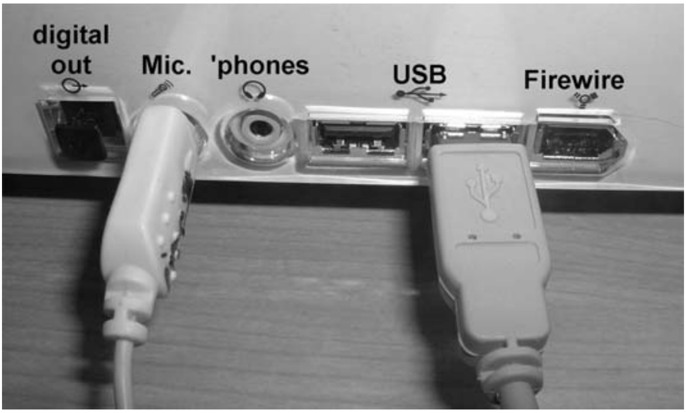

Figure 1.11 Ports, in this illustration located at the front of a casing. Note the symbols used for the USB and Firewire ports

external hard drives or DVD drives. Most modern computers also come with a network port, usually referred to as Ethernet 10/100 (the figures refer to speed in *Mbits* per second, not Mbytes per second).

Modem. The *modem* (Figure 1.12) is the device that connects your computer to the telephone lines and so to the Internet. Modems can be dial-up, using the normal telephone lines, or ADSL, requiring a connection to a nearby (typically within 6 km) telephone exchange that has been modified by BT to provide broadband (faster) connection. A modem can be internal or external, and the favoured system nowadays for a dial-up modem is the internal type because it is cheaper and does not need another external connecting cable and mains supply. Your planning decision here is whether to use the conventional type of modem (dial-up) that connects at a modest speed to your telephone line, so that you cannot simultaneously use the phone and the modem, or to go for the option of some sort of broadband, using a different modem to achieve higher speeds (and simultaneous use of the telephone). External modems, connected through USB, are favoured for broadband connections.

For a dial-up connection you should go for the fastest modem that you can get, which nowadays means the type labelled as *V90*. A modem will need a connecting lead to a conventional BT telephone point, and this will be packaged along with the modem. Broadband

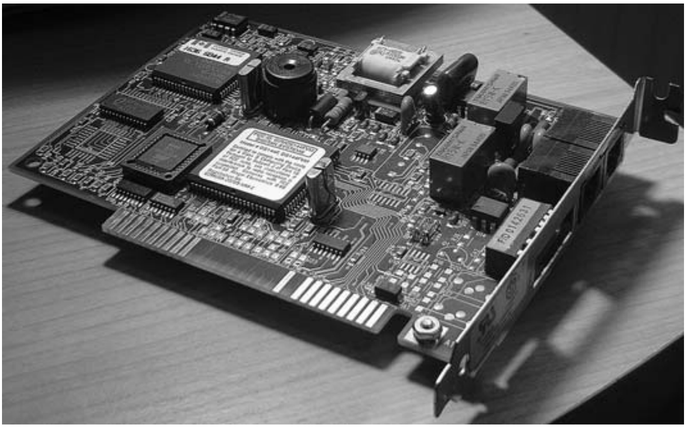

Figure 1.12 A typical internal dial-up modem card

is not so simple. To start with, unless your telephone exchange is equipped to handle broadband, and within about 6 km of your house, you can't have it. The cost is another consideration, with prices of a fixed fee connection (as much use as you want for a fixed sum per month that depends only on the speed of connection, typically ranging from three times to twenty times the speed of a dial-up modem) ranging from around £10 to £40 per month depending on the speed you want and the various extra services promised by the provider. Broadband is not dialled up, it is always on, and with many providers you pay a flat monthly rate no matter what your usage is.

- A more recent development is pay-as-you-go broadband such as is offered by Metronet. For this type of service, you pay a fairly low fixed fee, typically £10 + VAT per month for 512 kb/s (ten times faster than a typical dial-up connection), and for this you are allocated a maximum amount of monthly download such as 200 MB. If you download more than this you will be charged a small amount for each extra megabyte of data, usually subject to a capping limit so that if you need to download a very large amount of data you know that you will spend no more than you would have done with the older type of fixed payments connection. You can opt for faster connection by paying a higher monthly rate.

If you intend to spend many hours every day downloading films, music or software from the Internet, you might think the cost of a fixed fee connection worthwhile, but some fixed-fee broadband connections are only around three times faster than a dial-up connection, not really an economical buy.

- One other point about broadband is that you can use a telephone at the same time as using the broadband modem (though your modem speed will be halved by this). Each telephone that you have in the house needs to have a *microfilter* connected between the telephone and its connection point to avoid interference between telephone speech messages and the broadband signals. These micro-filters are not costly (typically £3 to £7) and the higher priced ones allow you to plug-in your broadband connection to any of your telephone points.
- Many low-priced dial-up modems use software to carry out actions that are performed by hardware in more costly units, and this intensive use of software demands a fast processor and can cause memory conflicts. The modem is the device that triggers the majority of problems when the most recent versions of Windows (such as Windows 2000 and Windows XP) are being installed.
- There has been a lot of publicity about low-cost sharing use of wireless networks operated by business, but unless you live in a 'hot-spot', close to a user of what are called WiFi connections, you can forget about this possibility. One spot of light at the end of this tunnel is the possibility of using local community wireless networks, but it all depends on where you live. Connection via satellite links is for business users with a deep pocket only.

THE OTHER BITS

The other bits that you need to connect up to check that you have a working computer are the monitor, mouse, and keyboard, all of which are bought ready to use (or which you may have already in stock). The CRT (cathode ray tube) type of monitor is still predominant in the lower price ranges (Figure 1.13) but slim monitors with a flat LCD screen are now available, but are still very expensive compared to the older type. Incidentally, an LCD monitor plus TV tuner is about half the price of an LCD TV for some unknown reason.

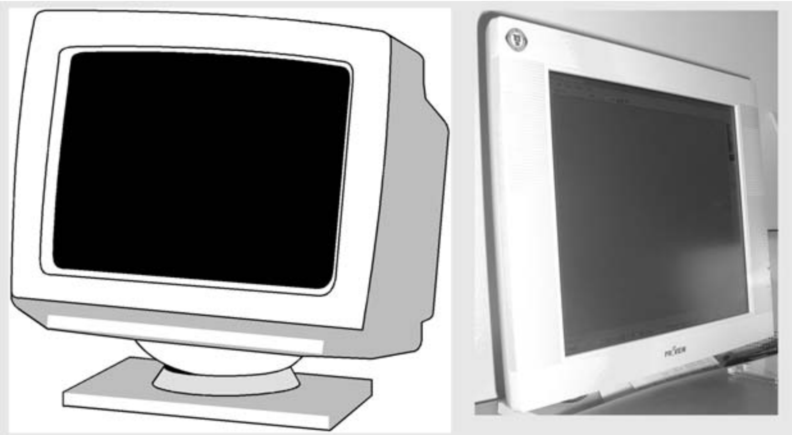

Figure 1.13 Monitors, showing a CRT monitor (left) and a modern LCD monitor

> Do not on any account attempt to convert a TV receiver into a monitor, or convert an old monitor into something suited to a modern PC, unless you have very considerable experience of working on TV equipment, and a set of circuit diagrams that you can use for guidance. Note in particular that any monitor **must** have an earthed chassis. If you fit your computer with a graphics card that has a TV output you can use a portable TV as a monitor, but its resolution will be very much less than that of a true monitor so that you can use only the most basic 640 × 480 settings.

Monitors from other types of machine will not necessarily be suited to a PC computer, though a few are adaptable if, and only if, you know how. Be particularly careful of monitors, particularly large-screen monitors, offered as bargains. Some of these work with non-standard graphics boards which must be supplied along with the monitor, because they cannot be connected to a standard VGA board, but you cannot be sure that your software (and that includes Windows) will be able to use such a monitor correctly, if at all.

- At the time of writing, a new type of connector known as DVI (digital video interface) is being introduced, using a different type of plug at each end. This can be used only if both the monitor and the graphics card are equipped for DVI connection.

For a modern machine, the keyboard and mouse (Figure 1.14) should each be of a type that uses a PS/2 connector. You **can** opt for USB, but since all motherboards feature PS/2 connectors this choice avoids problems of having too many items that need a USB connection. Older machines can use a serial mouse and a DiN keyboard connector, but these are not so easy to find these days, and if your keyboard and mouse are elderly, with unsuitable connectors, you might have to consider buying adapters or new keyboard/mouse.

Figure 1.14 A typical keyboard and mouse, showing a DIN plug on the keyboard and a modern PS/2 plug on the mouse

- Some mice come with a ridiculously short lead, making it impossible to place the mouse on the desk with the computer on the floor. Cable length is never quoted, but the Microsoft mouse always seems to come with a really long tail. Some keyboards have a nice click action, others are spongy and rubbery so it pays to try out a keyboard before you buy it.

FAQ section

Q Can my computer possibly be as good as one that I buy as a package?

A Yes, because you will probably be using the same parts. If you buy high-quality parts, it's quite possible that you can assemble a better machine than one on offer in your High Street. It will certainly suit you better.

Q What about maintenance? If I buy a complete machine there is at least a telephone number I can ring to listen to music for a time until a voice answers.

A If you have built it you have a better chance of being able to maintain it than someone who has never opened the casing. After all, you have unlimited access to the manufacturer.

Q If a part is faulty what do I do?

A Contact the seller and ask for a replacement in the usual way, just as you would if you bought a spare drive belt for the vacuum cleaner and it snapped.

Q What about installing Windows?

A If you had Windows on your old machine you should have the original installation CD or floppies. A copy of Windows is licensed to be used on one computer, but provided that you are not using the old machine and the new one as well with the same copy of Windows you are not doing anything illegal.

Q Don't I need some sort of specialized skill?

A Nothing spectacular. If you have ever used a screwdriver then you are fit to tackle a computer, because the bits all slot into place and are fairly distinctive.

Q Can I get any help on the Internet?

A Yes, many people are prepared to take time to help you if you clearly describe the problem. If your knowledge is limited, say so, and helpers will try to avoid being too technical. There are some web sites devoted to blow-by-blow assembly instructions with illustrations, such as the superb AMD site that shows how to assemble a computer using the Athlon chip (though this is updated only at intervals and may not show some of the most recent changes).

Finally in this introduction, computing has enriched the English language with a large number of new words and new uses of old words. If these are new to you, Appendix A contains a glossary with full explanations, and some have been explained already in this chapter. Note that the word *disk* is used to refer to a magnetic computer disk, and the more familiar *disc* is used for CDs. This distinction has become important now that the CD format is used to distribute software, replacing the use of floppy disks.

Chapter 2

Decisions

Some decisions about your computer have to be made early on; others can be left until later. As in any other DIY project, you have to be crystal-clear about what you want; otherwise you will almost certainly end up with something you do not want.

The most important decision concerns the type of computer you are constructing. It's a PC of course, because you can't get components to build any other type, but for what purposes will you use it? One use might be word processing because you need to write reports, articles, sermons, notes, books or whatever. It might be database use, because you need to keep track of several thousand items in a mail-order catalogue or points in a sports league or references in newspapers. It might be a spreadsheet because you need to keep tables of items in a way that allows you to work out totals and averages, or it might be a bookkeeping or accounting program for your business needs.

If your plans are for a machine with serious uses, meaning some word processing, keeping accounts, perhaps editing the parish magazine, then you can build a machine of modest specification at fairly low cost. If, on the other hand, your needs run to games with fast graphics, editing video or digital photographs, and working with sound (such as converting your old vinyl LPs to digital and removing intrusive scratch and hiss noises), then you need a fast machine with a lot of memory and a modern set of ports.

- Either type of machine can cope with the Internet, because this depends much more on just one component, the modem, than anything else. You certainly do not need the latest whizz-bang model if your main aim is to use the Internet or email.

You might, of course, decide that you want to construct a reasonably capable machine that can cope with most normal actions, with some word-processing, some work with still images, some sounds, and Internet use, without going to extremes such as paying £400 for the processor unit alone. This is reasonable enough and you need to know that any modern machine can cope as long as you are not expecting it to run the latest and most demanding software. For such a machine, a processor price of under £80 is reasonable, and you should look at the Duron (AMD) or Celeron (Intel) range of processors. You will then need a motherboard to match your processor.

Whatever your needs are initially, once you have experienced the advantages of working with the computer, and adapted your methods to the use of the computer, you will want to make it work harder for you. You are likely to buy other main items of software, and you are also likely to want to use the programs that are collectively called *utilities*.

The point about adapting your methods is important. Any task that you have previously done by hand usually needs to be done quite differently by computer. The computer forces you to work in a different way, but as a compensation it allows you to work with greater freedom. You can make corrections and alterations easily, for example. Try typing an article and then inserting a 20-word amendment in the middle of the work, plus some illustrations. This is simple routine stuff when you use a word processor, tedious and awkward when you use a steam typewriter. Try using a card index to produce a list of all UNF-threaded bolts in size 6 with cadmium plating and hex heads – it's easy with the computer running a database, but you must have organized the information correctly in the first place, and not as you would for a card index. When users feel disappointed with the use of a computer, the reason is almost always that they are trying to make the machine work in the way that they formerly worked with pen and paper.

Whatever you bought the machine for in the first place, you are likely to find that you have many more applications for it after a year or so. This is when you may come up against restrictions that seemed unlikely when you first bought the machine. You may need more memory to run larger programs, more disk space to store them, faster actions, and a better monitor. If you chose wisely initially you should find that your machine is capable as it is, and even if you went for the minimum that you could get away with, wise planning will ensure that you can easily upgrade the machine to do what you want. That sort of action is also covered in this book.

Remember, however, that a computer is rather like a hi-fi system – upgrading can be continued forever and eventually the gains are too small to notice. You have to ask yourself continually if an upgrade really fulfils a need or whether it simply allows you to use a more elaborate version of a program that serves you perfectly well at the moment.

- One problem that has been with us since small computers became available is *bloatware*. This means software that comes out in a new, enhanced and much larger form each year. You have to decide for yourself when the software that you use provides you with all you need and if a new version that is twice the size and runs at half the speed is really more useful than the older version. One useful side effect of this, however, is that you may be able to buy older versions at a fraction of the price of the most recent version.

Over the last year or so, it has become customary for computers to be offered for sale that are faster, and with more memory and disk space, than anything that has gone before. At the same time you see advertisements offering add-on devices that were either unknown or very expensive and specialized earlier. Examples of such items are digital cameras (still or movie), DVD recorders and scanners. At the same time, software has also become more demanding, needing faster processing and more disk space.

- Many computers that are currently on offer are grossly over-specified for the requirements of the average serious user, because they are aimed at the user who wants fast-acting games and video displays.

This is a rat race that you cannot win and, if anything, the home constructor is better placed than anyone else. Anyone who buys a complete computer system today can expect to find that in a month’s time it will either be offered at a lower price or it will provide an upgraded specification for the same price. If you have built your own machine, you will be much better placed to know how to upgrade and whether or not an upgrade is needed.

- Just to put all that in perspective, there are computer users all over the country who are perfectly happy with machines that have only a tiny fraction of the speed, memory and disk size of today's offerings. Their secret is that they are happy with the software that they are using and do not need any upgrade to the computer to use it. Their problem, however, is that if they need spares for their machine or new software that will run on it they may be quite unable to find any.

The important decision, then, after deciding what *type* of software you want to run, is to decide on the make and version of software you want to use. For example, the well-known graphics program *Corel Draw* is currently at Version 12 (at over £400), but you might find (as I did) that Versions 6–9 would suit you just as well, and can be bought for a fraction of the price. I find *Word 2000* indispensable for typesetting my books, but if your needs are more modest you might be perfectly happy with *Word 97, Word-6* or even *Word-2* (there were no versions between these, despite the numbering). These older versions will run happily on machines with much less memory and hard drive space than the latest versions. It is better, however, to use a modern version of Windows rather than an older one.

- In addition, the requirements that are often quoted for running Windows assume that you will be running several large programs simultaneously and transferring data between them. If you don't do this, then you can get by with a slower machine and less memory.

The third decision is much harder to make. What will your future demands be? For example, if you are content to make use of your existing word processing software, will you always want to type the words? There might come a time when you decide that you want to use word dictation software, speaking your thoughts directly into a microphone and watching the words appear on screen. This, however, demands much more of the computer, and is a prime reason for wanting a fast processor, more memory and more disk space. Another possibility is that you would like to convert all your old home video into digital form and record it on CD or DVD rather than transcribe it onto VHS cassettes. This sort of requirement also demands faster processing and large amounts of memory and disk space, as does the recording of sound.

If, on the other hand, you feel that you will not be tempted by new whizz-bang software and you are quite content with something that has already served you well, or which is modern but not too demanding, then this also points you in the direction of a machine that need not be in the top rank of the fast and furious.

- After all, if you have assembled your own computer you will also know how to upgrade it if you ever need more than it can supply in its original form. My suggestion throughout this book is to start with a basic machine that has only as much as you need to work (with Internet access) but no specialized frills.

Expanding the machine is not confined to simply increasing its memory and its ability to deal with more complex programs. Add-on boards exist for virtually every purpose for which a computer can be adapted and the PC machine forms an excellent basis for experimental work for anyone with experience in electronics. The current add-on fashion is fast video boards, allowing you to edit your camcorder tapes or work on video images from TV or from a video recorder. Similarly, you can capture Teletext pages, compensating for the short-sighted design of TV receivers that makes no provision for attaching a printer. You can also use your PC along with a digital camera and colour printer to replace the tedious business of buying films that have to be developed and printed, with no editing facilities. This, however, requires a good printer and good graphics-editing software.

A less-trumpeted aspect is control engineering, using analogue–digital converter cards, allowing the PC to act as part of a control system for process engineering, environmental control and so on. Similar add-on cards can also be used to make the PC part of a security system with the advantage that the response can be altered by programming the machine for yourself. You can also couple in devices such as bar-code readers and printers to make the PC part of a data system. All of these actions are too specialized for this book, but you should be aware that they exist and if you are interested, look out for books that deal with these topics. For some of these actions you do not need the latest and fastest type of PC, and in many cases the requirements are **very** modest.

The results of these decisions will all be relevant to the parts you choose for your computer, and you also need to take into account any parts that you want to recycle. For example, if you are retaining a monochrome printer (as most laser printers still are), there is little point in having the capability to work with colour images that need huge amounts of memory. If all your software is on a hard drive of reasonable size (and which is nowhere like full) then why buy a new one? On the other hand, you might find that if your monochrome printer packs up you could replace it only with a colour type because no manufacturer would now manufacture a monochrome printer other than the laser type. We will look at more of these types of decisions later.

What components?

> **NOTE:** If you intend to use Windows XP Home Edition, which was at the time of writing the most recent version of Windows for the home user, you must make sure, when you buy hardware or software, that the items you buy are XP compatible. This will save you a considerable amount of time and expense later when you come to install Windows. See Chapter 7 for more details. You should also ensure, if you are upgrading a computer, that you carry out all your hardware changes **before** you install Windows XP Home Edition.

A basic PC system consists of a main casing that contains the power supply in a sealed box, the motherboard with processor, memory and a graphics card, and the disk drives, along with a separate keyboard, mouse, and monitor. The contents of the main casing are the components that lend themselves to DIY assembly, and the monitor, like the keyboard, mouse and printer, is bought as a single, separate, item. A modern monitor will be either a 17-inch or 19-inch colour cathode-ray tube unit capable of much higher resolution than a TV receiver or a slim and flat LCD screen of the TFT variety in 15-inch or 17-inch size. Note that the screen area of a TFT screen is rather more than you get with the same quoted size of cathode-ray tube, and the weight is very much less. At the time of writing, several suppliers are offering 19- to 21-inch cathode-ray tube monitors, with the luxury option of 21-inch TFT flat-panel types.

The main advice on motherboards and processors is to avoid working with the older components. The 8088, 8086, 80286, 80386 and 80486 microprocessors are now completely obsolete and though there are millions of PCs working happily with these processors, they are simply not capable of running the mainstream of modern programs, particularly Windows *Me* and XP. Even the more recent Pentium-1 and Pentium-2 types of machine (and their AMD counterparts using the K6 processors) are by now too restricted in speed to run modern software. Windows *Me* and XP need a machine which is initially as capable as you can afford, and which can easily be upgraded, particularly with more memory, later. You will handicap yourself if you build using the old components (if you can find them) unless you are simply practising for a later effort. By contrast, quite old keyboards, mice and monitors (within limits) can be used until they fail – I have used the same IBM keyboard (with its excellent clicking key action, not the spongy modern variety) on the last four machines and only total keyboard failure would get me to relinquish it.

The assembly of a PC machine from scratch is, if anything, easier than making a working model from old-style Meccano, with the difference that you start with a full kit of bigger parts. The comparison is not entirely fanciful either, because a PC is put together using bolts of standard types, and circuit boards that plug into position; no elaborate tools are required nor is vast experience needed. What you need to know is what parts you need, where to buy them and how to put them together. You certainly do not need to know how to solder, and the highest order of electrical work you might be called on to do will be to connect up a standard mains plug (though even this is very unlikely). The main requirement is to know that the parts you are buying will match up with each other correctly.

The tools you need (Figure 2.1) are mainly screwdrivers, preferably in the smaller sizes, and both plain and crosshead (Philips) types. A pair of pliers is also useful though seldom essential, and tweezers are useful for retrieving small bolts from inaccessible places. A piece of Blutack is also useful, because small chunks can be put into a screwhead so that the screw will stick to a screwdriver – this is very useful for fastening screws into inaccessible places. Other than these you need common sense (square plugs do not go into round holes) and some

Figure 2.1 The essential tools for PC construction

motivation (such as lack of money or just fascination with computers). One useful point about assembling your own PC is that you can do it one step at a time. If cash is limited, you can buy one part each month until you complete the assembly.

- On the subject of cost, remember that assembling a *complete* PC outfit from scratch is *always* going to be more costly than buying a new machine made from the same parts and bought from the cheapest sources after some shopping around.
- Note that if you use a debit card (like *Switch* or *Connect*) you have no more protection than if you handed over cash. Stallholders at computer fairs will seldom accept credit cards because of the surcharges that this involves, though they will always take cheques backed by a bank card.
- Hardware is always changing, so that a book that describes in detail the construction of a PC with photographs of each stage will start to look out of date very quickly. In this book, we have concentrated on the essential steps (such as processor insertion and memory insertion) that do not change much, and illustrated these rather than less-important items that might look quite different in a few months' time. As an example, see the item on PATA and SATA and the Shuttle machine (Chapter 5). This book also concentrates on 'after-sales' advice, such as choosing and using peripherals, troubleshooting, and computer security, because problems in these departments can often (wrongly) lead a home constructor to think that the fault is in the hardware that he/she has assembled.

The essential bits in detail

The essential main bits of a PC are the casing (with power supply), the motherboard, processor, graphics card, and the disk drives. To check that a machine is working you also need a monitor, keyboard and mouse, but since these are bought ready-made and can outlast several computers we do not count them, or a printer, as part of a DIY project.

CASE

The case or casing contains the power supply unit (PSU) that converts the mains voltage (220–240 volts AC, and dangerous) to the low (and safe) DC voltages that the computer uses. The type of power supply is always the type referred to as *switch-mode*. The output voltages are so low that they present no risk of shock, but you should be careful to avoid placing metal tools onto live contacts because excessive current could flow to cause overheating and start a fire. The power supply unit is usually sealed with all the mains voltage parts inside and only a switch connection to the outside, along with space for the motherboard, a set of shelves, called *bays*, for disk drives, various LED indicators and switches, and a lot of empty space.

The most useful, and most common, type of casing is the small (mini or midi) tower construction. An alternative is the desktop type, which is also the cheaper but not so easy to find nowadays. Do not be tempted by old-style miniature slimline cases, because they are more expensive and often difficult to work with if you want to add more disk drives and cards. Tall full-size tower-block types are easy to work on, but they are cumbersome, more expensive, and may be difficult to house in a small working space. The modern trend is to SFF (small form-factor) cases such as the Shuttle, and we have dealt with this type of machine separately because it has a number of novel features as compared to the ordinary type of PC. By the end of 2004, many manufacturers will be working to a new set of standards for BTX motherboards and cases, all of a more compact design than the ATX types we have been using for several years.

- For machines of a higher specification you can buy the PSU separate from the casing and assemble the two together (not difficult). This allows you to buy a case that you like the look of (and which can be the modern aluminium type that dissipates heat better) and a power supply that is compatible with your motherboard and processor.

Casings once came in two types, AT and ATX, as well as a variety of shapes and sizes. The AT type of cases are now totally obsolete, and at the time of writing all modern computers other than the SFF type used the ATX motherboard layout, with the new BTXX designs still unavailable in the UK. Beware of special offers of very cheap cases or motherboards that turn out to be suitable only for the old AT layout.

- If you buy from a local shop or a computer fair, check out the noise from the fans in the PSU and on the CPU. Some fans are so noisy that they make working with the machine an irritating experience. The more expensive cases should be fitted with fans that are reasonably quiet. The fan on the processor is usually the noisy one, and special quiet fans are available if you specify them.

Looking at the side of the casing, Figure 2.2, of an assembled computer, you can see the power supply unit (PSU), the motherboard, the bays, and a lot of tangled connecting cable. One of the drawbacks of a home-assembled machine is that you have to use pre-formed cables because you cannot reliably assemble your own cables of just the

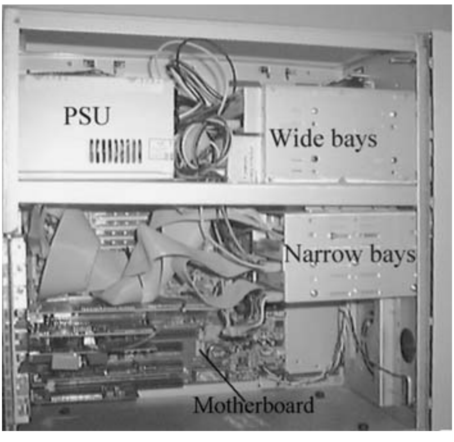

Figure 2.2 A side view of an assembled casing

length you need. For fast machines, cables may have to be carefully tied up and folded so that signals on the cables do not interfere with each other and with chips on the motherboard.

The back of the casing also has a set of six or more openings, usually temporarily covered by metal strips. These openings are at the *expansion slot* positions, and each time you expand the capabilities of the computer by adding a card, one cover plate will have to be removed to allow a connector mounted on the card to project outside the casing. These metal strips were formerly each located by a single screw, usually of the crosshead Philips variety, but on some modern casings, the covering strips may be attached, and you have to break small metal tabs to release a strip. Do **not** use the machine with strips removed unless there are cards inserted to replace them, because this will upset the fan-driven airflow inside the machine. The front panel of the casing has cut-outs covering bays for CD and disk drives, and also a panel of switches and LEDs. Some recent designs make provision for some connections (typically for audio or video equipment and USB connections) to be made at the front of the casing.

The front of a typical casing, Figure 2.3, usually detaches to reveal the bays, switches and lights, and will also contain a small loudspeaker

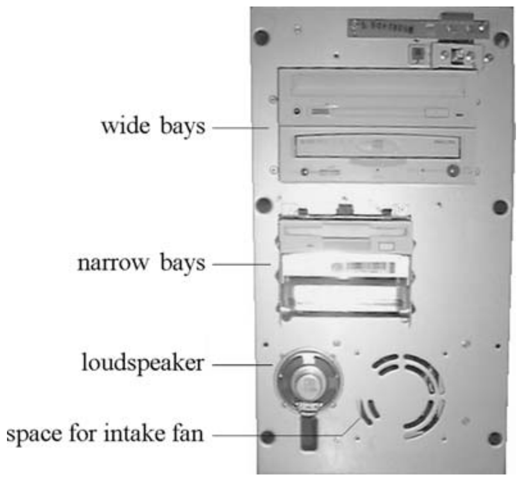

Figure 2.3 The front of a typical case with plastic panel removed

which will beep when the machine is starting (*booting up*) and which provides a few warning sounds. It will also contain a *reboot* switch for use when nothing else will release the machine from a software lockup (when pressing keys has no effect). This reboot switch should preferably be housed at the rear of the casing so that it cannot be operated by accident, but it's more usual to find it at the front. If the reboot switch is at the front it should be recessed or otherwise protected so that it is not so easily pressed accidentally.

At the rear of the empty casing, Figure 2.4, you will find most of the data connectors and also the mains connectors for the PSU. Conventionally there used to be two of these, as illustrated, but as often as not these days you will find only one. The essential one is the mains input; the other, if present, is a mains output which on older designs was controlled by the switch on the casing, and used mainly for the power connection to the monitor. On modern ATX casings this mains output is live as long as there is a mains input, it is **not** controlled by the computer's switch. Also within the PSU is the cooling fan for the whole computer. A separate miniature fan is used to cool the processor, and this can be noisy because it runs at a high-speed,

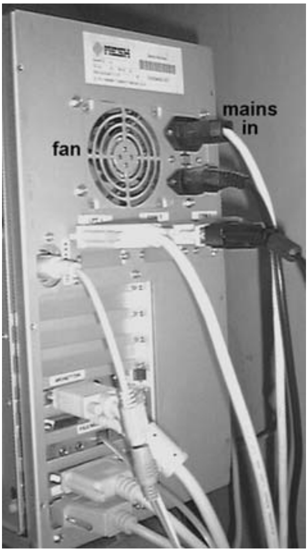

Figure 2.4 The rear of a typical computer

though you can specify a quieter type of fan (at extra cost) when you build your own machine.

Modern ATX casings have a PSU that is 'soft' controlled by Windows. This means that the main switch works on a standby (or *suspend*) system, so that when you opt to shut down Windows the whole machine goes into standby. The power is shut down to a low level, and the computer stops working, but it can be switched on again either by using the main switch or by actions (which you can select for yourself) such as pressing any key, moving the mouse or receiving a message over the modem. You are not forced to use this system, and my own preference is to switch the whole machine off at the mains when I have finished for the day.

Choosing the correct casing for your computer is very important because it can decide whether or not you can easily upgrade your computer if and when you need to. You need to decide on your choice of motherboard and CPU types before you finally select a case.

- Many of the mail-order suppliers sell unbranded cases. These may be excellent, but you cannot inspect them in advance and in particular you cannot tell which ones contain a suitable PSU and which may have a noisy fan. Note that you may need to look for a case that is marked as approved for the type of processor you intend to use, particularly for the faster types such as Pentium-4, Athlon and Opteron. Approval in this sense means that the layout of the case, the power output of the PSU, and the cooling are all suitable for a high-speed processor. Advertisements for cases seldom mention whether they are suitable for the faster processors, though if the advertisement for a case mentions a 350 W or higher PSU then it is likely to be intended for a fast system. The overall power, however, is **not** the main factor as regards suitability, and you need to ensure that the current that is supplied at each voltage level will be adequate (see later). Finding a case that is suited to your motherboard and processor is simple enough for the less-demanding requirements, very difficult if you want a high-performance machine.

MOTHERBOARD

The motherboard, as the name suggests, is the main printed circuit board of any PC machine and it carries the CPU, memory, and any other boards (or cards) that are added. It is a multi-layer board, and you must **never** drill it or cut it because the tracks that you see on it are only the surface tracks, with others hidden between layers. The motherboard contains the main microprocessor chip (the CPU), and the type of CPU that is used determines to a considerable extent the performance of the computer. Always handle the motherboard by the edges because a fingerprint on the working surface can affect the working of the board.

At the time of writing, low-cost motherboards use the Intel Celeron or the AMD Duron type of chip, and the faster motherboards can use the Pentium-4 or Athlon chips as well as the slower types from the same manufacturer. Socket-A motherboards can use the AMD Duron or Athlon chips but you will need a different type of motherboard for the 64-bit AMD Opteron, and different boards for the Intel Pentium and Celeron chips. The older Pentium and Celeron at one time used different boards, but both can now use the Socket 478 type of board. You should not consider buying a motherboard, no matter how cheap to buy, with a CPU whose number indicates an earlier design, such as the 80486, 80386, 80286, 8086 or 8088. Even the Pentium-2 and Pentium-3 are now completely out of date and almost impossible to find except on old machines.

- The motherboard contains sockets for all the important main units such as the processor and the memory. Motherboards are usually supplied as the *ATX* type, but by the time you read this the BTX motherboards may be available.

The motherboard has a socket specifically for the processor, and your choice of socket type commits you to the type of processor you can use. In general, the popular AMD Athlon and Duron processors use the same type of socket referred to as socket-A, so you can build a machine using a Duron and later upgrade to an Athlon if you wish. Using such a motherboard therefore allows you to upgrade from one type of AMD processor to another very easily. Similarly, if you opt for a Socket 478 motherboard you can initially use a Celeron and later upgrade to a Pentium-4.

The Opteron chips, along with the Athlon 64, are, at the time of writing, very new 64-bit chips, and could not be fully utilized by current software. That, and their cost, should deter you from trying any of them as the CPU for a self-build project. If you feel that this type of processor is a future-proof option, it is cheaper to buy a complete system than to try to build one, because the chip alone, bought as a separate item, can cost as much as one third of the price of a complete system using the same chip.

- The older Socket-7 boards are now obsolete, but you can still find some available, though it would be foolish to start building a new machine around such a board. See Chapter 12 for details of older machines.

The motherboard contains the slots for memory, and once again, the types of slot determine what type of memory, and how much of it you can use. Modern motherboards allow for the standard 184-pin DDR DIMM units to be used, and these can be fitted individually. For example, you could achieve 256 Mbyte of memory by one 256 Mbyte DIMM, and you could expand to 512 Mbyte by adding another such DIMM. If you wanted 512 Mbyte from the start, you could save money by buying and fitting one single 512 Mbyte DIMM. A more expensive form of RAM, called RAMbus, may be specified for some Intel motherboards, but is uncommon.

- Always check carefully that the motherboard is compatible with your memory, not just for the number of pins but for the *speed* of the memory.

As well as the main CPU and the sockets for memory DIMMs, the motherboard (Figure 2.5) contains all the other supporting chips (the *chipset*), all permanently soldered into place, and the connections (or bus) between the CPU and other sections. The other notable feature of the motherboard is the provision of *expansion slots*, sockets for cards that are plugged in to expand the use of the machine. The main type of slot for this purpose is called PCI, and most modern motherboards will provide four or more PCI slots. Few, if any, modern motherboards provide the older type of slot, ISA. All modern motherboards will also provide at least one AGP slot for a fast graphics board, even if a graphics interface is already provided on the motherboard.

All motherboards now include *ports*, usually two serial ports and one parallel, as part of the board, with short cables to connectors mounted on the rear of the casing. The parallel port is used to connect the printer, but the old types of serial port are seldom used nowadays.

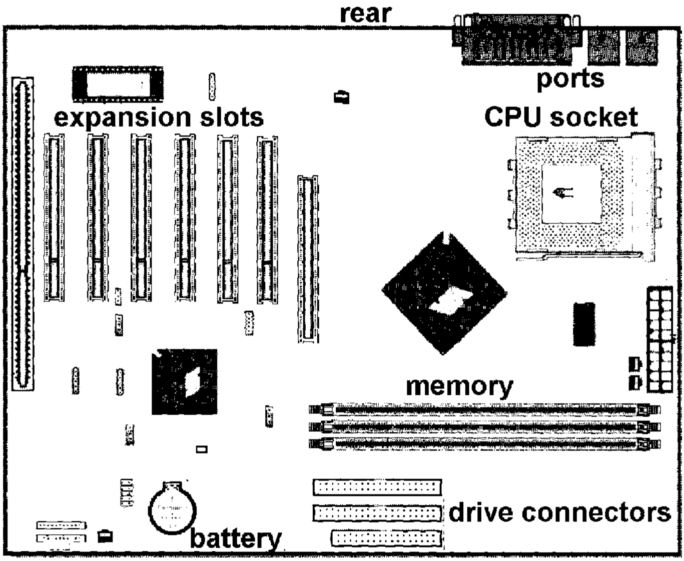

Figure 2.5 Sketch of a typical motherboard with important parts labelled

Modern motherboards feature also the USB ports, usually two or four, and these are now the faster USB-2 type. In future motherboards USB-2 and Firewire ports may be the only type of ports that are fitted. In the past, ports were added separately by plugging cards into expansion slots, but the modern way is to use on-board ports so that the motherboard needs fewer slots. The slots connect to the processor, and the set of connections is called a *bus*. Figure 2.6 shows a set of expansion slots in an (older) motherboard – more modern motherboards omit the ISA type of slot and are likely to use up to three PCI slots and one AGP slot.

The motherboard will also contain the connectors for cables to the floppy drive(s), the hard drive(s) and the CD-ROM drive(s) – note that you can have up to two of each device if you have the space to put them into your casing.

- The description of a motherboard in a magazine usually shows the manufacturer and model, socket type, support chip set, compatible memory type, and possibly ATA or SATA connections (see later).

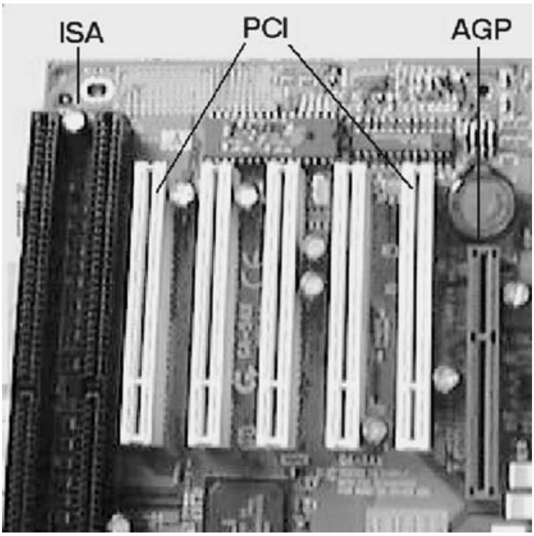

Figure 2.6 Expansion slots in a motherboard

Modern motherboards and casings usually come with a thin piece of metal called the I/O shield (Figure 2.7). This allows the casing to be made with a standardized rectangular slot to accommodate the ports, with the shield providing a guide and a set of symbols. The shields that come with the casing are cut for some popular motherboard arrangements, and some clip into place; others are screw fitted to the rear of the casing. If your motherboard does not use one of the common patterns, it will usually provide a shield, but this is normally a very thin metal item that presses into place on the rectangular aperture at the rear of the case.

Figure 2.7 A typical I/O shield

- For some layouts, you might need to knock out covers from an I/O shield to suit the sockets on your motherboard.

PROCESSOR

The processor is the silicon (not silicone, please!) chip that is the heart of the computer, providing all of the computing actions under the control of the operating system. Processors are sold in the form of a large slab-shaped chip that needs a slab of metal, the heatsink (Figure 2.8), to be clipped over it, along with a fan for cooling. The heatsink and fan are clipped tightly to the socket on the motherboard, so that the chip has to be inserted before these items are clipped on.

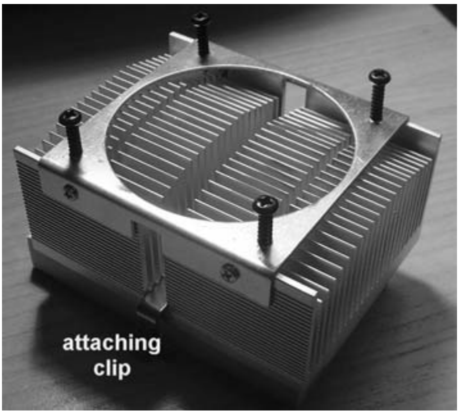

Figure 2.8 A heatsink, shown separated from the fan (which is secured using the four bolts)

You may see references in price lists to *boxed* processors. A boxed processor means a processor with a matching heatsink and fan supplied in the same package. The alternative and cheaper packaging system is described as *OEM* (original equipment manufacturer) and consists of the processor only. This leaves you free to use whatever heatsink and fan you prefer for yourself, but it's up to you to ensure that the heatsink and fan that you use are adequate for the amount of power that has to be dissipated. The amount of power that a typical processor will dissipate nowadays is between 35 and 100 watts. Use the boxed processor if you are building to average performance, but if you are going for a fast machine, or need a super-quiet machine, buy an OEM processor and add a heatsink and fan that will meet your requirements. Always check with any supplier that what you are buying will be compatible.

- Remember that you should avoid old types of chips, such as the 80486 type, despite their very low cost. Do not be tempted, because you will have great difficulty in finding motherboards and other matching parts, and performance on modern software will be very slow. Even old Pentium-1 types such as the Pentium-60 or Pentium-75 are simply not up to working with modern operating systems and software.

Be careful about processor speeds of modern chips. Intel Pentium processors quote the speed (technically, the clock rate), but AMD processors quote a type number that is intended to give an indication of comparative speed but which is not the actual clock rate. For the record, the numbers and corresponding maximum speeds for some current AMD Athlon examples are given in Table 2.1.

There are two basic types of fan. One (older) type takes its power from the disk drive supplies, the other type from a set of pins on the motherboard. The first type can be fitted on any machine, but the second can be used only if the power supply pins are on the motherboard.

Table 2.1

266 MHz FSB		333 MHz FSB		400 MHz FSB	
Number	**Speed (GHz)**	**Number**	**Speed (GHz) Number**	**Number**	**Speed (GHz)**
Athlon XP1800	1.53	AthlonXP 2500	1.83	AthlonXP 3200	2.2
Athlon XP2000	1.67	AthlonXP 2600	2.08		
Athlon XP2200	1.80	AthlonXP 2700	2.17		
Athlon XP2400	2.00	AthlonXP 2800	2.08		
		AthlonXP 3000	2.17		

The second type is **essential** if you want to make use of the chip temperature monitoring features of a modern motherboard.

MEMORY

Do not consider installing a memory of less than 128 Mbyte and never fill your motherboard with memory initially, because that makes it very expensive to upgrade later. At the time of writing, memory prices are very low, but you cannot assume that they will always be. DDR (double data-rate) DIMMs are now the standard system, and many motherboards provide for up to three DDR DIMMs, so that you can usually upgrade easily to the limit of 512 MByte that is set by older versions of Windows, or to the much higher limits of Windows XP. Very few motherboards, and only these using Intel chips, cater for Rambus memory units. Memory is a vital component, and if you are constructing a fast machine you should preferably use memory from a well-known source, such as Crucial or Kingston. I suggest that you fit a single 512 Mbyte unit, providing adequate memory for most purposes and allowing for expansion if you later need it.

DRIVES AND ROMS

The hard drive and CD/DVD drives are the other essentials, because a computer by itself is as useless as a CD player with no CDs. In computer jargon, the *hardware* is useless without *software*. Most of the memory of a computer is the kind described as *volatile*, meaning that it is wiped clear each time the machine is switched off, so that all the instruction codes that the machine needs to do anything have to be stored in a more permanent form. The three most familiar permanent forms are as a chip (a ROM or read-only memory chip), a magnetized disk, or a CD in its drive.

Modern machines use all three of these systems, and your motherboard will contain one or more ROM chips that contain a comparatively small amount of program code. This is sufficient only to allow the machine to respond to the keyboard in a limited way and to operate the disk drives, also in a limited way. The rest of the essential codes, the operating system, are read in (*booted*) from a disk, usually the hard drive.

The aim of this multi-part storage is to build into the machine just sufficient permanent instructions to read in an operating system that you can choose for yourself. The operating system is something that needs to be upgraded each time the capabilities of the computer are extended and if it were in ROM form it would require the ROM chips, see Figure 2.9, to be replaced or reprogrammed. This action of using a small section of code to read in the rest of the operating codes is called *bootstrapping* (from the old myth of lifting yourself by your own bootstraps) or *booting*, and the action of switching on a computer is referred to as *booting* or *booting up*. The smallest handheld machines do not use a disk drive, and they keep all of their operating system code in a ROM.

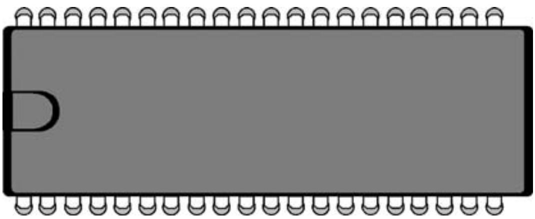

Figure 2.9 A typical ROM chip of the older type. Modern ROM chips are programmable, meaning that their content can be altered by using commands. This is a risky business, because any error could stop your computer working until a new ROM chip could be inserted

- The main ROM chip is called the *BIOS*, meaning Basic Input Output Services, and this is a good description of what it provides.

Most modern BIOS chips are now re-programmable, so that your computer can be upgraded by downloading a new ROM program from the Internet, saving it in a floppy disk, and then using special software (supplied with the motherboard) to change the contents of the BIOS chip. This is a high-risk operation if you are unsure of what you are doing, and it's not something I would do if I were in the middle of a project that needed the computer on a daily basis, because if it all goes pear-shaped you cannot just go out and buy a new ROM. For one thing, it's not a stock item, and for another it is soldered into the motherboard. Some motherboards have a jumper that can be set so as to make it impossible to modify the contents of the BIOS-ROM, because there was a scare once about hackers sending out virus programs that disabled a computer entirely by scrambling its BIOS contents.

BIOS chips can come from a variety of suppliers, and the type that you find on your motherboard determines what additional facilities you may be able to call on. In particular, the BIOS chip works along with a small CMOS-RAM memory chip that is used to store machine information such as the date and the machine facilities, using a battery backup so that the information is held permanently as long as the battery lasts. Because this is a form of RAM its contents can be changed at will.

The disk drives are vital to a desktop machine, and most modern machines use at least three – one floppy drive that uses replaceable magnetic disks, one hard drive which uses a set of magnetic disks that are fixed and encased in a sealed container, and a CD-ROM (some types will also play DVDs), CD writer or DVD writer drive. The floppy drive is used so that you can copy short programs (software) that you buy and place on the hard drive, and also for holding your own data. A hard drive has a limited life, so that it is essential to have a copy on tape, on floppy disks or on CD-ROM of all your *data* on the hard drive (for programs, you will have the disks on which your programs were originally distributed). At one time it was possible to use a computer with a floppy drive only, but modern programs are too large to fit on a floppy drive, and the drive itself is too slow to allow a program to be run using just the floppy drive. The CD drive is used because the size of modern software is just too much to allow the economical use of floppy disks, and many machines come with CD drives that allow writing a CD as well as reading it.

- More recently, many machines are using just one drive, a DVD writer capable of writing or reading the two main DVD formats and also all formats of CDs. CD rewriters may be phased out in favour of DVD writers, and on the horizon now are new DVD writers that can work with multi-layer discs (and so large amounts of data), and a scheme called BlueRay that uses a blue laser beam to write much more data to a disc of the normal DVD drive. One snag is that such high-capacity discs are much more susceptible to corruption by dust, so that they may have to be enclosed in cartridges. As always, it pays to build what is available now, and wait to see what emerges later, because otherwise you could find yourself out on a limb.

The motherboard carries the disk interface circuits that convert the numbers stored in the memory into pulses that can be recorded magnetically, and vice versa. The type of disk interface that is almost universally used at the time of writing is called the ATA or EIDE system, the initials meaning *AT Attachment* and *Extended Integrated Drive Electronics* respectively. Either name may be used, but it's the same system. You will find two sockets on the motherboard labelled as *Primary* and *Secondary* EIDE connectors respectively, and the usual arrangement is to connect the hard drive to the Primary EIDE and the CD-ROM drive to the Secondary EIDE connector. Each socket connects to the cable which has two plugs at the other end for the drives. This allows the primary EIDE connector to work with two hard drives and the secondary one to work with two CD drives (one CD-ROM and one CD writer), or one CD-ROM and another hard drive.

- The term ATA has appeared more recently to mean what we all used to call IDE. The reason for the distinction is that this is the more correct name, because SCSI drives (see later) are, technically, also integrated drive types and could be termed IDE.

Recently, both PATA and SATA interfaces can be found. The PATA (Parallel ATA) is the type that has been in use for several years and is still predominant in current models of computers. Serial ATA (SATA) is faster and needs much less bulky cables, and provided that your motherboard, drives and power supply unit will accommodate SATA it can be an advantage. At the time of writing, provision for SATA was patchy, but I expect it to supersede PATA eventually. All the new motherboards of the BTX design will use SATA.

GRAPHICS CARD

The essential card that must be added to the motherboard (usually into a PCI type of slot) if its action is not built into the motherboard is the video graphics card that converts the computer pulses into video signals that a monitor can use. Once again there is a universal standard called VGA or SVGA, and adding this card will allow you to connect up the monitor and see what happens when the computer is switched on.

- The bog-standard type is referred to as VGA, meaning video graphics adapter, and the name is a flashback to the days when computers were used mainly for text and any sort of picture display was sheer luxury.

The old VGA standard permitted full compatibility with earlier types of display, and it adds displays of 640 × 480 16-colour graphics and 720 × 400-colour graphics, using a 9 × 16 grid for characters with colour. The VGA type of card used nowadays is classed as SVGA (S for super), and it permits much higher resolution (such as 1280 × 1024) and the use of a large number of colours (16 million or more). You should not consider using an older type of graphics card on a modern PC, because some modern programs would not run on an older type of card, and others would provide very disappointing graphics.

- You should ensure that your graphics card is suitable for your monitor. There's not much point in specifying a graphics card that allows high resolution displays in millions of colours if your monitor is hard-pressed to deliver 800 × 600 in 256 colours.

The number of colours that you can display depends on the number of digital bits that are used to code the colour. In the early types of monochrome display, only one digital bit was used for each dot because the dot was either on (1) or off (0). More bits are needed if we want to encode a range of colours, and the formula for the number of colours is 2^N, where N is the number of bits per dot (pixel) on the screen. For example, 8 bits per pixel allows you to display 2^8 colours, which is 256, and 16 bits per pixel allows 2^{16} colours, which is 65 536. For high quality colour, 24 bits are used (16 777 216 colours), and this is usually referred to as 16-million colours. Photographic images demand the use of 30, 32 or even 36 bits for coding colours.

All this means that a colour picture can use a lot of memory. For example, if you want to print out a picture that is 5 inches by 4 inches at 300 dots per inch, using 24-bit colour, you will need to be able to store 5 × 300 × 4 × 300 × 24 bits, which is 43 300 000 bits. With 8 bits in a byte, that's 5 400 000 bytes, around 5.15 Mbyte. Worse still, this picture will need a lot of screen space because your monitor probably works at 100 dots per inch or less, so that the picture appears magnified, and you will not be able to see all of it on the screen. You can opt for a reduced view by zooming out, but the fine detail cannot then be seen because of the limited resolution of the screen.

The more memory your graphics card can use, the more easily it can work with high-resolution and high-colour images, and most graphics cards come with 32 Mbyte or more of their own memory. Others make do with less, and some, particularly the ones built in as part of the motherboard, will grab memory from the computer's RAM, which is not an ideal situation unless you are using 256 Mbyte or more of RAM. Graphics cards for fast games use require 128 Mbyte or more of very fast memory, and you pay accordingly, £300 or more for the top end of the market.

Another point to consider is that it takes time to transfer the large numbers of bytes that images require, so that the speed of a graphics board is important. Originally, a graphics board was slotted into the ordinary (ISA) expansion slot of a PC. This ran at a comparatively slow rate and to achieve faster rates of transfer of bytes, later graphics cards have used slots connected so that they could operate at higher speeds. The most recent standard is AGP (advanced graphics port) which operates at a standard speed of 66 MHz. At the time of writing, it would be quite difficult to find any graphics card that did not feature AGP connection, very often at a 4× or 6× speed. Machines using BTX motherboard and cases will use a new standard, PCI Express, which offers speeds equivalent to 8× AGP. The other change that may come soon is the method of connecting the graphics card to the monitor, with the current 15-pin connector replaced either by USB-2 or by the *Firewire* system (see later).

- See later on how to fit a graphics (or any other type) card into a slot on your motherboard.
- Note that you can now buy monitors and graphics cards using the new DVI connections. Both monitor and graphics card must be to DVI standards if you want to use this type of connection.

Planning for upgrading

Don't assume that every upgrade means opening the case and replacing parts. There are many upgrading paths that involve no more than buying a component and plugging it into a socket on your computer. These are what I call **convenience** updates; they are easy to carry out but they can add a considerable amount to your enjoyment of the computer and to its efficient use.

We'll start by considering upgrades that do not require the cover to be taken off the computer because they simply replace an existing external peripheral or can make use of sockets on the outside of the computer.

If most of your use of the computer is directed towards producing text documents, one addition that can be very convenient is a really good keyboard. Most of the keyboards that come with package-deal computers, and most of the keyboards that you are offered for home construction, are of the rubbery type that are far from pleasant to use and which do not sound or feel anything like the keyboard of a good electric typewriter. The best types of keyboard use a set of little switches under the keys, unlike the cheaper keyboards which use a rubber membrane with metal contacts to provide a switching action. The difference in the sound and the feel of these keyboards is enormous, and you would think that anyone supplying the better type of keyboard would make a point of advertising the difference.

- If a keyboard is advertised as *spill-proof*, it's usually because it's of the rubber membrane type. If you buy a switch-type keyboard, keep liquids away from it, and keep it covered when it is not in use.

In fact, it's quite difficult to find a good switch-type keyboard nowadays, which is why I am still using an IBM keyboard that I acquired some 10 years ago. Currently, keyboards by Cherry seem to fit this demand, but you need to get your hands on one to determine if it's for you. If you want a really good keyboard, you really can't order by mail or the Internet, you have to get your hands on it to feel and hear the key action.

The next possible convenience addition is a mouse. If you are using the bog-standard type of mouse with two buttons, consider upgrading to one with a central wheel. The wheel can be pressed to see a new menu, or it can be moved to scroll the screen by as many lines as you want to shift your text. This can make the use of your mouse considerably more convenient if your documents consist mainly of text. If your documents contain graphics, then consider the use of a trackball in place of a mouse. These also come in a large variety of types some of which have extra buttons whose action you can choose for yourself, and with the wheel action in addition. The trackball is particularly useful if you don't have a lot of desk space for moving a mouse.

A rather larger item for the convenience type of upgrade is a better monitor. At one time, computers came with decidedly small 14-inch monitors, which made it quite difficult to work with more than one window at a time. Larger monitors are now available at a comparatively low cost for the older cathode-ray tube type, though their size and weight is rather discouraging. At the time of writing the flat screen LCD type of monitor is becoming more affordable and it offers a larger amount of visible screen for its size than the cathode-ray tube type. Sizes of 17-inch upwards are still expensive, but with greatly increased production on the way prices should soon drop to a much more reasonable level. These types of screen make it much easier to work with multiple windows, which was always what was intended for Windows. Many LCD monitors now feature the DVI type of connection, which demands that the graphics card must also have a DVI connector. Many also offer a connector for a TV tuner so that you can have a monitor that will also act as a TV (without using the computer) at a price very much lower than that of an LCD TV of the same size. You might not get a remote control, but is that worth the price difference (of about £250 at the time of writing)?

- If your computer has a graphics card capable of two outputs, you may be able to use twin monitors so that you have a full screen for each of two windows or much more screen space for four or more windows than would be possible with a single monitor.

How old is your printer? Unless your use of a printer is mainly for producing documents for business purposes it's most likely that your printer is an inkjet type rather than a laser type. Nevertheless, it may be an inkjet type that is now seriously out of date and which you should consider replacing. Remember that all printers are mechanical devices that have a limited life, so that if your printer has a large number of miles on the clock it may very well pack up fairly soon. Modern inkjet printers usually feature a larger number of tanks than the old types, usually four to six, and you can replace an individual tank when its ink is exhausted. Such printers are capable of turning out excellent photographic quality on suitable paper, but can also be used in monochrome draft mode for text-only documents with minimal use of ink.

Another consideration may be that your old printer is greedy on ink cartridges so that you could save considerably on this continuing expense by choosing a more up-to-date printer of another brand.

Don't be tempted by low-price special offers on printers, because running costs for a printer are much more important than the buying price. Currently most printers offer both USB and parallel port connectors, but in the near future it's likely that only the USB type of connector will be used.

As a change from all these replacement items, have you considered the addition of a scanner if you are not already using one? A scanner allows you to make copies, like a photocopier, and to make computer files of both images and text. When a scanner works on text it creates an image that can be edited in a graphics program but not by a word processor. Every scanner, however, comes with software, referred to as OCR meaning *optical character reading*, that will convert the image of text into word processor text so that you can read text from a document directly into your word processor. This can save considerably the time you might spend typing, particularly if you often need to extract words and phrases from documents.

If your telephone line permits broadband use you might consider changing from dial-up access to broadband access. You do not need to remove an internal modem from your computer to do this, nor do you necessarily have to install a new modem inside the computer, because many modems and routers used for broadband access connect by way of the USB ports on your computer. All you have to do is to plug the hardware in and make a deal with a broadband provider such as Metronet.

There is one last upgrade that you can make without opening the case of the computer and it is particularly useful if your computer is running slowly because of the amount of data on the hard drive. If your computer has either USB or FireWire connectors available, you can add a hard drive (or any other type of drive) externally in a self-powered case. This does require a little more effort than simply plugging in, unless you buy the casing complete with its hard drive, in which situation all you have to do is plug the connection between the casing and the computer, and between the casing and a 13 A socket. If you have a suitable hard drive sitting around not being used, then you can buy the casing without a drive and install the drive for yourself, something that does not call for special skills.

I have emphasized that this is a useful upgrade if you have a large amount of data on the hard drive. The idea is that you transfer all the data from your internal hard drive to their external one, and you need not even use the external one when you're not transferring data.

It's not quite such a useful upgrade if your internal hard drive is choked full of programs because you can't just copy programs from the internal drive to the external one and expect them to work. Instead, you have to uninstall a program from the internal drive and install it from its original CDs on to the external drive, and repeat this for several programs until the internal drive is less clogged. Not all programs will take kindly to this and I much prefer to use external drives purely for data, particularly if you have data consisting of picture or video files which take up a large amount of space.

The way an external drive works is that it does not appear in your Windows Explorer list until the power is switched on to the external drive. When you switch this on, you will hear a bell sound from your computer's loudspeakers, and the drive is then available for use. When you want to switch off, you need to click an icon that will have been added to the toolbar at the foot of the screen. This checks whether any data still remains unwritten to the drive, and you need to make sure that the external drive is not selected on your Windows Explorer display otherwise it will always appear to be busy. When clicking the icon shows that you can remove the external drive, you can switch it off, so saving on power and also wear and tear on this particular drive.

Finally, in this set, if you have a modern fast computer you might consider the use of direct voice input rather than typing on the keyboard in order to input text to your word processor. Programs such as Dragon Naturally Speaking 7.0 will, after a test period of speaking, allow you to speak at a normal rate and see the words appear on screen. Inevitably when you first start to use the system, many mistakes will appear, but if you use the training facility in the program then these mistakes are never repeated and you will find that you can produce fairly long documents with very few errors. Unless your typing speed and accuracy with a keyboard are of a very high order you can normally achieve better speed and accuracy with dictation. I must emphasize, however, that a fast, modern computer is necessary to get the best out of this large and complex program.

INTERNAL UPGRADES

Internal upgrades mean opening the case, and we shan't take up much space dealing with them at this point because most of this book is concerned with how to install new components within the case of the computer. If your upgrade is one that requires more speed, more up-to-date facilities, and/or more memory, then it's inevitable that the upgrade has to be internal. The types of upgrade that we're considering here are:

- new processor (on existing motherboard)
- new motherboard (and processor)
- more memory
- new video card

and all of these actions are fully described in the pages that follow.

Chapter 3

Other bits

Floppy drive

The floppy drive on modern machines is the 3½-inch type that has been used for many years and which is also used on other types of computers (Macs, for example). There is no particular reason to prefer one make of floppy drive to another, and you should look for a low-price unit, because the floppy drive is seldom used on a modern computer. Do not be tempted by the expensive high-capacity floppy drives that can use equally expensive high-capacity floppy disks, because though these disks can be replayed on your drive you might want to exchange disks with someone who does not have the same drive. If you need large capacity removable discs that can be exchanged with other computer owners, look at the modern range of CD or DVD writers, see later. A CD-R disc holds 650 Mbyte and costs about 50 p at the time of writing.

- Another option is to forget about the floppy drive altogether (when did you last get a program delivered on a floppy?) and go for a pen drive (containing a form of RAM that retains data even when there is no power applied) that can be plugged into a USB socket. This gives you a choice of memory capacity, and most users opt for 128 Mbyte, well in excess of the 1.25 Mbyte of a floppy.

Hard drive

The hard drive is another essential component that needs some tough decisions. Hard drives have developed in capability at the same time as prices have been falling, so that they represent excellent value for money. The price I paid for my first 32 Mbyte hard drive now buys 80 Gbyte of space. New computers (laptops apart) usually feature hard drives of 80 Gbyte to 128 Gbyte capacity.

- Do **not** consider using a second-hand drive, or taking one from a machine you have been using for several years. You cannot tell what life to expect from an older drive and, worse, still, the performance of an old drive can be poor. In the extreme you may find that an old drive simply will not work with modern equipment – a **really** old drive might need a separate interface card fitting to an ISA slot, and a drive as old as that could not expect many more hours of life.

For some time now, all new hard drives have used a system called *DMA*, meaning direct memory access. On older PCs, a hard drive was read or written by using the processor as an intermediary. The processor would read a byte from memory and then write it to the hard drive, or read a byte from the hard drive and then write it to memory. This involvement of the processor for each byte made the process slow and also prevented the processor from being used for anything else at the time of writing or reading.

- The DMA system uses the processor only to set up conditions (how many bytes, where from, where to) and then allows another chip, the DMA chip, to do the work. This releases the main processor for carrying on with its computing tasks, with a considerable benefit in speed.

The earlier DMA has now been replaced by a faster version *UDMA*, the U meaning Ultra, and if you are building or upgrading you should not consider using an older type of hard drive that is not labelled as UDMA. Your motherboard must be capable of dealing with UDMA, but you are rather unlikely to buy a motherboard (other than a second-hand or remaindered one) that does not. The only snag is that older operating systems might not be able to make full use of UDMA.

Nowadays, do not consider using any hard drive that is not at least to the ATA-100 standard, and preferably to the ATA-133 standard, permitting very faster transfer between the drive and the motherboard. This type of drive is essential if you are going to use applications such as digital video editing that handle a large amount of data at a very high-speed. Even if you are not considering such applications at the moment, it is likely that you'll find that slower forms of transfer become obsolete, and it's never a good idea to be saddled with obsolete equipment. By the time this book appears, the ATA standard may have been upgraded yet again.

A hard drive can be *partitioned*, meaning that its storage space can be (magnetically) divided into sections called partitions. You might, for example, partition a 60 Gbyte hard drive into two partitions, each of 30 Gbyte. There are several advantages to this. Each partition will be allocated its own reference letter, so that a single drive partitioned into two would show on a Windows Explorer display as C: and D: drives. This allows you to separate programs from data, keeping your programs on one partition and data on the other. It is **essential** to partition if you are using a version of Windows that will not make full use of any partition of more than 32 Gbyte – it would be rather pointless to have an 80 Gbyte hard drive and be unable to use more than 32 Gbyte. A partition is intended to be a reasonably permanent feature of a drive, and at one time it was impossible to change partition position without losing all the contents of the drive. Such changes are now possible using software such as Partition Magic (or facilities built into Windows XP), but it's not exactly something you need to do very often.

- A drive must have at least one partition. We'll look at that point again in Chapter 6.

Note that if you use Windows XP and opt for the NTFS disk system your partitions can be as large as you like (and a file can be as large as the partition can hold). The only snag is that you cannot easily convert back to the older FAT system if you revert from Windows XP to an older Windows version for any reason. On my own machine, I removed all options to revert, and I use NTFS on all drives (including a removable drive, though this means that I cannot put the removable drive into any machine that does not use Windows XP).

CD-ROM drive and DVD

A CD-ROM drive, once considered a luxury, is now a standard item for a low-cost PC, but any other machine will probably come with a CD or DVD **writer** drive. When CD drives were introduced, it was to allow multimedia software (text, images and sound) to be run, because this would have been impossibly clumsy if floppy disks had to be inserted and removed at frequent intervals. Nowadays, the CD-ROM drive has become essential because operating systems and applications software packages have become so large that large numbers of floppies are needed for distribution, and the CD represents a much cheaper and more secure way of holding programs. The price of a CD writing drive (a *CD burner*) is now so low that it makes no sense to construct a machine with only a simple CD-ROM drive, and even a DVD writing drive is now reasonably priced.

Note that there are three varieties of CD as there are of DVD also. The pressed type is mass-produced and is the type you buy in shops or find on the covers of magazines. The data is coded in the form of tiny pits in the surface of the disc. The CD-R discs are coated with a coloured dye that changes colour when it is affected by the laser that is used for writing. This change is not reversible, and the lower power that is used for reading does not affect the dye. CD-R discs can be read on any CD-ROM drive or modern music CD player. The CD-RW type uses a much more complicated system of exotic materials whose magnetism and light-reflecting ability are linked. You may find that a CD-RW disc you have recorded cannot be replayed in a music CD player, or even in an older CD-ROM drive on another computer. It will always be replayable on the drive that created it, however.

- The rewritable discs are not so robust as the pressed type, so you have to be more careful with handling them. Always hold a CD by the outer edge, because a disc is recorded from the innermost area outwards, so that on most discs there is nothing recorded in the outermost tracks.

CD drives are graded by speed, and because the speed of a CD is not constant (it spins faster when reading the inner tracks than when reading the outer tracks) the figure of comparative speed is used, with the audio (music) CD taken as a standard. A CD-ROM drive that operates at 4×, for example, will spin four times faster than a music CD. Reading speeds of 24× are now common, but though higher speeds are possible, they are not necessarily much of an advantage.

The CD-R/RW drives will write as well as read. They can read any normal CD as well as the types they create for themselves. The CD-R discs can be written, but not rewritten, and though you can **add** data to such a disc until it is full, you cannot then rewrite it with other data. The CD-RW, by contrast, can be written and rewritten like a floppy. In packs of ten, the CD-RW discs cost around 70 p each at present, with the CD-R type costing around 25 p each (though some high-street suppliers still try to charge much higher prices). Prices vary according to the packaging; the lowest prices are for 50 discs on a spindle, the highest for each in a 'jewel-case', and an intermediate price if the discs are in the flatter plastic cases which are ideal for posting. Two such cases will fit well into each slot of the CD stacks and drawers that are used for CD storage.

Advertisements for CD writer drives always quote two or three speeds. For the CD-R type, the two speeds that are quoted are the read speed and the write speed (always lower), so that a CD-R drive quoted as 24×, 12× will read at 24× and write at 12×. The CD-R/RW types of drive that can use any type of disc quote three speeds, the first for reading, the second for CD-R and the third for CD-RW.

- Be careful of old rewriting drives which ran at around 4×, because some will not work with the modern CD-R and CD-RW discs designed for faster speeds. Each pack of CD-R or CD-RW discs will state the maximum speed at which they can be used, but I have often found problems if some material, notably sound or video, is recorded at the maximum speed. Do not try to use old 4× discs in a modern fast writing drive.
- If you are contemplating writing CDs it would be rather short-sighted to buy an old type of drive that dealt only with CD-R and not with CD-RW as well, but the CD-R type of blank disc is now so inexpensive that you will probably find that you seldom use the RW type. All CD writer drives sold nowadays will work with either CD-R or CD-RW discs.
- Beware of rip-off prices on CD-R discs, usually under the excuse that they are specially designed for recording music. Computer data is much more fussy than music tracks because a single error can crash a program.

DVD means digital versatile disc and the name applies to a more modern type of CD that holds very much more information, typically 4.7–17 Gbyte. The 'normal' speed of a DVD is higher than that of a CD, so that speed factors such as ×6 for DVD refer to much higher speeds than ×6 for CD. DVD players can be used for reading CDs and at the time of writing, DVD reading drives are being fitted to many types of computer packages. These drives can read CDs of all types as well as DVDs, so that it's an advantage to specify such a drive rather than one that handles CDs only. DVD writers are now quite common but there is a compatibility problem.

DVD writers can be manufactured using any of three competing technologies, known as DVD+R/+RW, DVD−R/−RW, and DVD-ROM. Each needs a different form of recordable disc, and each has its own advantages and disadvantages. At the time of writing, most DVD writing drives offer either +R/+RW or −R/−RW, and a substantial number of drives will work with either type. The DVD-ROM format is due to Panasonic, and is less common, though Sony manufactures a DVD writer that can take this format as well as the other two. My advice would be to buy a drive that can record and read the two main types of discs, the DVD+R (or +RW) and the DVD−R (or −RW). If you have a DVD recorder replacing your VCR it will be useful if your computer DVD recording drive can work with the same type of discs. Any type of DVD writer will be able to read and write CD-R/CD-RW discs.

- You cannot distinguish CD-ROM drives from CD-R/RW or DVD-R/RW by looking at the boxes, because the box shape is the same. This makes it easy to replace one drive type with another.

Ports

Most PCs currently come with two serial ports, a keyboard port, possibly a separate mouse port (of the PS/2 type), a printer port and two or more USB ports; possibly a Firewire (IEEE 1394) port. In future, these different connecting devices may all be replaced by a set of universal serial bus (USB) connectors, but that has not yet happened at the time of writing. At present, USB will be found in addition to the other ports, because so much equipment still uses the older types of port. The old type of parallel printer port, however, is fast disappearing, and there seems little point in retaining the old types of serial port.

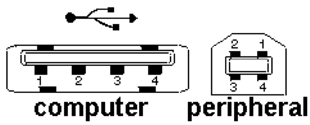

Figure 3.1 USB connector shapes and symbol

On many current motherboards, the printer port and the serial ports are linked by short pieces of cable to connectors that are mounted on the case. The PS/2 keyboard port and a PS/2 mouse port will always be provided mechanically fixed to the motherboard at a position that coincides with a hole in the casing. If you try to match a motherboard to the wrong type of casing this is one error that you will find quite soon. The USB type of port is mounted either on the motherboard or on a separate card.

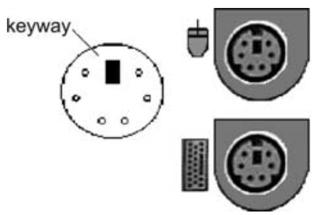

Figure 3.2 PS/2 socket shape, showing symbols for keyboard and mouse

- If (very unusually) no PS/2 port is provided for the mouse you can assume that a serial or USB mouse is needed. If your present mouse is not a serial type you can buy an adapter that allows a PS/2 mouse to be used on a serial port.

Operating system

Your computer is useless without an operating system. If you buy a PC it will quite certainly come with Microsoft Windows *Me* or XP, and you will most likely want this operating system for your own machine.

If you do not have the Windows *Me* or Windows XP disk, only the disk(s) for an older system such as Windows 98 or Windows 95, you can still install one of these older systems and upgrade later. This is an advantage, because buying a copy of Windows 98 for installation on a hard drive that has no operating system currently installed (an OEM copy) is more costly than buying an upgrade disk for use on a machine that is already running Windows.

Legally, you should not be running the same copy of Windows on two machines, but if you are scrapping an old machine when you commission the new one there is no problem about this.

Sources

There are three main sources for components of DIY computers: local computer shops, computer fairs, and mail-order suppliers. Most of the mail-order suppliers will take orders and payment over the Internet, often with the incentive of no carriage charges, so that this can be a useful option if you already use a computer with an Internet connection, but there can be disadvantages, as we'll see later.

A quick flick through magazines such as *Computer Shopper* or *Micro Computer Mart* will show that the prices of components bought by conventional mail order look low, but you have to remember the cost of carriage, which can be out of proportion if you want just one small item. This is a particular advantage of buying on the Internet if you can. Some suppliers will levy a surcharge if you pay by credit card. My instincts are to avoid these suppliers, because buying with a credit card provides protection that is not available if you use any other form of payment such as debit card or cheque.

Obviously, ordering over the Internet means that you cannot inspect the goods closely until you receive them, and you need to be quite sure of what you are buying because many mail order suppliers will impose a 're-stocking' fee if you return an item that you ordered but have had second thoughts about.

- You should look for mail order sources that have lengthy clear descriptions of components, and if you are in doubt, ask for more details when you are ordering. If you are ordering using a supplier's web site, print out the specification and read it carefully before you place an order.

- One important point is that no web site supplier I have ever come across allows you to check that a set of items, such as motherboard, processor, casing and memory, will be compatible. This is particularly important for casings, because many cases use a power supply that is woefully inadequate for a fast processor using a large amount of memory. It's not the overall power rating that is important but the amount of *current* that can be delivered on each supply line. If you buy a case that comes without a power supply you can then choose a suitable separate power supply to install, and you can easily obtain a specification, but when you buy a case with a built-in power supply it can be very difficult to find anything relating to the power supply other than the wattage rating.
- Just to emphasize that point, I have a machine running a fast processor with 512 Mbyte of memory, but using a power supply rated at 200 W. It is perfectly stable. Another machine using a casing whose PSU was rated at 350 W was unstable until the processor speed was reduced from its recommended value of 1.8 GHz to 1.5 GHz. Needless to say, the motherboard manufacturer blamed the memory, the memory manufacturer blamed the processor, and the processor manufacturer (rightly as it turned out) blamed the PSU. The supplier of the case/PSU did not answer emails, telephone calls or any other communications, and my only form of recourse is to make sure I never buy anything else from them.
- If an Internet or mail-order supplier is reluctant or unable to discuss compatibility, or does not answer your emails, forget it and go elsewhere. You will soon find for yourself a list of suppliers who can be trusted (for the record, I have never had any reason to complain about Dabs or Simply Computers).

Local shops have the considerable advantage that you can see exactly what you are getting, and can even take a look at manuals and diagrams before you buy. You will often need to pay extra for this, but this is not inevitable, and it can be very comforting to know where you can return an item that turns out to be faulty, and possibly get some help or advice. Do not, however, expect to buy the time of an expert for the amount that you pay for a small item – it's another matter if you are paying out several hundred pounds. That said, local shops are usually run by enthusiasts who will offer guidance and will frequently go out of their way to help you.

- No two shops are alike, and you cannot expect the same level of attention in a large shop as you can in a small one where every customer counts. It may be irritating to wait in line while another customer has several worries sorted out, but you can learn a lot by listening, and it's good to know that you too might get the same level of attention.
- I like to use a local shop for critical items such as motherboards and case/PSU assemblies, though I buy memory, processors and all peripherals over the Internet (specifying memory by Crucial or Kingston).

Computer fairs are an increasingly popular way of selling hardware components (though they do not usually sell printers). In addition, you can find components that are not readily available in other outlets, such as out-of-date components. Though it's unlikely that you want to build a PC of ten years' old design, this can be handy if you want to repair an old machine before disposing of it.

- Computer fairs also allow you to see the goods and to get information. The stallholder at a fair is likely to be knowledgeable, and can assist you in making a choice, and you can also readily compare products and prices between several suppliers.

At one time, the fear of computer fair purchases was that the supplies were of dubious quality and origin, and that the supplier might never be seen again. Nowadays, computer fairs are run by reputable companies who take some responsibility for vendors, and you can see which stalls show a name, address and telephone number and which show only a mobile number (avoid these!). Goods are in their original packaging, so that you aren't likely to be sold out-of-date items in plain boxes.

As always, however, you need to exercise some caution, and one good way is to pay by credit (*not* debit) card. Some vendors will take credit cards, and the advantage (not available if you use a debit card) is that the goods theoretically belong to the credit card company until you pay the bill. This means that if the goods are faulty, the credit card company will take responsibility. There aren't many traders who will refuse to change an item when the credit card company is conducting the negotiations. Remember that you may be surcharged for using a credit card.

More often than not, however, traders at a computer fair do not have credit card facilities and will insist on cash or a cheque. If you attend the same fair regularly and know that the trader you are dealing with appears equally regularly you can probably take the view that it will be safe to pay by cheque or cash, knowing that you can return any faulty goods at the next fair. It's unusual to get anything that is faulty (one trackball is my only example in many years), but I always prefer to use a credit card for anything major (such as a motherboard), though cash/cheque is no problem for the smaller items.

Avoiding laptops

There's just one last point. All of this is about the full-scale or compact desktop or tower case computer, not about laptops, portables or palmtop machines. The plain desktop type of PC is of standardized design so that you can fit components from a huge range of suppliers in the confidence that all will fit and work.

This is not true of any miniature machines, which exist in the legendary 57 varieties. Each manufacturer has a different layout and uses custom-built components extensively, so that there is no market in interchangeable components. The only exception is the supply of small hard drives for replacement purposes. There is no source, other than taking a trip around the computer markets in Taiwan, of sets of components that you can buy to make your own laptop. In any case, you need a ten-year apprenticeship as a sardine packer before you feel confident enough to try it.

This does not mean that you have to avoid all small machines, because the type of miniature desktop machine (SFF, small form factor) typified by the Shuttle is, if anything, easier to construct than any standard desktop machine. At the time of writing, these machines were becoming increasingly popular, not least because you can buy with confidence a casing that is completely fitted and wired up with its motherboard so that your work consists of inserting items such as processor, memory, drives, and cards. Because of clever design, it is remarkably easy to work on these machines; easier, in fact, than on most conventional types. We'll look at the construction of such a machine later on in this book.

Part II

Basic Construction

Chapter 4

Starting work

Initial work

If you are upgrading an old machine you first need to strip it down so that you leave only the bits that you are not upgrading. In many cases this can be a fairly complete strip down, because it's likely that a thorough upgrade will require a new motherboard so that you will be removing the old motherboard and all the cards it contained along with processor and memory. If, on the other hand, the existing motherboard is of a design that allows you to upgrade by fitting a faster processor and faster memory units, all you need to do is to remove these units from the motherboard. Since the actions that are needed to upgrade are the same as these needed to build a complete basic computer, you can then follow the instructions that follow for the items that you need.

You should prepare initially to build a basic machine, meaning one that contains the minimum of components. It is always very tempting to wade into a construction project and use every one of the bits and pieces that you have bought and then take up the case and plug it all in, but this is not a very sensible way to approach a self construction project on a PC. It's perfectly natural to want to do this, because you're in a hurry to get something up and running, and you want to get the case closed and ready for use. The snag of this approach is that if your machine does not run properly you may not have enough experience to know why and what to look for. You should certainly not install or attach a modem, network, printer or scanner initially, because these items are best dealt with once you have a machine that runs reliably.

The best way of going about it is to start with the motherboard in its case, processor, one unit of memory (if you have more than one, always try a single unit first in case the PSU will be overloaded by using two), CD-ROM drive (or DVD drive), hard drive, and any graphics card that is needed assuming that this is not provided on the motherboard. If the machine gives problems with this layout, it certainly would have given them if you had added anything else, and it is best to know at this stage whether it's working or not. Modern cases are easy to work with, and it's not difficult to insert other components as required.

- The exception here is if you are building a miniature desktop machine such as the Shuttle, because some items are not easy to reach once the machine is built up. You can, however, omit such items as a modem card, or a graphics card (if the motherboard is one of the types that provides for graphics on board). See the end of this section for advice on building a Shuttle machine. At the time of writing, BTX components are not available, so that these constructional outlines refer to ATX, since the components will be available for some time to come.

We'll look now at the steps in construction from scratch, starting with preparing and inserting the motherboard. Obviously, if you are upgrading without replacing the motherboard these instructions do not apply. They do not apply either if you are building a Shuttle or other miniature machine in which the motherboard is already installed in the case with all of its connections made.

Motherboard preparation

Before you can consider starting assembly, the motherboard needs to be inspected carefully, and you also need to read the manual or other documents that accompany it. Apart from anything else, you need to be absolutely certain that your motherboard will accept the type and speed of processor you intend to place into it. If there is no form of documentation, contact the suppliers of the motherboard because you **cannot** assume that you will be able to find the correct connections or to make the correct settings by instinct or by comparing it with an older motherboard. Most modern motherboards need no adjustments – they can sense the processor you are using and make the settings using software. Nevertheless, the more information you have on everything, the better placed you are to detect something that is not quite right. Manufacturers' web sites are useful, but only if you have access to them while you are building the computer, and that means using a spare computer.

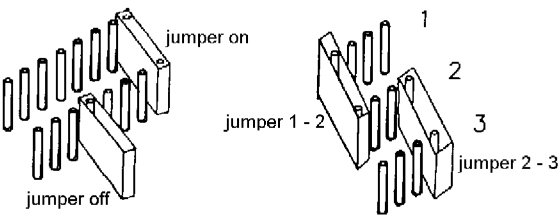

Figure 4.1 Typical jumpers

Jumpers, Figure 4.1, are used on many motherboards, particularly the older types, to switch actions in or out, or to allow for options. Each jumper unit normally consists of a row of three small pins with a bridging clip, the jumper itself, which can be placed over two pins to provide two settings (sometimes three settings if the design provides for the jumper to be removed altogether). Jumper settings should be correct if you have bought a bare-bones system with the motherboard already installed in its case, and very often there is little chance of altering jumpers once the machine is fully assembled. Many types of motherboard design now are self-adjusting or set by software, so that no jumpers, or a very few, are provided.

- Even on a motherboard in which almost all of the settings are made by software, there may be a jumper that is used to provide power to the CMOS-RAM. This may be supplied in its disabled position to minimize battery drain, and you will have to set it to the enabled position so that the CMOS-RAM will retain information. There may also be a jumper that enables or disables the ability to alter the

ROM (flash ROM) by software, and if this is at the *enabled* setting you should set it to *disabled*. You have enough to worry about without needing to worry about making changes to the ROM.

When you have read all the information on the motherboard and made notes about anything you need to watch out for, unpack the motherboard. The final wrapping will be of a material that is slightly electrically conducting, and when you take the motherboard out of this material you should lay the board down on this sheet of material to make an inspection. Hold the motherboard only at the edges, and try to keep your hands away from the metallic connections as far as possible at all times. Fingerprints on the metal of a motherboard make electrically conducting tracks, and that's not desirable.

You will need to check any jumper settings very carefully again before you place the new motherboard into the case. The small (and usually anonymous) manual or leaflet that comes with the motherboard will list the jumper settings, if any, and these are often pre-set correctly, particularly if you have specified the type of processor chip you will be using. If they are not, it is not always clear what settings you ought to use, and you may need to enquire from the supplier of the board.

- Make a sketch for yourself on a larger scale of the way the jumpers are set. This makes it easier to check before, during, and after installation. Some jumpers may be almost impossible to reach after installation unless you remove other units.

Another problem is that manuals usually show the jumper pins numbered, but this numbering is not necessarily printed on the motherboard or, if it is printed, it is obscured by chips or other resident obstacles. The description that follows is of jumpers on a recent Socket-A board. This is fairly typical of modern practice on older Socket-A boards, and most boards that you are likely to come across will provide for a similar list of jumpers. Most motherboards now, however, are almost totally jumperless.

Typical jumpers

- If you have to alter jumpers on a board that is already in place, you must always switch off the computer and allow a few minutes for voltages to decay to zero before you attempt to change jumpers. Always check jumper settings again after you have made a change.

- On modern boards catering for faster processors, the core voltage is usually set automatically, typically at 1.6 V, and you should not try to alter this setting even if there is any provision for doing so. Other settings are also made automatically by reading data stored within the CPU itself.

The next important settings are the internal clock speed jumpers which are set for the type of processor you are using. Some motherboards omit these, using software setting only; other boards have a jumper that can be set so as to allow either software or jumper setting of clock speed. The settings are usually graded from 1.0 to 15 or more, and the higher settings may result in the processor running too fast, a situation called *overclocking*. You will need to check the manual for the motherboard and any leaflets that come with the processor to know how to set these manually. Most modern motherboards make this setting automatically by sensing the type of CPU that is inserted, and some jumper settings work differently with different processors. These internal speed jumpers allow you to overclock the CPU, and some CPUs (such as the later Celerons) will totally ignore the settings. On later boards, this figure (called the multiplier) can be set by software and is usually set automatically by reading data contained in the CPU.

- Never set the multiplier speed so as to overclock a processor when you are building a new machine. You **might** consider this action (with great caution) when you have several months of faultless performance from the machine but certainly not before. Some motherboards are designed so as to make overclocking as difficult as possible.

The other clock setting, again usually by software but on some boards by jumper, is labelled *External clock* or *FSB* (front-side bus) and typically allows for bus speeds of 100 MHz and 133 MHz, often higher speeds (400 MHz or 800 MHz) also. On older motherboards you may find the 66 MHz speed for the slower old-style chips. On modern boards, this also will be set automatically. You will, once again, need to check carefully to find if you need to use a different speed.

- Remember that if you are using a 133 MHz (or faster) bus speed that your memory chips need to be of the faster type. Motherboards for the faster Athlon and Pentium chips will need to provide a 133 MHz (or more) FSB speed, and must use memory that is capable of operating at this speed. This speed capability extends to the other supporting chips, but if the motherboard can use 133 MHz it's almost certain that the chips that come on the motherboard can also. See later for using DDR memory which operates at twice the speed of the FSB, so that a 133 MHz FSB results in the memory being used at a clock rate of 266 MHz. Most modern boards use higher rates now for fast machines, but the 133/266 rating is appropriate for general-purpose computing. Memory chips operating at 333 MHz or more are now specified for really fast machines.

- Note that the motherboard design (usually in association with hardware in the ROM) fixes the maximum speed of CPU that you can use. If your present requirements are for a comparatively slow chip it makes a lot of sense to spend a few pounds more on the motherboard that can be used with a chip running at double the speed you are sure you require. This makes it very much easier to upgrade your system when you need more speed.
- Raising the e*xternal clock* (FSB) speed beyond its recommended rate is one way of making a chip work faster than the maker has intended, but you must not experiment unless you are prepared to lose your CPU. Some users have reported that this overclocking can be done safely on some chips, but it's on your own head if you do so and burn out the CPU. You also have to be certain that other chips on the motherboard will accept the higher rate. Check Internet sites such as:

  http://arstechnika.com/paedia/celeron_oc_faq.html
  http://www.sysopt.com/howtooc.html
  http://www.speedguide.net/overclocking/Overclocking.htm

  before you make any attempts to overclock a chip, and only if you are certain that the machine is stable with its existing settings. Never attempt to overclock a new machine.

Take your time, enquire if necessary, and do not install the motherboard into the case until you are totally satisfied that the jumper settings are correct. A familiar problem is that the documentation may tell you that the setting you want is to jumper pins 1 and 2, but there is no pin numbering on the motherboard. If you come across this problem, you will often find that you can deduce pin numbers by looking at other settings which you are fairly sure have been correctly pre-set. You may find, for example, that pin 1 is the pin closest to the end of the motherboard that contains the expansion slots.

Once the jumper settings have been dealt with and double-checked, you can install the CPU, unless this has already been done by the supplier. Normally, if you buy a board and a CPU by mail order, the CPU will have been inserted and the jumpers set, except for the CMOS-RAM jumper. If you buy the motherboard and processor separately (at a computer fair, for example), you will have to insert the CPU for yourself and also check that the jumper settings are correct.

- See later for details of setting up a chip using a jumperless motherboard. This has to be done after the chip has been installed on the motherboard put in place.
- If you are building a Shuttle, you will insert the CPU and memory into the motherboard that is already installed in the case. For other designs, however, you should insert these components before installing the motherboard, because it's much easier to carry out the actions without straining the motherboard (the Shuttle design makes it easy to insert a CPU without any strain on the motherboard).

Inserting the CPU

The procedure for inserting a CPU into a socket is much the same for all the main types of sockets (Socket-A, Socket-370, Socket-478, Socket 754) and the following description is for a Socket-A CPU, as used on so many ready-built computers nowadays.

- The 64-bit AMD Opteron processors use a 940-pin socket, and because these are intended for very high-end processing, it's most unlikely that you will be using such a beast for your own computer.

Before inserting the CPU, check that it is the type you ordered, because it's more difficult to remove a CPU than to install it (because the heat transfer compound sticks the heatsink to the processor). Note which corner has a pin missing, a notch, and a white dot, because this locates which way round the chip will fit in the socket. Take a close look also at the heatsink. For the slower CPU chips, the heatsink often comes with a paper cover over the flat surface that is clamped against the top of the chip. Do not peel this paper away until you are going to place the heatsink over the chip, because it covers the heat transfer compound that helps transfer heat from the chip to the heatsink. If this is exposed to the air for some time it will no longer transfer heat so efficiently. For the faster chips, you will usually be supplied with a small container of heatsink grease that has to be spread over the surface of the CPU that the heatsink makes contact with. You should not use any metallic instrument for spreading this grease, and in most cases it can be roughly spread from the nozzle of the tube, because it will spread evenly as you clamp down the heatsink.

- If you are using a heatsink that is not of the bog-standard design, such as a highly efficient type or one that uses vapour cooling, or one that supports the use of a low-speed fan, read carefully any instructions that come with the heatsink.

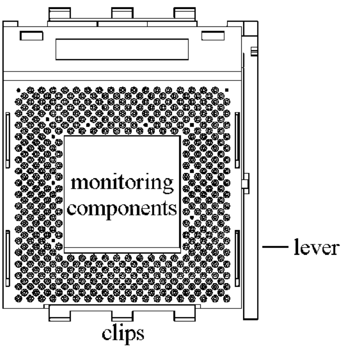

Figure 4.2 The view over an empty Socket-A holder

Pull the lever away from the body of the Socket-A on the motherboard and then pull it upwards, Figure 4.2. A CPU for Socket-A has a pair of notched corners where there is no hole for a pin, Figure 4.3, and you have to insert the chip so that it drops into the socket with the corresponding positions that lock a pin fitting into place. The CPU should drop easily into place, any resistance probably indicates that it

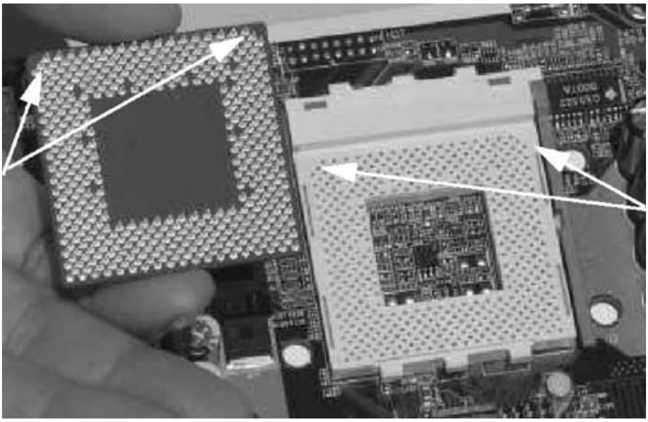

Figure 4.3 The socket and the chip (pins up) with arrows showing the corresponding points. Photo courtesy of AMD, Inc.

is the wrong way round. Once the CPU chip has been dropped in you can replace the lever so that the chip is locked in place.

- On a machine designed for fast processing, the heatsink and fan may be so heavy that you have to be careful about moving the finished machine. Ideally, if you want to carry the computer in a car, you should lay it down on one side so that the fan and heatsink are above the CPU. This way, vibration will not pull the processor out of its socket.

You can then fit the heatsink and cooling fan, Figure 4.4. This item clips over the top of the chip, and the clips are **very** strong because they have to keep the heatsink in very close contact with the chip. You will need to support the motherboard to avoid excessive flexing when you press down the clips on the fan, and the best way to do this is to lay the motherboard down flat on the conductive plastic that was used to contain it, and press the heatsink and fan unit down until the clips can be located. You might need to use pliers to pull the clips into position.

- In this respect, the fitting for a Shuttle machine is very much easier, because the heatsink can be bolted down on to retainers so that it is tightly clamped against the processor surface.

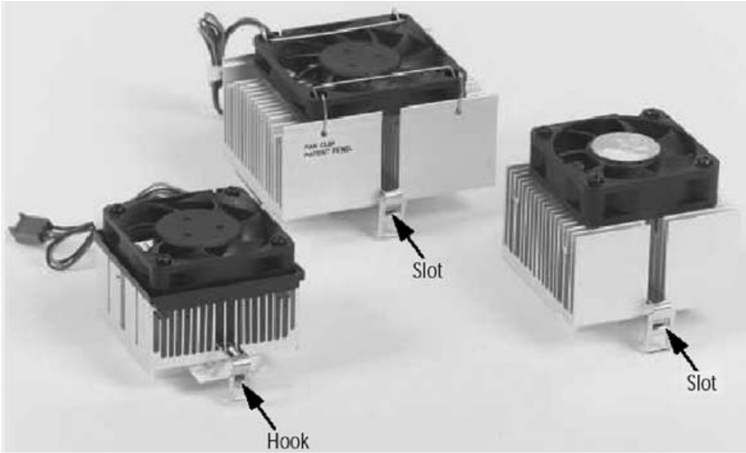

Figure 4.4 Typical heatsink and fan assemblies for Socket-A use, photo courtesy of AMD Inc.

Memory

- By this time you will have sorted out which of the many varieties of memory chips your motherboard can use and bought the appropriate type.

Following CPU insertion you will need to install memory, and on all modern motherboards this uses DDR DIMMs. These strips have 184 pins (the previous generation of slower DIMM memory strips used 168 pins), and you must ensure that the pin number and layout of your DIMMs is correct for the holder(s) before you try to insert memory. The strip will go in only one way round (because of a locating slot) and is inserted directly into its slot and clipped in place – the older SIMMs had to be inserted and then turned to lock them in place.

A considerable amount of force is needed to get the retaining clips into place over the notches in the end of a DIMM strip, and the best method is to pull on the slips with the edges of the first fingers of each hand, using the thumbs to push down the DIMM strip. This way, you are less likely to put a strain on the motherboard as you would if you were pushing the DIMM down until the clips could be located. This requires much more force than you might expect, and it's not uncommon to find that one side of the DIMM strip pops out of place later. Check it all carefully before you replace the covers on the casing.

Connections are made to the DIMM just as they are to expansion cards, using an edge-connector, a set of tiny metal tongues on the card which engage in springs on the holder, Figure 4.5. The DIMM is clipped in by spring-loaded holders at each end. Nowadays DIMMs come in sizes from 128 Mbyte to 1024 Mbyte, and you can use a DIMM singly, so that you could use a single 512 Mbyte DIMM for this amount of memory, allowing you to expand your memory later as required.

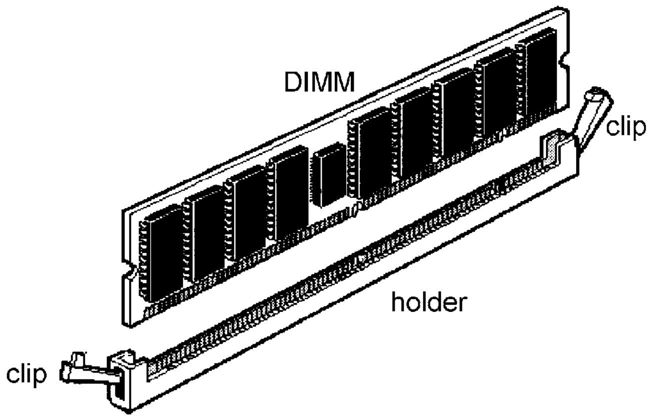

Figure 4.5 Fitting a DIM memory board into its holder. The clips at each end are pushed inwards to complete the insertion

You should not put more than 512 Mbyte total into the motherboard (which usually takes 128 Mbyte or more) unless you are certain that your operating system will cope with a memory of more than 512 Mbyte. For Windows 95 or earlier, the limit is 64 Mbyte, but if you are using Windows 98, or Windows *Me*, you can use (and are likely to need) up to 512 Mbyte. Windows XP can make use of larger amounts of RAM, and a size of 512 Mbyte to 1024 Mbyte has become almost standard for the more expensive machines now on offer.

- Don't forget that RAM requires power, and a 1024 Mbyte memory may draw as much as 30 amps from the PSU. Suppliers of memory are notably reticent about how much current each DDR strip will draw from the PSU, but the supplier of the PSU should be able to guarantee to you that it can support the amount of RAM that you intend to fit. If you want to use 1024 Mbytes of RAM, I recommend buying a 512 Mbyte DDR DIMM first and checking that your computer is totally stable with this amount before you lash out on another 512 Mbyte.

DIMM units come in several types, and there are two notches in each DIMM board that must match with the socket to ensure that only the correct type of DIMM will fit. One notch determines voltage supply (3.3 V, 5.0 V or reserved); the other is marked *Unbuffered*, *Buffered* or *Reserved*. The reserved positions are likely to be used if or when new varieties of DIMM boards are manufactured.

Motherboard insertion

Once the CPU and memory units have been inserted, the motherboard can be mounted into the casing, but don't rush into this task. To start with, look at the motherboard and casing, with the motherboard lying the correct way round (port connectors to the rear) and still on its conductive plastic material. Take a close look of how the motherboard will be mounted into the base of the casing. Some case designs allow a complete 'pan', a metal base sheet, to be removed. The motherboard is then mounted on this pan, so that you do not need to fumble your way past other units to reach everything. Once the motherboard has been mounted on the pan, the pan can be placed back into the case. If you can easily remove the motherboard pan for fitting, do so. The presence of a pan does not mean that it will be easy to remove or replace, and the more expensive cases definitely score over the cheap types in this as well as in other aspects of convenience.

At this point, fit the I/O shield to the casing. You should by this time have checked which shield to use (often the one that comes with the motherboard is best) and whether or not it needs any openings punched out. If you are using a shield that came with the motherboard it should fit the port arrangement of that motherboard perfectly, and such a shield will usually clip into place with a bit of pressure round. Offer the shield up to the slot in the case from the inside of the case and with the printed port symbols towards the outside, and press the edges all round until the shield is firmly in place.

- Metal cases for the PC have their locating fasteners located in standardized positions, and motherboards are provided with matching location holes, so that it is very unusual to find that there are any problems in fitting a new motherboard into a new case.

Do **not** expect, however, that a new motherboard will have *exactly* as many mounting holes as there are fasteners on the casing, or that all of the mounting holes will be in the same places. Remember, though, that a motherboard should **never** be drilled because the connecting tracks on the surface are not necessarily the only tracks that exist; most boards are laminated with tracks between layers. Drilling through any of these tracks would be a very expensive mistake. It is possible that you cannot make use of all the covers that come with the casing, but you should certainly be able to use as many as the motherboard provides holes for. Remember that at least one pillar must be a metal one that makes good electrical contact to both the casing and the motherboard.

The fitting methods vary, but the most popular systems use either a brass pillar at each fixing position or a single brass pillar with plastic clips at other positions, Figure 4.6. The brass connectors are screwed into threaded holes in the case and the motherboard is bolted in turn to the pillars; the plastic clips that fit into slots in the case are pushed into the holes in the motherboard and then slotted in place.

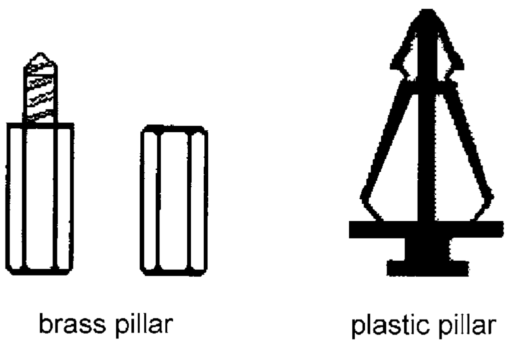

Figure 4.6 Typical shapes of brass and plastic motherboard fastenings

Now place the motherboard, handling it by the edges, into position, though not fastening it yet. There must be at least one brass pillar fixing that is used to earth the motherboard electrically to the casing. Quite often, only two screwed fittings are used, with the rest being either clips or simply resting points. The motherboard must be well supported under the slots, because this is where pressure is exerted on it when cards are plugged in. If there are no supporting pillars in this region you may be able to get hold of polypropylene pillars of the correct size and glue them to the floor of the casing – do not under any circumstances glue anything to the motherboard itself.

When you have the motherboard in place, check everything again. You may find, for example, that you have put pillars upside down, resulting in the motherboard being too high to match up with the holes in the back of the case, or that some expansion slots do not line up correctly. It is much easier to make changes at this stage than after you have thoroughly fastened the motherboard into place. In particular, some of the plastic pillars can be quite difficult to remove once they have been put in – you have to use tweezers to compress the springs before you can shift them.

- Before you tighten up the fastenings on the motherboard, check that you can insert an expansion card and fasten it to the top of the casing. A surprising number of motherboards and casings do not fit particularly well, and make it very difficult to fit and clamp expansion cards. If there are going to be difficulties, it's better to file out the fastenings for the expansion cards rather than alter the mountings of the motherboard.

If jumpers have been set on the motherboard, remember that it is remarkably easy to plug in jumpers with only one pin making contact, for example, and when you come to make other plug and socket connections this is also a hazard to look out for. If the paperwork that came with the motherboard did not have a sketch of the motherboard, this is the time to make one for yourself that shows where the board is mounted and where the jumpers are. Remember that it is often very difficult to alter jumpers once a motherboard has been fitted in place, particularly if the jumpers are underneath the power supply box.

Once the motherboard has been fastened into place, you can fit the PSU cable connector(s), Figure 4.7, supporting the motherboard with a finger underneath if necessary because you may have to use a fair bit of force to insert the plug. The thick and stiff set of cables from the

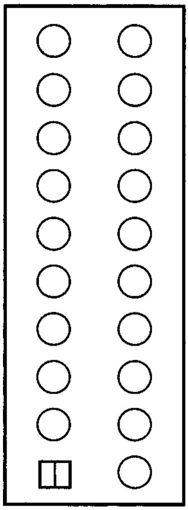

Figure 4.7 The 20-pin connector type used for the power socket on an ATX board

PSU makes this task of fitting more difficult than you might expect. Once this plug has been inserted, the risk of damage to the motherboard caused by static electricity is much less (not that it was all that great; components that are mounted on a board are much less liable to electrostatic damage than unmounted components).

- Note that the PSU may use more than one connector, so that it can be used for boards supporting Intel Pentium processors. If you are using an Athlon or Duron processor you can ignore this additional plug.

Switches and indicators

With the motherboard now fastened in place inside the case, the next step is to fasten the set of leads for switches and indicators that come from the front end of the case and are plugged into two rows of pins on the motherboard. This set includes connections for the small loudspeaker that is fastened inside the casing.

- One of the bonus points of building a Shuttle machine is that all of this is already done for you.

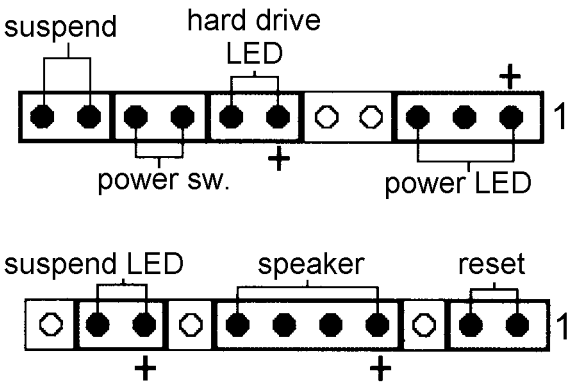

Figure 4.8 Switch and indicator connections between the case and the motherboard

The leads are colour-coded and also usually labelled, though you may need to use some intuition to match the name on a cable with the name that is used on the motherboard description. Figure 4.8 shows a typical arrangement of two lines of pins at the front end of the motherboard, with the names that are used on the motherboard documentation. Some of these connectors might not be used, but others are essential.

Looking at the example in order, the *Suspend* leads must be connected, otherwise the computer cannot be switched on. These leads come from the on/off switch, and their connection to the motherboard allows the computer to be put into standby mode and switched on by the main switch, or by selected events like pressing a key, moving the mouse, or getting an email (if you have a permanent Internet connection).

The *Hard drive LED* connections are needed to ensure that the LED indicator on the front panel will light when the main hard drive (the boot drive) is working. The *Power LED* similarly indicates that the computer is fully operative, not on standby.

The *Suspend LED* indicates when the computer is on standby, and this LED may not be provided on some cases, so that there will be no leads to connect. The loudspeaker leads should always be used so that you can hear the welcome beep that indicates the machine is booting up correctly. Finally, the *Reset* pins allow the *Reset* pushbutton on the front panel to act.

The thin strands of cable from the case connect to these pins using tiny clips, and you might find it easier to use tweezers to hold the clips and insert them. Note from your documentation of the motherboard where the connections need to be correctly led to a pin marked +; in general, switch connections can be either way round, but LED connections must be correctly oriented, and it isn't always clear which strand of a cable pair is + and which is −. If a LED does not light, incorrect orientation of the connections is the most likely cause.

Chapter 5

Drives and connections

Adding drives

We need to look at the installation of a hard drive first, because on a flip-lid casing it is normal to keep the hard drive in the lowest of the drive bays of a set, making it less accessible once the floppy drive has been fitted. The tower type of casing sometimes provides a bay at the back of the case for the main (or only) hard drive, making this easier to get to without removing anything else. Modern tower casings often group all the 3½-inch bays together, with one set up for a floppy drive (Figure 5.1). It's difficult to make any hard and fast rules here, because casing designs can vary quite amazingly from one example to another. Some of the better cases provide a drive cage which can be detached from the main case, making it very easy to fit drives because you have clear access to each side of the drives. See later for details of adding drives to a Shuttle design.

Do not assume that a drive will be provided with all of its mounting brackets at exactly the same places as the slots in the drive-bay, though these positions are usually standard on PC clones. An adapter will be needed if you want to put a 3½-inch hard drive into a 5¼-inch bay on an old casing, but modern cases are always well provided with 3½-inch drive bays; it's the 5¼-inch type that is the endangered species. You should

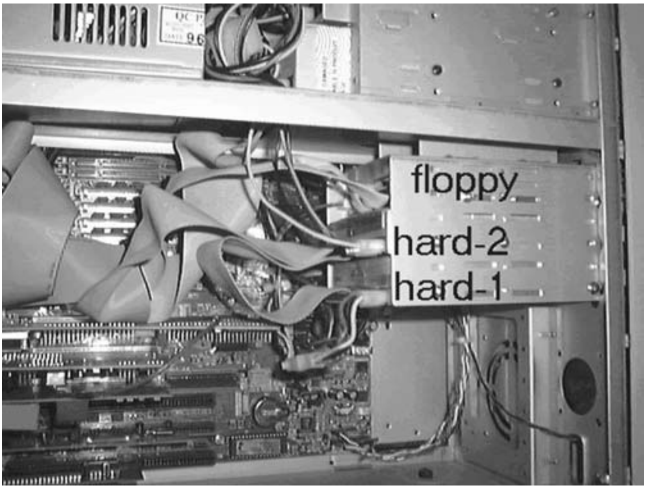

Figure 5.1 Typical drive bays in a casing

enquire when you order or buy the drive what provisions are made for mounting it on the style of casing you are using. Make sure that all mounting bolts and connecting cables are supplied with the drive.

The drive bay has slots at the sides to allow for to-and-fro adjustment of a drive and two sets are usually provided at different heights in the bay. These should fit the hard drive in a 3½-inch bay without any problems and also fit a 5¼-inch bay using an adapter plate. Hard drives must be mounted to the bay or the adapter plate by way of small bolts fitting into their threaded mounting-pads. This is important because these pads act to cushion the drive against shock. Any drive that has external access should be adjusted so that its front panel is flush with the front panel of the casing.

In no circumstances should you ever consider drilling the casing of a hard drive in order to mount it in any other way. You should also handle a hard drive by its casing, not holding its weight on any other points. In particular, avoid handling the connector strips at the rear of the drive or any of the exposed electronic circuits. Read any documents that come with the hard drive to find if there are any prohibitions on the use of mounting holes – sometimes you are instructed to use only a specified set of holes.

Modern 3½-inch drives use underside mountings as well as side mountings, which makes it easier to attach them if the side fastenings are difficult to reach. If you have problems, which is nowadays unusual, Meccano brackets and strips can usually ensure that you get the drive unit firmly fastened. In a desperate situation, there is nothing wrong with fastening the drive to a metal plate and sticking this to the casing with self-adhesive foam pads. Maplin supplies very useful side-plates for fitting a 3½-inch drive into a 5¼-inch bay.

Drive jumpers and switches

The simplest possible installation of a hard drive is as the first hard drive in a machine which has only one floppy drive; or the replacement of an existing hard drive with an identical type. You will, however, encounter more difficulties when software has to be installed. Mechanical complications arise only when a second (or further) hard drive is being installed, or when there are uncertainties about the compatibility of parts. The methods that are required vary according to the type of drive that is being fitted, and in this book we shall concentrate on the modern type of EIDE/ATA UDMA drive which is standard on modern PC machines, whether the older parallel type (PATA) or the more modern SATA (with S for serial).

- The size of hard drives nowadays makes it possible to use a single drive (partitioned as required) for all your needs, and on some machines this is all that is possible. I personally like to use a second hard drive as a backup, and if only one drive can be internal (as on a Shuttle machine) it is easy to install a backup drive in an external casing (with its own power supply) fed from a Firewire or USB-2 socket. This has the additional advantage that this drive need be switched on only when you are backing up on to it, so that its life can be very much longer than that of the main drive, and it is easily transferred from one machine to another.

An EIDE hard drive can be installed as a first (master) or a second (slave) drive. In normal circumstances, these will correspond to drive letters C and D respectively. The complication here is that these letters, known as logic drive letters, are assigned by the computer automatically, with both A and B reserved for use with the floppy drive(s), whether you have one or two floppy drives. The first hard disk will be assigned with the letter C, and other drives, such as CD-ROM, with letters D onwards. If you have two hard drives, these will be assigned as C and D, and your CD-ROM will then be drive E. This assignment is carried out when you first switch on after installing the drives.

- This automatic allocation system also works for partitioned drives. For example, you can install a 40 Gbyte drive and partition it, using FDISK or other suitable software (see later) into two 20 Gbyte sections. One of these will be assigned as C and the other as D. This partitioning is essential if you are using an older variety of Windows that cannot deal with partitions of more than 32 Mbyte. Note that if you use two partitioned disks, each with two partitions, the first (boot) disk will be partitioned as C and E and the second drive as D and F.

Rather than talking about drive numbers or letters, though, it is preferable at this stage to talk about first and second hard drives. Some manuals will refer to these as hard drives 0 and 1, or 1 and 2. When you install a single EIDE drive on a machine, it should be configured as the **master** or **only** hard drive. This means that jumper or switch settings on the hard drive case have to be made to ensure that the hard disk signals are taken from the correct point in the computer, so that the operating system can make use of the disk.

In technical terms, this is done by selecting the correct BIOS address number and the correct port address range on the controller board. The settings are made by way of jumpers or DIP-switches. For a first hard drive, these settings are almost always ready-made for you, and you need only check them. For a second hard drive, alterations will have to be made unless the suppliers have done them for you. On a modern drive, this usually amounts to a single jumper setting.

The complication can arise if you are fitting a second hard drive in a machine which has previously used a single hard drive. You will need to alter jumper settings so as to configure the second drive as a **slave** of a pair of drives. On **older** drives, you will also need to take out the first hard drive (if it is already fitted) and configure this as the **master** drive of two. You will also need a data cable that has two hard drive connectors and which is long enough to reach drives that may be some distance apart. The documentation accompanying an EIDE drive is often very sparse, no more than a sheet of paper. Using modern drives, you do not normally have to alter jumpers on the master drive, only on the slave (Figure 5.2).

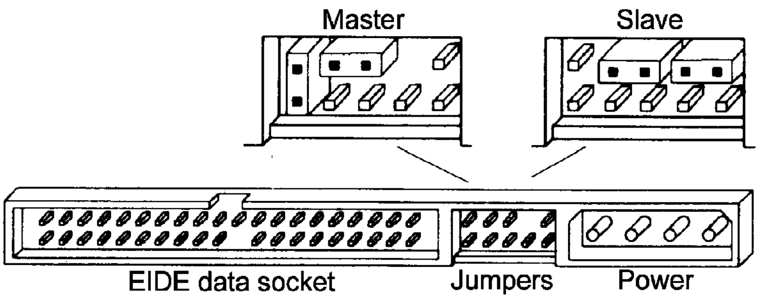

Figure 5.2 Typical hard drive jumper settings

You should not need to alter any other jumpers, and unless you have specific instructions to do so you should leave all other settings as they are.

- Please, **please**, read the instructions that come with the drive!

If you are installing a second EIDE drive in an existing computer, try to use a drive from the same manufacturer as the first drive, and cables to match. This will help to avoid any problems of incompatibility. If this is not possible, enquire of the suppliers to check that the new drive you intend to fit will be compatible with the first type. This is normally not a problem with modern drive types, but some makes of drive in the past have been notoriously temperamental in this respect.

- Using modern drives, you have less to worry about, as long as the drive is set correctly as master or slave.
- If you want to use more than two hard drives you can add another drive on the Secondary IDE connector, with the CD-ROM as master and the added drive as slave, though this restricts the data-handling speed of the slave hard drive. For a larger number of hard drives, your options are either to add another EIDE card fitting into a PCI slot, or to fit external drives that are connected either to a Firewire port or by USB-2.

Drive installation

Before you start, check the drive package to make sure you have all of the mounting bolts, any adapter that is needed, cables (if not already on the computer) and instructions. Check that you have the necessary tools – a Philips screwdriver (possibly a plain-head type) and a pair of tweezers are usually needed.

The bolts are usually either 6–32 UNC × 0.31 (5/16″) or metric M4 × 0.7–6H, but some drives use M3 × 0.5. UK suppliers use millimetre sizing for the length so that the size will show 5 rather than 0.5 or 6 in place of 0.6. The frame of the drive may be stamped with M for metric or S for UNC. If you need spare UNC bolts you will need to contact a specialist supplier, but the M4 metric types can be bought from electronics suppliers such as the well-known Maplin or RS Components.

At this stage, check that any jumpers or switches are correctly set. Once the drive is in place these will be impossible to reach without removing the drive. Use tweezers to manipulate these devices. It is not always obvious from the accompanying instructions what settings are needed, and though drives are often set ready for use in a standard type of machine you cannot rely on this. Jumpers will quite certainly need to be set if you intend to use more than one hard drive. Do not change any settings unless you know what you are doing.

Unpack the drive carefully and read any accompanying manual carefully, particularly to check any prohibitions on drive fastening or mounting positions. Make a careful note of any settings that are printed on to the disk casing, because these will be needed in the event of the settings not being automatically recognised. No drive should ever be mounted with its front panel facing down, but most drives can be placed flat, or on either side. Check that any adapter plate fits into the mounting bay on the casing and that all bolts and cable adapters (see later) are provided.

- At the time of writing, ATA drives use either a PATA or SATA type of connection. The PATA (Parallel ATA) type requires bulky data cables, and this is the main reason for the change to SATA (S for Serial) type, but another reason is that the new SATA drives can use much less power than the older type. The SATA drives also need a different power connector, but adapters are available, see later.

The (first or only) hard drive is usually placed as the lowest in a set of drives on a desktop casing, and in a position nearest to the motherboard in a tower casing. Check also that the drive data cable will reach from the EIDE connector on the motherboard to the drive – you may need to put the IDE board in a different slot if the cable is short (as they often are). The older parallel EIDE cables are bulky, but the modern SATA type are easy to manipulate. If you have any instructions on how cables should be routed (to avoid electrical interference or to avoid obstructing cooling air paths) make sure that you follow the recommendations, otherwise follow commonsense in keeping the cables clear of hot items.

- You may need to juggle with positions of hard drives if you are using more than one, because your first hard drive (C:) will have to be connected using the plug at the end of the IDE cable, and your second hard drive on the plug that is a few inches further down the cable. If the cable is rather short, as they often are, you may need to place the hard drives so as to suit the cable, rather than placing them where you would most like to have them. It's a lot easier to check out these positions before you secure the drives into place than after.

Fasten the 3½-inch drive to its bay or adapter, using the small bolts that are provided to bolt into the mounting pads. Tighten these up evenly and not excessively. If an adapter is used, bolt this into its bay. Check that you can still place a floppy drive above the hard drive unit, if this is where it will be put. This latter point is important, because some older makes of floppy drives have an exposed flywheel on the underside, and the slightest contact against this flywheel will prevent the floppy drive motor from spinning. There should be no such problems if the 3½-inch floppy drive is being mounted sideways in a bay specially provided for this purpose, because such a bay is usually well clear of any others.

Installation is not a particularly skilled operation, though experience with a Meccano set as a child is helpful. Problems arise only if the mounting pads on the drive do not correspond with openings in the bay, or you have no adapter for a 3½-inch drive, or an unsuitable adapter, or you manage to lose a mounting-bolt. A mounting-bolt that falls inside the drive casing or the computer casing can usually be shaken out or picked out with tweezers. Do **not** use a magnet to retrieve a bolt from a disk drive casing. Do **not** attempt to make use of other bolts, particularly longer bolts or bolts which need a lot of effort to tighten (because they are ruining the threads in the drive). It is better to mount a drive with only three bolts rather than to add one bolt of the wrong type.

- Because of the speed of data transfer, the length and position of drive data cables can affect the stability of a computer. Ideally, each cable should be only just long enough to reach each drive, but this can be achieved only in the Shuttle type of machine with cables pre-cut to length. Do not under any circumstances attempt to reduce the length of a cable by cutting a chunk out and trying to rejoin the cut ends, or to add another connector to a cable. If a cable is too long, lay it out in a path away from other components and fold the excess neatly so that it is not draped all over the inside of the computer.

EIDE/ATA INTERFACE

Now connect up the cables to the drive(s). There are two sets of cables required for any hard drive, the power cable and the data cable. The PATA power cable is a simple four-strand type with a four-way connector (some drives use only two connections of the four). This connector, Figure 5.3, is made so that it can be plugged in only one way round, but it often needs a fair amount of force to plug it in and to unplug it. When unplugging, avoid at all costs pulling on the wires. The SATA connector uses 15 pins, but is the same size as the older PATA type. If you are using a SATA hard drive with a PSU that provides only the older type of connector, you can buy adapters (often provided with a SATA drive because manufacturers have been slow to provide PSUs in cases with SATA power connectors, and because many other drives such as CD and DVD drives still use the older type).

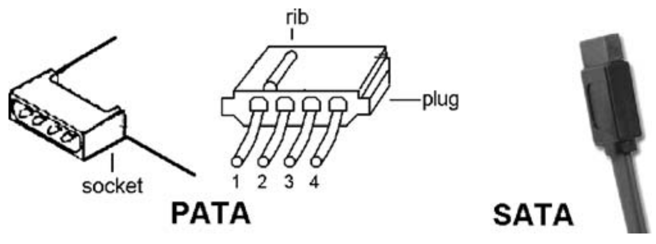

Figure 5.3 The standard older (PATA) form of power connector for drives and a modern (SATA) power plug and cable

The PATA type of power cable is currently used for floppy drives and for hard drives, and modern AT machines usually provide four or five plugs on the cable. The plug is a tight fit into the socket and usually locks into place. The socket for the power plug is obvious but some disk drives need an adapter which should be supplied.

The data cable, Figure 5.4, that connects to the IDE drive is either of the flat 40-strand PATA type or the skinny SATA variety. This plugs into the matching connector on the motherboard at one end and into the drive at the other, with no complications. Look for one strand of the cable being marked, often with a black, striped or red, line, to indicate pin 1 connection. This makes it easier to locate the connector the correct way round. Do not assume that one particular way round (such as cable-entry down) will always be correct, or that a second hard drive will have its pin 1 position the same way round as your first hard drive.

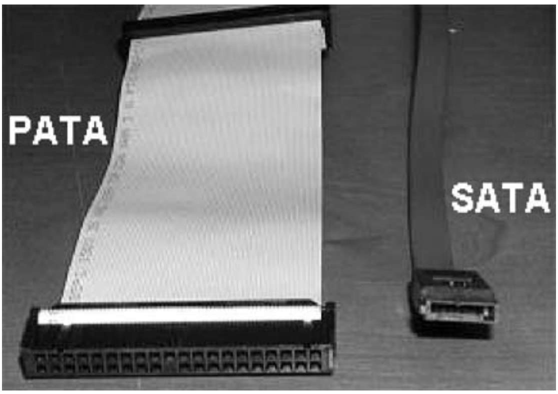

Figure 5.4 The standard (PATA) and newer SATA forms of IDE cable, showing drive connectors. The SATA cable is much easier to drape round components

- The conventional system is to use the IDE plug at the end of the cable for the master drive and the other (mid-cable) connector for a slave drive.
- If you make a mistake and get the hard drive data cable the wrong way round this does not, in my experience, cause any damage, but the hard drive will not appear in the CMOS-RAM screen display.

When you have the hard drive running satisfactorily, see later, it is desirable to mark the cable connectors so that you can replace them correctly in the event of having to remove the drives for servicing. Use *Tipp-Ex* or other white marker on the top side of each connector and write on the use (DATA 1, DATA 2, POWER 1, POWER 2 and so on). Mark also the pin 1 position on the cable and on the drive.

- If you are going to have two hard drives, remove the data cable from the secondary drive until you are sure that the machine is working correctly.

Floppy drive installation

Are you going to use a floppy drive? At the time of writing, desktop machines are still being supplied with a floppy, but so little software is distributed in this way that it is used mainly for minor backups. Laptops seldom now use a floppy, and it's much more common to carry out minor backups using a memory stick that plugs into a USB port. This has the advantage of allowing you to use much more storage space than can be obtained using a floppy. For program installation, only the CD-ROM or DVD drive needs to be used.

So much of the installation of a floppy drive follows the same pattern as fitting a hard drive that very little needs to be said here. Fitting a 3½-inch drive into a 5¼-inch bay is done by way of an adapter kit, but this is most unlikely to be needed if you are using a modern casing with more 3½-inch than 5¼-inch bays. As before, take great care never to lose the fixing screws for these conversion holders and for drive bays, because they are types that are not easy to replace unless you have access to a computer shop with a good selection of hardware.

Never assume that because a bay is provided this means that the cables supplied with the machine will be able to reach a drive added to that bay. Cables are often supplied that are so short as to restrict your layout seriously, and you may have to alter the positions of drives in the bays so that the drive with the shortest cable is closest to the motherboard. Floppy drives still use the older parallel type of cable, but this is not identical to the PATA hard drive cable so you need to be careful not to confuse the two (the pin numbers on the connectors are different, so they cannot be interchanged).

- If the case layout is such that some cables cannot possibly reach a drive then you will have to look for cable extenders, but only for power cables. Longer data cables can be bought, and this is a better solution than any kind of extender for a data cable.

Check before you tighten a drive into place that there is clearance between the underside of the floppy drive and any drive that is fitted beneath it. This is not a problem when the floppy drive is fixed on its side in a bay intended for this purpose, but when you need to fit a hard drive and a floppy drive into adjacent bays you may encounter problems. The problem is that on some designs (now rare) the flywheel of a floppy drive is on its underside and can easily be fouled by any slight projection from the drive above it. The amount of leeway in the mountings usually allows you to separate the drives enough to avoid the problem.

That apart, the main points to note are that the floppy drive has its jumpers (if any) set for use as Drive A or 0, and that the power cable is correctly used. Power cables nowadays are fitted with two types of plug, one of the standard size for hard drives and a smaller type for some makes of 3½-inch floppy drives. The plugs are easy enough to insert, but it is not always easy to ensure that they are inserted correctly with all pins engaged. It is remarkably easy to insert a power plug with each of its pins against a piece of insulation rather than against the metal of a socket.

On the older versions of power units, all the power plugs are of the larger type, and an adapter is needed to fit to some makes of 3½-inch units. This is straightforward, but if you do not have the adapter then you cannot proceed until you lay your hands on one. A good computer shop will often have some in stock. Remember to ensure that the connector to the 3½-inch drive is correctly inserted. The data connector should be plugged in the right way round, using the pin 1 marking on the data cable as a guide. Do not assume that the plug goes in with the cable facing down – this can vary from one cable to another. Inserting the data plug the wrong way round has not caused any damage when I have tried it, but the disk system does not work. A common symptom of a data cable the wrong way round is that the drive light remains on all the time the computer is switched on. Most modern drives and cables are keyed so that the data cable cannot be inserted incorrectly.

CD-ROM and DVD drive(s)

- The shape, size, and connections of CD writing drives and DVD drives is identical to that for CD-ROM, so that one description serves for all.

Because most CD-ROM or DVD drives for internal fitting (meaning that they fit inside a computer in the same way as a conventional disk drive) are so similar, a typical description will serve to show how to go about this task. The software that accompanies the drive will usually be on a floppy, and will have running instructions on its label. Any DVD drive sold for computer use will read all types of CD as well, but a CD-ROM drive, unless it is specified as capable of reading DVDs, will read only CDs (and a few older types will not read recordable CDs).

- Note that the speed ratings of CD-ROM and DVD are not the same – a DVD drive rated at 5× speed for a DVD disc is roughly equivalent to 32× for CD-ROM use.

In order to add an internal CD-ROM or DVD drive, you need to have a 5¼-inch drive-bay free. If you want to use multimedia you also need to have a sound board installed, but if you are not interested in sound you need not fit this board. Remember that you can hear CD sound through earphones by using the jack point at the front panel of a CD-ROM drive. If you are using a DVD drive for video you will need suitable software (such as the most recent version of Windows Media Player).

On some machines the hard drive will be fitted in the lowest of the drive bays, but many modern cases locate the hard drive elsewhere in the casing. Unless you have specified a machine with other drives (such as a tape drive), there will probably be no other 5¼-inch units, so that all the bays of this size will be free for use.

If you have only one 5¼-inch bay available, your best way of using it is to install a DVD-Writing drive (see later). This allows you to use the same drive for all kinds of purposes, playing or recording CDs or DVD discs.

- Do not assume that a CD-ROM drive will be provided with mounting brackets at exactly the same places as the drive-bay, though these positions are usually standard on PC clones. You should enquire when you order the drive what provisions are made for mounting it on the style of casing you are using. You must never drill the casing of a CD-ROM or DVD drive.
- Modern CD-ROM drives use a 40-strand IDE (PATA) type of connector such as is provided on the hard drive cable. On a modern motherboard you would normally use the primary IDE connector

for a hard drive and the secondary IDE for the CD-ROM. Check when you order a drive that it uses this type of connection because a few use the SCSI system which is suitable only if your computer uses this type of interface. Check also that your computer uses the EIDE system that allows more than one type of drive to be connected to the hard drive cable.

The drives are provided with mounting holes at the side, rather than the sprung pads that are used for magnetic disk drives. This makes it easy to fasten them into the standard type of bay which has slots cut in the sides for the mounting bolts. The drive bay normally has slots at the sides to allow for to-and-fro adjustment of a drive, and two sets are usually provided at different heights in the bay. These should fit the mounting positions of the CD-ROM drive without any problems.

The fastening is by way of small bolts fitting into the threaded holes. In no circumstances should you consider drilling the casing of a CD-ROM drive in order to mount it in any other way. You should also handle the drive by its casing, not holding its weight on any other points. In particular, avoid handling the connector pins at the rear of the drive. Be careful also not to lose the bolts, because they are not easy to replace.

Installation work

- The installation of a CD-ROM drive follows the same steps as for a CD rewriter or for a DVD reader or rewriter.

Before you start, check the drive package to make sure you have all of the mounting bolts, any adapter that is needed, cables (which may be packed with the sound board, but are more usually with the CD drive) and instructions. The power cable for the CD-ROM drive will be one of the existing set that is used for the hard drive and floppy drive. The power supply usually is fitted with five or more connectors so that one should certainly be spare, but check that it will reach the CD-ROM drive. You may need to cut one of the plastic cable-ties in order to pull the cable connector over so that it reaches the drive. The drive will be installed so that its front panel is flush with the front panel of the computer casing, Figure 5.5.

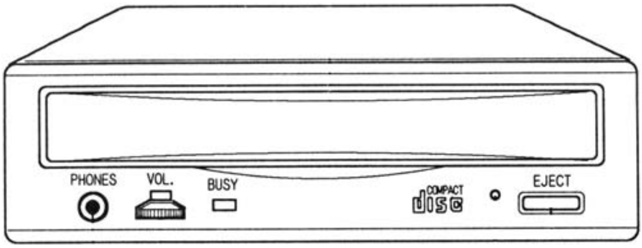

Figure 5.5 A typical front panel for a CD-ROM drive

Check also that you have the necessary tools. A Philips screwdriver (possibly also a plain-head type) and a pair of tweezers are usually needed. The bolts are either 6–32 UNC $\times$ 0.31 (5/16″) or metric M4 $\times$ 0.7–6H. If you need spare UNC bolts you will need to contact a specialist supplier, but the M4 metric types can be bought from electronics suppliers such as the well-known Maplin Electronics or RS Components.

At this stage, check with your manual for the CD-ROM drive if any jumpers or switches need to be set. The modern plug'n'play (PNP) system usually ensures that no such settings are necessary, and if you see jumpers or switches this might indicate an old model of drive. Remember that once the drive is in place, any adjustment points will be impossible to reach. Use tweezers to manipulate these devices. Figure 5.6 shows a rear view of a CD-ROM drive, with data and power sockets and jumpers labelled. It is most unlikely that you will have to

Figure 5.6 The rear of a CD-ROM drive

make any adjustment to the jumpers on a CD-ROM drive, and you must not do so unless you have been clearly instructed in a manufacturer's booklet to do so.

Switch off the computer if it has been running, wait for a minute, and remove the main cable. Open the cover – some hinge out of the way, others need to be removed completely. You can now install the CD-ROM drive. Handling the drive by its casing, place it into the mounting bay and check that the slots in the mounting bay match with the fixing positions in the drive.

Place the bolts by hand and tighten evenly. Check as you tighten the bolts that the drive is positioned correctly. The CD-ROM drive will need to have its front panel flush with the computer front. Once again, this installation calls for patience rather than skill.

Problems arise only if the mounting pads on the drive do not correspond with openings in the bay, or if you manage to lose a mounting-bolt. A mounting-bolt that falls inside the drive casing or the computer casing can usually be shaken out, or you can use the flexible grabs that are sold in tool shops. Do not use a magnet to retrieve a bolt from a disc drive casing (don't bring a magnet anywhere near a computer at any time).

Do not attempt to make use of other bolts, particularly longer bolts or bolts which need a lot of effort to tighten (because they are ruining the threads in the drive). It is better to mount a drive with only three bolts rather than to add one bolt of the wrong type. There is no great amount of strain on these fastenings because the CD-ROM drive is much lighter than a hard drive.

There are two essential sets of cables for any CD-ROM drive, the power cable and the data cable set, Figure 5.7. The power cable is a simple four-strand (thick wire) type with a four-way connector (some drives use only two connections of the four). This connector is made so that it can be plugged in only one way round. The same power cable is used for floppy drives and for hard drives, and modern PC machines usually provide four or five plugs on the cable. The plug is a tight fit into the socket and usually locks into place. The socket for the power plug is obvious.

- The small data cable is for audio signals and will connect to a corresponding socket on the soundboard. You must use the data cable that was packaged along with your CD-ROM drive – do not try to use the cable from another type. For many applications on modern machines the audio data cable is not used.

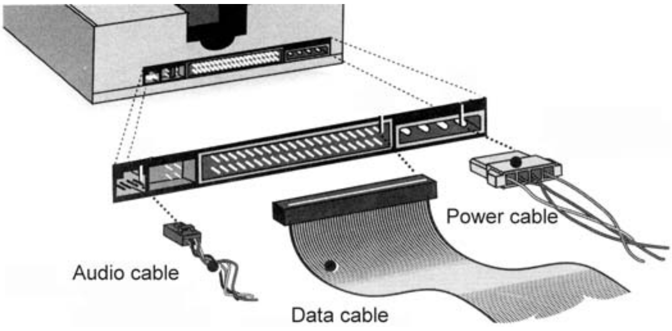

Figure 5.7 Power, data and audio connections to a CD-ROM drive

The main data cable that connects from the IDE controller board to the CD-ROM drive is of the flat type, usually ending in a 40-pin plug at the CD-ROM drive end. This plugs into the matching connector on the controller board at one end and into the drive at the other, with no complications. Look for one strand of the cable being marked, often with a coloured or speckled line, to indicate pin 1 connection position. This makes it easier to locate the connector the correct way round.

As before, do not assume that one particular way round (such as cable-entry down) will always be correct, or that a board connector will have its pin 1 position the same way round as it is on another board. Check carefully with illustrations in the leaflets that come with the units. If you are fitting a CD-ROM writer as well as a fast CD-ROM reader, use the (primary) connector at the end of the cable for the reader and the secondary connector for the writer.

- Remember that if you have bought different units in different places there will be no guarantee that the connectors will match – this is why you are strongly recommended to buy a package from one source.

Now tighten up any mounting screws that you may have had to loosen so as to slide the CD-ROM drive into place. Check everything again – it's always easier to check now than later. Replace the cover of the computer, push in the power cable connector, and get ready to install the software.

CD/DVD rewriter drives

If your interests include sound recording, or if you need to store large amounts of text, graphics files or even video files, a writing drive for CD or DVD is a very useful accessory. At the time of writing, there are many type available at very attractive prices, and all of them offer the three options of reading, preparing write-only CD discs (CD-R) or preparing rewriteable discs (CD-RW). Though this type of drive can be used as your only CD drive, it is preferable to install it along with a (much cheaper) fast CD reader drive. The CD-R/RW drive is then connected as the slave drive to the CD reader drive, using the connector that is placed midway along the data cable. DVD writers are more complicated because there are three varieties, and most manufacturers now supply drives that will accept either of the common types of blank discs, DVD+R/+RW and DVD−R/−RW.

- Combi drives are also available, which combine the actions of a CD-ROM drive, a CD-R/RW writing drive, and DVD reading drive. These are very often supplied with new computers (but very difficult to find as separate components), but if you want a really universal drive, it's best to go for the DVD+R/+RW and −R/−RW type.

Look in the manual to see if any jumpers need to be altered. Some manufacturers assume that your writer drive will be the second (slave) on the IDE cable; others assume that you will need no other drive so that it will be the first (master).

The drive will need added writing software (the reader drive is operated from software that is built into Windows), and this software can be installed once Windows is up and running. Currently, drives are usually packaged with software from Adobe or with the Nero software, making the creation of CD-R/RW discs or DVDs simpler, if anything, than the creation of floppies.

Essential cards

Though a great deal of the actions that once were handled by cards or boards added to the basic PC are now placed on the motherboard, there are additions that you can expect to have to make on almost any motherboard. Chief among these are the graphics card, modem and sound card. Some motherboards feature graphics built in, others feature sound built in, very few at present have both of these features together. No motherboard currently advertised can boast of a modem built in; and many have none of these actions incorporated into the motherboard. When you are constructing a machine, however, the only facility that you need to start with (if not provided on the motherboard) is a graphics card.

INSTALLING A BOARD

Add-on devices are fitted to a PC machine by using the plug-in slots on the motherboard inside the casing. This description covers the installation of any type of card, but the details concern the sound card.

Looking at the back of your computer you will see the existing set of connectors along with some metal blanking plates that cover the vacant slots (Figure 5.8).

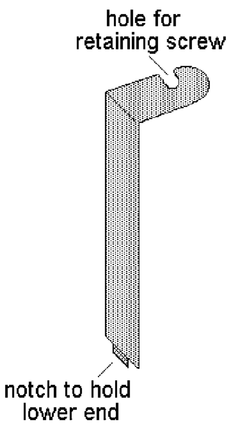

Figure 5.8 The blanker plate that covers the slot

Turn the power off, and wait for a minute. Remove the power-input cable from the computer, and then remove the cover so that you can see inside. When you open the casing you will see the other side of the blanking plates, and for each blanking plate there will be a ‘slot’, a set of electrical connections in the form of a long thin socket.

The metal blanking plate is unscrewed from the rear of the casing so that connections can be made to whatever board you plug in, and the same fixing screw is used to hold the new board in place.

- At one time, sound cards had to be configured, and contained sets of jumpers that needed to be adjusted. If you are installing a modern plug’n’play card on a modern Pentium computer, there will be no jumpers and no need for adjustments.

Your sound card will have a set of connectors (audio connectors) that connect with the CD-ROM drive by way of the audio data cable. If this connection is not made, you cannot play audio CDs through your sound system on old computers, except by way of the front socket on the CD-ROM drive. Many modern systems route the signals through the buses, so that the audio data cable is not used.

Now take a look at where you will insert the sound card, remembering that this must be either one of the long ISA slots or a spare PCI slot. Place the card temporarily over the slot (do not push it into the slot yet) and check that the little audio cable from the CD-ROM drive will reach.

Now remove the metal blanking strip at the end of the slot where you will install the sound card. Place the sound card over the slot, and check that the tongue on the card is correctly lined up with the aperture of the slot. Push the audio cable connector into its socket at this stage, because it will not be so easy to reach later – the connector fits only one way round. Gently push the card down, rocking it slightly to help open the spring contacts, until the card slips into its holder. You can now clamp the card into place with the screw that was used to hold the blanking strip – do not force the card into position or over-tighten the screw because the purpose is only to ensure that the card does not pop out of place.

You can now replace the cover of the computer and turn the machine so that you can see the connectors on the rear of the sound card – Figure 5.9 shows a typical set.

If all is well, this can be a simple and quick operation. Problems arise, however, if you find that you have difficulty in setting the screw that holds the card into place. This is usually because the motherboard is not quite close enough to the rear of the casing, and though you can sometimes overcome this by loosening the motherboard pillars and then gently screwing them up again with the motherboard pressed

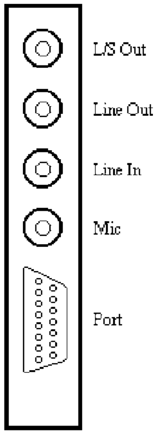

Figure 5.9 The rear of a typical sound card, showing connectors

towards the back of the case, this does not always work. If you simply cannot fasten the extension board down without severely straining it and the motherboard, then it's better to take the drastic step of filing the slot that fastens the card in place. Remove the card, put it into the plastic bag that it came in with the slot fitting protruding from the top. Now use a small Swiss file to elongate the fastening hole and at intervals wipe this clear of metal filings and try the card in place again. Eventually you should be able to fasten it down without problems.

You can now plug in connectors to the rear of the sound card from the outside of the computer. The main connector is for the loudspeakers and this connection is made by way of a jack plug pushed into the appropriate socket.

- In the lifetime of this book, monitors are likely to appear that use USB-2, Firewire or other connectors, and several monitors will provide for connection to VCR, DVD and Digibox equipment as well as to PCs.

DRIVERS

A driver is a program that is used to control the signal output from the computer to a device such as a monitor, printer, mouse, keyboard, scanner and so on. Windows provides a set of drivers for the most commonly used graphics cards, and also for several that you are not likely to encounter in the UK.

If your chosen graphics card is of more recent vintage than your version of Windows, however, you will have to use one of the drivers that will be supplied along with the card itself. You will usually be offered several sets of drivers, for DOS applications, Windows 98, Windows *Me*, Windows XP, and Windows NT, and you need to use the one that corresponds to the version of Windows that you are using.

- If you want to use DOS, each application (program) that you use must have its own driver. One of the advantages of working with Windows is that once you have installed a Windows driver to suit your monitor and graphics card it is then used for any program that runs under Windows. Do not install any DOS drivers unless you are thoroughly familiar with DOS and intend to use programs running under DOS.

The drivers that are supplied along with graphics cards are not always of a high standard, and some will even manage to conflict with Windows. It's always better to go for a graphics card whose drivers are available in your version of Windows, because the Windows drivers are usually more reliable. This means that you should avoid the most recent graphics cards in favour of one that has been around for long enough to have a driver built into your version of Windows. Note that there was a second edition of Windows 98 with an updated set of drivers, released a few months before the release of Windows 2000; a third edition followed later in 1999.

- It is very unusual to have problems if you set a resolution of 640×480, and Windows often reverts to this if other drivers are causing problems. Problems are more likely to arise if you are using really high resolutions with a new card that is not recognized by Windows. You may find that an updated driver is available on the Internet.

Remember that you can use the fast AGP type of graphics board **only** if your motherboard supports AGP with an AGP slot. If the graphics capability is built into the motherboard then it is likely to be of the AGP type. A few cases have been reported in the past of the AGP slot working only if USB (Universal Serial Bus) was enabled, so watch out for this if you have problems with an AGP board.

High performance graphics cards

If your PC is intended for use with text and ordinary graphics, as for most business applications, then there is absolutely no point in having a high performance graphics card. Such cards come into use only when you have demanding applications such as fast games and video editing in mind, and one general rule is that the more memory onboard the graphics card the better. Beware of graphics cards which claim to have a large memory but which in fact simply use part of the RAM from the computer.

A computer intended for the fastest possible processing rate needs to have considerable attention paid to choosing the processor, the motherboard, the RAM, and the graphics card. Of these, the graphics card is often the most limiting factor, particularly any graphics card that fits into the ordinary PCI bus. Such cards are now becoming rare, and its more usual to find that any graphics card you will be offered will fit the AGP slot that is present on modern motherboards. The more recent motherboards offer an AGP slot that is rated at four times the rate of the original types (identified by the 4× symbol).

Prices of graphics cards can range from around £20 to £300 (including VAT), depending on exactly how much you want from them. At the bottom end of the price scale you can get a card such as the DTI range 128 Ultra 32 MB AGP for around £25 and near the top end MSI make the G3Ti 1500 ProVTG GeForce Ti 1500 DDR 64 MB AGP at around £250 all up.

- Don't ask me why graphics cards get lumbered with such impossible names.

The cards for higher performance have names that often include the term *GeForce*. This refers to the chipset that is being used, so that cards of this type are available from several suppliers as are also those with the *nVidia* title. At one time the top performing card would be any design using the GeForce2 or GeForce2 Pro, but cards of this type are now be bought for prices ranging between £22 and £60 all up. The fastest cards at the time of writing are now using GeForce3, and are considerably more expensive, but you can expect the prices to fall steadily, and then considerably when the next version (GeForce4) appears at a reasonable price.

For any particular design of graphics card you can expect a fair range of on-card memory. The days of cards with 4 Mbyte to 16 Mbyte memory for fast-moving applications are long gone, though you can still buy these cards at very low prices if your applications are less demanding. Modern fast video cards will use anything from 32 Mbyte upwards and providing that this is fast DDR memory that is actually placed on the video card, these can provide very high performance.

Several types of graphics card offer rather more than straightforward graphics. Several, for example, offer TV and video signal inputs, providing conversion of analogue to digital for such signals, and TV outputs are yet another option. The ATI All-in-Wonder type of card is a good choice if you want a single card to tackle all these options. See Chapter 8 for details of TV/video input cards.

CHECKING OUT

When a hard drive has been installed so that all the relevant steps described above have been carried out, you can check that the disk is mechanically capable of use. Check first that all connectors are firmly in place. It is quite common to find that all your efforts in plugging in the hard drive end of the cable have loosened the other end that plugs into the socket on the motherboard.

You need to make the machine ready for use. Plug the keyboard connector into its socket on the motherboard – this is usually either a PS/2-type socket located at the back of the machine close to the PSU or one of the USB sockets. Insert the video graphics card that you intend to use, easing the card into its slot and screwing it into place. Plug the monitor data cable into the socket on the graphics card. Insert the monitor mains plug – if this is a Euroconnector it can be plugged into the socket on the PC main case, otherwise use a standard mains plug for the moment.

With all cables plugged into their correct places and the lid shut, switch on the power. If the monitor is separately powered make sure that it is plugged in and switched on. You should hear the high-pitched whine of the hard disk drive motor start and settle to its final speed. If absolutely nothing happens, check that the Suspend cable is connected from the front panel to the correct pins on the motherboard.

If you hear a lot of disk activity and the machine tries to boot (possibly with some error messages) then the hard drive is already formatted, and the formatting steps noted in the following chapter can be ignored. Congratulate yourself – you have avoided several tricky steps. This, however, is most unusual unless you have transferred a hard drive from another machine. It is much more likely that the drive is not formatted, so that it cannot be used, but can be recognized by the machine. There will be more on this point later.

This is as far as you can go for an unformatted hard disk, because you cannot use the drive until it has been formatted. If this is a second drive you have added, you can check that the machine is still booting up correctly from the first drive, and that the second drive is recognized. You should always check that the new hard drive is recognized in the CMOS-RAM settings, see later.

- Normally, a new hard drive is supplied with no formatting, and you have to use both the FDISK utility and the *Format* command, see later. When you try switching on the machine you will get a message to tell you that you need to insert a *system disk*. At this point you can insert a system floppy to check that the machine will boot and run MS-DOS. An option on modern machines is to specify in the CMOS-RAM that your first boot disk is the CD-ROM, so that you can insert the Windows CD-ROM distribution disc and use this, providing it is the correct type of installation disc (a new installation as opposed to an upgrade).
- Some hard drives feature SMART, meaning self-monitoring and reporting technology. If your new hard drive has this feature you might need to look for a CMOS-RAM entry to ensure that it can be used. Once SMART is installed, disk problems will be notified.

At this stage, unless the machine has booted from the new drive, you do not really know whether you have any major problems, because all you can tell is whether the hard drive motor is running or not. If there is no sound from the drive, particularly when you are using a single hard drive, then the drive motor is not running. Check the power cable if the drive has just been installed or replaced. This requires you to switch off, disconnect the mains lead, remove the monitor and open the lid.

It is most unusual to have this problem, because the power supply cable can be inserted only one way round. It is possible, however, that if an adapter has been used it is incorrectly wired or that a wire is broken. Check also for any signs of a break in the power cable, particularly at the connector.

If the hard drive can be heard spinning but is not recognized in the CMOS-ROM (see later) this is almost certainly due to the data cable being incorrectly inserted. Check to see which end of the connector is the wrong way round.

Testing a floppy drive is easy enough. With the machine set up with monitor and keyboard (see above), place an MS-DOS boot disk (see later) into the drive that is to be the A drive. Switch on, and wait to see evidence of activity from the drive. The machine should boot up if all is well.

Building a Shuttle

Building a Shuttle might seem (particularly if you have looked inside one) a daunting process, but it's remarkably easy, and if anything is easier than building a machine from scratch. Basically, what you do is to buy a barebones pack. This provides an aluminium case with PSU and cooling equipment, a miniature ATX motherboard that is completely wired up to all the ports (front and back) and lights on the case, and a set of drivers on CD-ROM. There are many models, depending on what level of performance you want and which type of processor you intend to use; but the price is around the £200 mark. Figure 5.10 shows the exterior casing of a typical Shuttle.

Figure 5.10 The external casing of a Shuttle computer, front view

This may seem steep compared to the price of a cheap case and motherboard, but you are paying for quality, pre-wiring of all the really difficult bits, a superb cooling system (making it very easy to put the processor in or take it out), and a great selection of ports (serial, USB, Firewire, LAN, optical; the lot). The minimum set of bits you have to buy separately and fit for yourself (though many shops will do this for you if you ask and pay a modest fee) consists of:

1. processor,
2. hard drive,
3. memory,
4. modem (unless you are using broadband connected through the Ethernet port)

because the Shuttle motherboards contain sound, graphics and LAN hardware built in.

The instructions that come with a Shuttle barebones pack are excellent, and you should follow them to the letter rather than assume you already know it all from a previous effort at construction. The outline of the construction is as follows (see the Shuttle manual for details). Figure 5.11 shows the typically packed view with the case cover off.

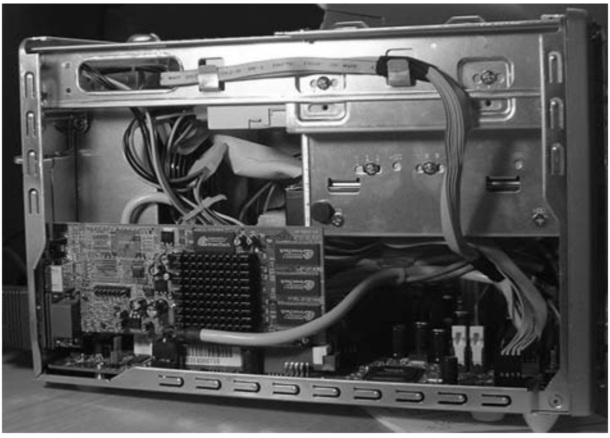

Figure 5.11 A view of one side of a Shuttle with case cover removed. The processor cannot be seen behind the AGP graphics card

You start by removing the cover (screws at the back of the casing) and taking the dummy front pieces off. The bays for the drives can then be removed, and your drives inserted while the bays are separated – usually one hard drive of 80 Mbyte or more, one floppy, and one DVD-writer. Back at the main casing, you need to insert the memory in the conventional way, and also the processor. The CPU socket assembly is covered by a heatsink that is held in place by four bolts, and these need to be released so that the heatsink can be moved away from the processor. You usually have to release the radiator section also to make enough room to insert the processor. The CPU fits into the socket in the conventional way, and the active surface of the CPU is smeared with heatsink grease (supplied in the pack). The heatsink then needs to be put carefully into place and the bolts inserted and tightened up uniformly. Once these are tight, the radiator can be secured again.

The drive bays can now be replaced, making the connections to each drive as you offer up the set of bays. Do this carefully, because it can be tedious to redo if you get it wrong. With the bays bolted into place, the connections need to be made, using the special cables (cut to length) that come with the pack. These need to be routed along clips and through slots as illustrated in the constructional manual. Do not ignore these routings, because they ensure minimum interference between cables.

You can now install any cards that you need. The provision is for one PCI card and one AGP, because the motherboard has sound circuitry and also basic graphics. If you are using a dial-up modem, it can be placed in the PCI slot, and I preferred to use a separate AGP graphics card because the built-in graphics circuits make use of the main memory of the machine.

That's about it, and you can then replace the cover and connect it to your peripherals. The lowest-price Shuttles have no parallel port, but with printers now almost universally using USB that's no loss. A less-satisfying aspect is that the lower-order shuttles such as the SK41G run at a fixed clock speed, so there is no point in using a processor faster than 1.5 GHz unless you are experimenting with overclocking. The consolation is that the cooling of the Shuttle is so good that the limit of overclocking is more likely to be set by the memory speed. I have used a SK41G with an Athlon XP2700 with the FSB of the motherboard set to 150 MHz, and DDR333 memory.

- The only criticisms I have heard of the Shuttle is that any failure of the motherboard (such as the voltage regulation) is difficult to deal with, because spare motherboards are not easy to come by. The power supply is also of limited output, but unless you plan to use 1 Gbyte or more of memory there is not so much to drain power with just one hard drive and one optical (CD or DVD) drive. My own experience has been good.

One unforeseen advantage of building a Shuttle is that it gives you a taste of working with compact layouts, such as will become normal when the BTX standard is totally adopted.

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Part III

Set-up

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Chapter 6

Connecting for testing

Positioning the boxes

Once you have installed all the cards on the motherboard on a machine that you have constructed from scratch, you should check again that all connections are sound and any jumpers correctly set. Then, and only then, you can close the lid or put the covers back on.

You should now turn your attention to the set-up of the whole computer system. This is something that is often neglected, and by spending just a little more time at this stage you can make it all much easier for yourself later. The first point to consider is how you intend to locate all the separate sections that make up a PC. When you are first testing your handiwork, the sections should all be accessible, and the monitor is best placed temporarily on one side of the main casing.

The conventional format for a flip-lid desktop case, Figure 6.1, is to place the monitor on top of the main casing, with the keyboard in front and the mouse to one side. This places the weight of the monitor on top of the lid of the case. If the monitor is a heavy one, as all colour monitors using cathode-ray tubes are, you should spread the weight with a square of plywood or chipboard placed between monitor and case, so that the edges of the case are taking the weight rather

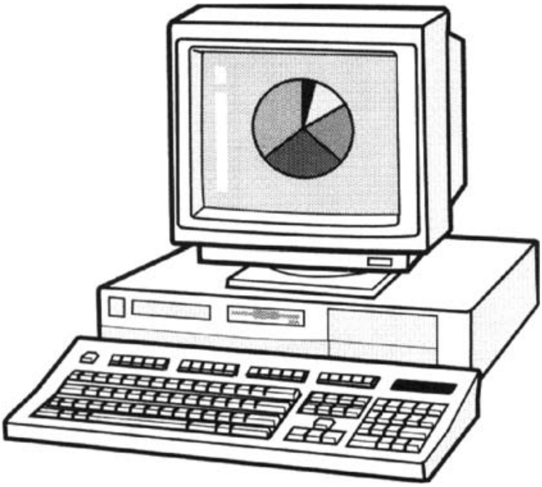

Figure 6.1 The conventional desktop arrangement with monitor on top of the main unit

than the more vulnerable lid. This scheme is really not suited to the larger sizes of colour monitor (17 inches upwards), though it is coming into its own again now that thin flat LCD screens are becoming more affordable. It has the merit of placing all your equipment in a reasonably small space.

This arrangement does not allow you to flip open the lid without first moving the monitor, and if you need to make periodic adjustments or additions to the main unit, a much better method is to place the main casing on a separate shelf, preferably under the desk or table. An old coffee table of the low variety can be used, and if there is enough clearance above the main case this allows you to remove the cover without the need to shift anything. This is a much more suitable set-up if you are likely to be making frequent changes to cards and other aspects of the interior of the machine. You may, however, need cables between the monitor and the main unit that are rather longer than are usually supplied.

- Some mice of anonymous (or anonymouse?) manufacture have very short connecting leads, preventing you from placing the main unit under a desk. Since you cannot tell from the packaging what length

of connecting cable is supplied, this makes mouse replacement rather a haphazard operation. The Microsoft mice all seem to come with a good length of cable. Extension cables for the mouse can be bought, though you have to search for suppliers.
- If you are tempted by cordless mice or keyboards remember that they have to be able to pass signals in other ways, so that your computer will have to be fitted with a card that sends and receives these signals, which can be optical or radio (Bluetooth).

The popularity of the tower form of construction, particularly the mini or midi tower, is due to the small *footprint* it makes on a desk, Figure 6.2. A tower can sit on the edge of a desk, allowing the monitor and keyboard to be arranged more centrally, and an alternative is to place the main tower under the desk – this is essential for a full-size tower which would be too large on a desktop. Another advantage is that using a tower for the PC box allows space for a larger monitor now that such units are reasonably priced. It also leaves more space for other items such as a printer and a scanner.

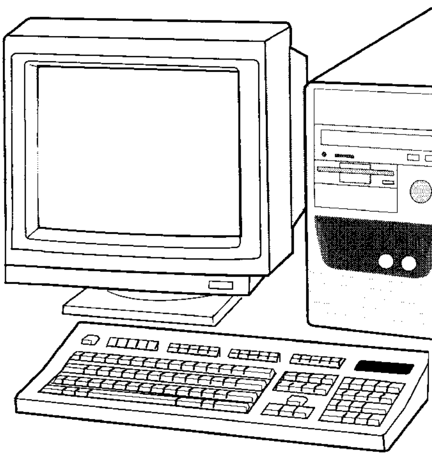

Figure 6.2 Typical tower case arrangement

You can place the mouse to the left or to the right, and software will allow you to interchange the functions of the mouse switches to allow for left-hand or right-hand use. Both mouse and keyboard should come with leads that are long enough to give you considerable choice about where you place them relative to the main casing, but see the note on short mouse leads, above.

The use of a small-format computer such as the Shuttle allows a full set of equipment to be placed on the working surface of a small computer desk, even allowing for a printer, scanner, and broadband router on the desk along with a 17-inch LCD monitor, without restricting access to both front and rear of the computer casing, and room to remove the lid for internal work.

Power cable connections

The standard form of power supply that is used in the PC would at one time have used a Eurosocket connector that was intended for the power to the monitor or the printer; sometimes both could be connected. Modern PSUs omit this power output, which made sense only when the output was switched by the computer's main switch, a practice that ceased when the modern system of 'soft' control started. If you are reusing an older casing that employs this scheme you can connect the monitor in this way. Some monitors are provided with a Euroconnector, but if none is provided, you can connect your own.

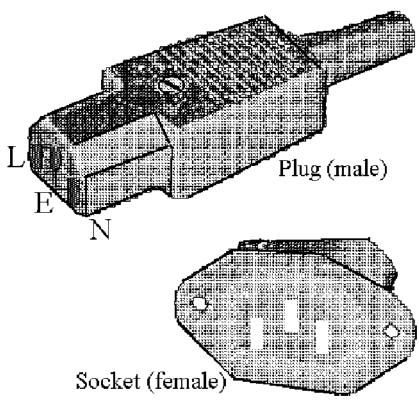

Figure 6.3 The Euroconnectors

Euroconnectors, Figure 6.3, are available from the main electronics supply firms such as Maplin and RS Components (Electro Components). Remember that the Euroconnector you use for a monitor power lead should be the cable-end pin type to match the socket type used on the computer. The exposed pins of the connector must **never** be connected to a mains plug. The Euroconnector can be obtained as cable fitting (plug) or as chassis fitting (socket), and either form can be male or female.

On modern cases, the power-out Euroconnector is not used, and monitors now always come with a moulded UK mains plug at the end of the power cable. If you have several other auxiliary units such as powered loudspeakers, a scanner, a low-consumption printer, etc., you may want all of these to be switched on and off with the computer. This is particularly important now that so many items come without a separate mains switch, and it avoids the usual scenario that you switch off the computer and go away, leaving a printer or monitor on standby. You can solve this by buying one socket strip that is connected to the mains and which feeds the computer and the monitor, along with other switched socket strips that can be used to supply items such as printer, scanner, loudspeakers, digital camera power unit, and other items. These can then be switched on when required rather than remaining on for all the time the computer is in use.

The power cable to the main casing will use another Euroconnector, and you will normally have a mains plug ready-fitted. If you need to fit a mains plug for yourself this must be a standard UK 3-pin plug, and the fuse **must** be a 3 A type. Do not on any account fit a 13 A fuse, because the internal cabling of the machine is not rated to take such a current without serious damage. If a plug has been supplied, check the fuse rating for yourself, even if you have been assured that it is a 3 A type. At this stage, do not insert the mains plug.

To connect up the units, you need complete access to the rear of the main case – do not try to insert connectors by feel. The keyboard connector should be inserted first. If you have decided to go for the older system and avoid using USB, the connector is usually a rather small and fragile PS/2 type of plug, and its socket is directly mounted on the motherboard.

Locate the keyway for the plug, and try to use the minimum of force when inserting it, because the socket on the motherboard is not particularly rugged. If the plug does not slide easily into the socket, stop and try to find out why – you may be trying to put the plug in with the pins turned to the wrong angle. The keyboard cable is usually coiled, and if it does not stretch far enough in its coiled form, pull it out a bit. You can buy cable extenders if needed.

- A keyboard can be easily replaced in the course of an upgrade, though there is seldom any need to do so unless you have been working on a very old machine with the 83-key arrangement. Do not worry about having a keyboard whose plug does not match the motherboard socket, because you can buy DIN-to-PS/2 and PS/2-to-DIN adapters. Some keyboards, such as those of the old Amstrad PC 1512, are non-standard and cannot be used with a new PC.

The mouse can now be connected, either to its PS/2 mouse-port if it is the bus type of mouse, or to a serial port. If you are using the USB type of keyboard and mouse, the mouse will fit into the USB outlet of the keyboard. If you have a 9-pin connector on the COM1 port, use this for a serial mouse. The connectors that are used for this port can normally be screwed into place but do not screw them down when you are first testing. Drape the mouse cable to one side of the keyboard, leaving enough slack to allow you to move the mouse easily.

Now connect the monitor, inserting the Euroconnector into the PC (female) socket, or plugging in to a mains power point if you have opted to keep the monitor separate from the PC supply. The monitor data plug then has to be inserted. The standard type of 15-pin monitor D-plug will fit only one way round, and even for testing purposes it is advisable to fasten the plug into the socket using the screws at the side. The data cable for a monitor is usually thick, because it uses several sets of twisted leads, and it is also stiff because of metal shielding, so that the connector is likely to be pulled out if you move the monitor unless the plug is fastened in.

- Note that the conventional monitor data plug uses three rows of pins, unlike the 15-pin games port plug. The USB type is slimmer and easier to work with.

Once all the essential parts are connected you can start setting up and testing. Items like printers and scanners should not be connected until you have thoroughly checked out the computer using Windows. Before the operating system can be used, however, you need to check the settings in the CMOS-RAM.

CMOS-RAM set-up

When you switch on a PC without any operating system installed, you can make use of small fragments of programs stored in the ROM memory. These allow very limited control (no use of the mouse and only a few keys recognized) over the machine so that you can prepare it for use and installation of the OS.

The PC keeps some data stored in CMOS-RAM memory backed up by a small battery that is located on the motherboard. This data includes the vital statistics for the hard drive(s), so that the computer can find how to make use of the hard drive each time the machine is switched on. At this point, you should be certain that you switched the jumpers on the motherboard so that the CMOS-RAM was active.

Some older motherboards provide for an external battery to be used either together with or in place of this internal one, and if you encounter problems such as a request to alter the CMOS-RAM set-up each time you boot the machine, battery failure is the most likely cause. For a machine you have constructed with a new hard drive you are likely to get a message when you boot to the effect that an unrecognized hard drive is being used. Along with this you will be asked to press a key to start the CMOS set-up. This type of message is delivered when the machine senses that there is a discrepancy between what is stored in the CMOS-RAM and what is physically present, but minor changes such as adding ports will not necessarily affect the CMOS-RAM.

- Some motherboards are set up so that a hard drive will be automatically recognized, and even if you change a hard drive there is still no message from the CMOS-RAM.

Older machines used a nickel–cadmium rechargeable battery on the motherboard, but this has now changed in favour of a single lithium cell, which is more compact and has a longer life. Do not attempt to measure the voltage of this cell (nominally 3 V) using an old-fashioned voltmeter because a conventional voltmeter will take more current from the cell than the CMOS-RAM does, and will shorten its life. If you must check the lithium cell, use a digital voltmeter.

If you do not get a CMOS-RAM set-up notice when you boot, you may see a notice on the screen notifying you that you can press a key in order to get into the CMOS set-up. The way that is used to make the machine run its *set-up* depends on the make of chips tha uses (the chipset). One common method, used with AMI BIOS machines, is to offer you a short interval in which pressing the Del key on the keypad (at the right-hand side of the keyboard) will enter set-up. Some AWARD chipset machines require you to press a set of keys, for example Ctrl-Alt-Esc. Make sure that you keep a note of what has to be done, because otherwise you might find yourself locked out of the CMOS-RAM editor.

Note that if your motherboard is one of the modern type that uses soft set-up, the first of the screens you'll see on the CMOS-RAM is for setting up the processor. Normally, the processor that you have fitted on the motherboard will be recognized and its speed and other settings will be correct. You will need to use this screen only if you change your processor, or if you want to overclock the processor to obtain more speed (so invalidating any warranty). A portion of a typical soft set-up screen is illustrated (this is a simulation rather than a screenshot) in Figure 6.4, showing an AMD Duron 850 installed, with the settings that have been made for it through this software. When you opt to fill in values for yourself, the items that are shown in the illustration starting with a letter *x* are shown with a hyphen to indicate that you have to supply a value. You would supply values only if you were experimenting with overdriving the chip, or if you needed

	CPU Name is	AMD DURON (TM)
	CPU Operating speed	850
x	Multiplier Factor	×8.5
x	CPU FSB/PCI Clock	100/33 MHz
x	CPU FSB Plus (MHz)	0
x	Speed Error Hold	Disabled
	CPU Power Supply	CPU Default
x	Core Voltage	1.6V
x	I/O Voltage	3.40V
	Fast CPU Command Decode	Normal
	CPU Drive Strength	2
	Enhance Chip Performance	Enable
	Force 4-Way Interleave	Enabled
	Enable DRAM 4K-Page Mode	Enable
	DRAM Clock	HCLK+PCICLK

Figure 6.4 A soft set-up page of the CMOS-RAM for an Award BIOS

to set values for a chip that was not automatically recognized by the system.

Whatever key or key combination is to be used to get to the CMOS RAM screen, it should be noted in the documentation for the motherboard, and also on the screen when you start up the computer. Note that pressing the *Delete* key (in the set of six above the cursor keys) as distinct from the Del key will have no effect – this is because the machine is at this stage being controlled by a very small program in the ROM which allows only very limited capabilities.

The snag is that the monitor may not be ready in time to display the message. Colour CRT monitors in particular tend to miss the message because they warm up slowly. The remedy is to boot up in the usual way, and when the monitor is fully active, press the Ctrl-Alt-Del key combination. Use the Ctrl and Alt keys to the left of the spacebar and the Del key on the keypad at the right. This key combination causes what is called a *warm boot*, meaning that the computer re-starts (clearing its memory on the way), but omits some self-test routines so that the re-start is faster. During this re-start you should see a message such as:

WAIT…
Hit <DEL> If you want to run set-up

– the AMI BIOS message is illustrated here.

Whichever method is used, when you move from the soft set-up screen to the first of the options screens, it should be possible to see a display such as that illustrated in Figure 6.5. This is an example of a modern Phoenix Award BIOS and chip set display and those for other machines will differ in detail.

The important point is that you are offered a set of optional menus to choose from, of which the first (already selected) is by far the most important at this stage. Until you are thoroughly familiar with the system, do not attempt to use any menus other than the *Standard CMOS Features* which is usually selected by default, as illustrated. The only exception is that if you find the system misbehaving after a change in the CMOS set-up you can recover by entering the set-up again and selecting the *Defaults*, in this example, the *Fail-Safe Defaults* which will ensure stable running unless there is a serious fault in the system. The BIOS set-up reminds you of this when you opt to use either of the main set-up menus.

This main menu contains the password options that allow you to create a password for either *supervisor* or *user* or both. Passwording can

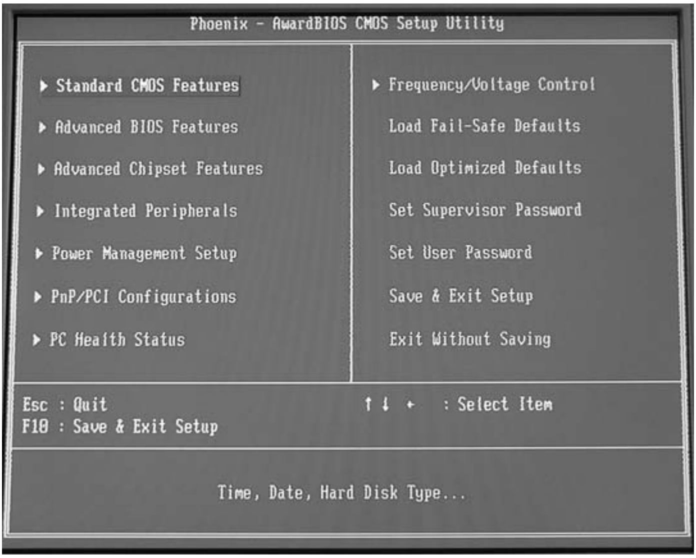

Figure 6.5 A typical CMOS-RAM main menu display

be useful when a machine is available to a large number of people, but unless you have security problems it is best to avoid passwording. For one thing, you need to remember your own password(s). If a password is easy to remember, it is usually easy for someone else to guess.

If you forget a password you will be locked out of your own machine and there is no simple way then of disabling the passwording, though it can be done by an expert. If you are desperate, some varieties of AMI-BIOS provide for the password changing to *AMI* when the back-up battery is discharged or momentarily disconnected. Another option on other boards is to change over a jumper to clear the CMOS-RAM by disconnecting the battery. Find out for yourself how to reset a forgotten password if you decide to use this form of protection. Note that you may have to re-enter CMOS-RAM information after this action. It's a lot of work to have to do just because you have forgotten a password. Fortunately, there is a web site:

www.cgsecurity.org/cmospwd.html

in which you can find a wealth of advice on clearing passwords, and a short zip file that can be extracted to provide DOS routines that will deal with password problems, including a command that will (usually) kill the existing password.

When you opt for the Standard set-up, you will see a display that is, typically, as illustrated here in Figure 6.6.

Figure 6.6 A typical CMOS Standard set-up panel

The important point is that the information on the drive types should be present. Any alteration in the installed drives has to be notified, otherwise the CMOS-RAM set-up table is likely to be presented to you each time you boot. If you have constructed a machine from scratch, or altered the drives of an older machine, you will certainly need to check the particulars shown here.

For a modern motherboard, the information as illustrated is all that is needed. The name of the hard drive indicates that the data has been copied automatically from the hard drive into the CMOS-RAM, and the same is true for the DVD drive on this computer. The arrowheads at the side of each line of information indicate that you can look at more detail by pressing the Return/Enter key, but if your drives have been correctly recognized there is no need to do so.

- Altering a line of information is, typically, done by using the arrow keys (cursor keys) to move the cursor to the item(s) you want to change, and pressing either the *Page Up* or *Page Down* keys to change the item. Note that you cannot type in numbers or day names, only cycle through the options that are provided. What is less clear is how to find and enter the information about the hard drive that you need to supply to the system. At this stage in its action, the computer cannot make use of the mouse, and only a few keys, such as the cursor and Esc keys, are recognized. These keys are listed at the bottom of the CMOS-RAM screen display.

If you want to see what hard drive information has been read into your CMOS-RAM, move the cursor to the line labelled *IDE Primary Master* and press the Return/Enter key. This will bring up another screen of information, in which there are columns labelled TYPE, SIZE, CYLS, HEAD, PRECOMP, LANDING ZONE, SECTOR and MODE. The information in these columns either will be read automatically from a new drive, or can be filled in from the information supplied with the hard drive. You should have copied this information from the casing of a hard drive or from documentation that came with the hard drive, in case the automatic recognition system fails (most unlikely).

- The *IDE Primary Slave* can be used for a second hard drive, and the *IDE Secondary Slave* for a CD-R/RW drive (if you have a CD-ROM drive in the *IDE Primary Slave* position).

If the hard drive has not been recognized, do not try to fill in values of size, cyls, head and so on, unless you have to. The usual method of forcing the computer to recognize the hard drive is to select *Auto* as the TYPE, so that the drive will be recognized the next time you boot the computer. Another method is to use the option in the main menu of IDE HDD AUTO DETECTION. If you need to use manual entry for any reason (an older hard drive, usually) then moving the cursor to the *Primary Master* line allows you to use the *Page Up* and *Page Down* keys to alter the setting to USER. You can then fill in figures for your own hard drive.

- I must emphasize again that all modern systems will recognize a drive automatically, and you should not use a drive that is so old that it is not automatically recognized. For working with older components, see Chapter 12.

- Unless your ATA hard drive is recognized correctly in the CMOS-RAM settings it will probably not operate correctly – you might find that at best its capacity was incorrectly recorded; at worst that it did not retain data. There is no point in proceeding further until you are sure that the main hard drive is being recognized. Older machines will not be able to use more than 32 Gbyte of a large hard drive, so that partitioning will be needed if you have an 80 Mbyte drive and want to use it all. If you are using Windows XP with the NTFS option then you can use as large a hard drive as you can buy.

FLOPPY AND DISPLAY DETAILS

Once the hard drive details have been entered you should check the portion of the *set-up* form that deals with the floppy drives. Once again, this should appear automatically, showing a 3½-inch 1.44 MB type – note that this counts 1 MB = 1000 KB rather than 1024 KB.

On the option list for floppy drives (move cursor to the *Drive A* line and press Return/Enter key) is a *Not Installed* option which is used for machines that are part of a network and which do not need disk drives. It is also a simple way of preventing a casual user of the computer from inserting a floppy and loading in software that contains a virus. A knowledgeable user would know how to change the CMOS-RAM setting (though you can protect this using a password). The *Drive B* option is a hangover from the past and is not now needed – machines with two floppy drives are less common now than sightings of a dodo.

The video line will always show the normal option of *VGA/EGA*, whether you use a colour or a monochrome VGA monitor. There may be a *Not Installed* option that would be used for server machines on a network, and, as before, if you are refurbishing such a machine or using its motherboard you might find this option set. In this type of BIOS you have options for *Halt On*, specifying the kind of errors that will prevent the boot action from proceeding, and the usual option is *All Errors*. Other options are *No Errors*, *All but Keyboard*, *All but Diskette* and *All but Disk/Key*. The *All Errors* option is the default and you should not change this unless you know what you are doing. In the example, using the option of *All but keyboard* prevents any error being signalled if by chance a key is being pressed when the machine is switched on. Normally, only the Del key is permitted (so that you can get access to the CMOS-RAM screens).

You can then go back to the start of the list to correct the calendar and clock details if necessary. The calendar details are usually correct unless the board was not set up correctly initially, or the battery has failed, but the clock may be a few minutes out. The clock and calendar will probably need to be set from scratch if you are using a new motherboard and the CMOS-RAM has been cleared. You are not obliged to set the calendar and clock at this stage, but it is useful to do so. If you want to correct the time later it can be done using the Windows *Date and Time* controls rather than by using the CMOS-RAM option.

This is as much as you should do with the CMOS-RAM at the moment, because all the other options will probably use good default settings, and you can ensure this by taking the option in the main CMOS-RAM display to load safe defaults. You should then leave the CMOS-RAM by selecting *Save and Exit Setup*. We'll look at the other CMOS-RAM options later in this chapter.

Stability options

For testing purposes, it makes sense to under-run your processor at first, ensuring maximum stability. This is not necessary if you are starting at a modest level, such as a Duron 1300, but it can be useful if you are using one of the higher-end Athlon chips, such as the XP2700. When you have achieved stable running, you can then start to make changes, logging each change, so that if any trace of instability occurs you will know what step caused it. If all the vital components are working perfectly and are perfectly compatible you will not find any instability when you reset the CMOS-RAM for full rated speed of processor and memory.

Instability, incidentally, is unmistakeable. One minute your computer is running well, the next minute it has rebooted without any form of warning. I have seen an unstable machine reboot even in the middle of the CMOS-RAM setting actions, sometimes before it had booted up completely. The main causes can be bad memory, poorly regulated power supplies, faults in the motherboard, or a faulty processor. If you start with under-running, you will know that if operation is stable then any instability at full ratings will be due to the additional loading.

For example, are you running the memory too fast? Try reducing the memory speed (many CMOS-RAM settings allow you to make the memory clock a fraction or a multiple of the FSB), and if this helps then either your memory is deficient or you have been running it too fast. By contrast if you have two memory boards and removing one restores stability, this points to either a faulty memory strip (the removed one) or inability of the PSU to cope with the current requirements of two memory strips.

Booting up

You are now ready to start installing the essential operating system into the computer, and you need some way of doing this. Booting up means starting up the operating system of the computer, and if you have built a machine from scratch there will be no operating system ready. The Windows system comes on a CD-ROM, but this is of little use until the PC has enough software stored to allow it to read a CD. Modern BIOS chips usually provide a CMOS-RAM option that allows you to pick the CD-ROM drive as your boot drive, so that if you select this option and insert the Windows CD (full version) into the CD-ROM drive, you will be able to install Windows as soon as you leave the CMOS-RAM set-up.

If you do not have the option of booting up from a CD, most unlikely if you are using a modern motherboard, then you need what is described as a bootable floppy, one that contains the essential parts of the MS-DOS operating system, particularly the driver software for the CD-ROM drive. If you insert such a floppy into its drive and now leave the CMOS set-up program, taking the option to *Write to CMOS and Exit*, the machine will try to boot, and will usually try the floppy first, otherwise it will recognize the hard drive and try to find the operating system first on the hard drive, and then on the floppy.

With a completely new main hard drive, no floppy and no CD you should get a message asking you to insert a disk with the MS-DOS operating system in place. The message is:

Error loading operating system
or
Non-system disk or disk error

and this is a signal to you that you need to insert the MS-DOS (system) disk into its drive and press the Enter key on the keyboard. This is a preliminary to installing Windows, but if you want to partition your drive you need to run the FDISK program (which is on the set-up floppy) first. The set-up (or system) floppy should be provided along with a CD-ROM in the pack that contains the full version of Windows. Obviously, if you are updating an existing Windows on a reused hard drive this step is not needed because you will boot from the existing Windows.

- Remember that Windows is supplied in two forms. If your computer already contains an older version of Windows you can use the (cheaper) upgrade CD-ROM. If, as is most likely, you are starting from scratch then you need the full version, sometimes referred to as the OEM version. When you insert an upgrade CD-ROM, you will usually be asked to insert the previous full version as a check that you have bought a complete version of Windows at some stage.

FDISK is an old type of program that at one time seemed obsolete because hard drives were once supplied with the disk partitioning action already carried out. Nowadays a new large-capacity hard drive is normally supplied without partitioning so that you **must** use FDISK, even if you do not want to create more than one partition. Every hard drive has at least one partition, and though Windows XP allows you to dispense with FDISK (see later), earlier versions of Windows do not. You will need a modern version of FDISK such as is included with Windows *Me*, or use software supplied by the manufacturer or retailer of the hard drive. The following description applies to FDISK being used from a floppy system disk, rather than installation from a CD-ROM.

Start the computer with the MS-DOS system disk in the floppy drive, and wait until the prompt A:> appears. Now type the command:

FDISK

– and press the ENTER or RETURN key. You will see a display that includes the lines:

```
Current fixed disk drive: 1
Choose one of the following:
1  Create DOS partition or Logical DOS Drive
2  Set active partition
3  Delete partition or Logical DOS drive
4  Display partition information
5  Change current fixed disk drive
   Enter choice : [5]
   Press ESC to exit FDISK
```

If you are setting up the one and only hard drive, use option 1, but if you are setting up a second hard drive use option 5 (as illustrated) to select your slave drive. This option 5 will show the drive details for both drives so that you can select which one to partition. Once the drive is selected, the display returns and you can choose option 1. You will be asked if you want to set the whole drive as a single partition, and for a modern computer you should answer Y to this question. The partitioning action will be carried out, and you can press the ESC key until the system reboots.

You may, however, want to partition a large hard drive into two or more partitions (the limit is four), and this is done using option 1, following which you have to use option 2 to set the active partition, meaning the one that contains the operating system. FDISK is a very old program that runs only under MS-DOS, and which must never be used on a hard drive that contains data or programs. FDISK will *always* delete any existing data on a drive. If you need to alter partitions on a drive that is already in use, or if you just want a more user-friendly partitioning program, look for a copy of Partition Magic (from PowerQuest), which is an excellent modern solution to the problem of partitioning. If you use Windows XP you can alter partitioning by using Start – Administrative Tools – Computer Management and then click on Disk Management. Do not use this or any other disk partitioning software unless you know what you are doing and have backups of all your data.

- If there is no response to typing FDISK (ENTER), or you see a message that no such filename exists, this means that your boot disk does not contain the FDISK software, and you will have to find a copy on a floppy.

Once FDISK has been used (a very fast operation) control returns to the A-drive, as indicated by a screen message:

A:>

so that you can then use the MS-DOS system disk in Drive A to format the hard drive. For a single master drive, the command is:

FORMAT C:/s

– and press the ENTER or RETURN key. The /s part of this command will ensure that the MS-DOS operating system is copied from the floppy to the hard drive, so that you can from then on dispense with the floppy and boot from the C: drive. If there was any stored data on the C: drive (or partition) it will be removed by this command, which prepares the machine for using the CD-ROM drive to install Windows. For a second hard drive, you will probably use D: as the drive letter, so that your command becomes FORMAT D:, omitting the /s part this time because you neither need nor want another copy of MS-DOS to boot from. If you are formatting a slave drive be very careful that you do not mistakenly re-format your main (master) drive instead.

A new hard drive is not usually provided with Windows preinstalled unless you have specifically asked for this and paid for it, so that once you have MS-DOS working you can proceed to install Windows. You should test now that you can boot from the (master) hard drive by taking out the floppy system disk and rebooting. If your CMOS-RAM set-up allows you the option of booting from the hard drive directly without checking the floppy drive, take this option because it makes booting up faster and avoids the error message

Non-system disk or disk error

that appears if there is a floppy in the drive that is not a system floppy.

For Windows XP, you can install, even to a clean hard drive, from the full (**not** upgrade) version of Windows without using a floppy. To do this, you need to set the CMOS-RAM so that your first choice of boot drive is the CD-ROM drive. If your CMOS-RAM does not offer this option, then you will have to use a floppy containing the essential skeleton operating system that will allow you to use the CD-ROM drive for the main Windows disc. You do not have to format the drive or use FDISK, because the installation procedure for the full version of Windows XP will carry out these tasks. During installation, you can opt for one partition or several, and specify the size of each partition.

- Remember that installation is always much simpler and faster if you are upgrading Windows, with an older version already on the hard drive. You do not need to use FDISK or FORMAT, simply insert the Upgrade CD into the CD drive and follow the instructions that appear on the screen.

CMOS-RAM fine tuning

When you first fire up the computer, the only part of the CMOS-RAM that you need to use is concerned with the correct settings for the hard drive(s), and most other settings can be left at their default factory settings. Once you can boot from the hard drive, however, it is useful to check what other settings exist. Some of these can be left, a few can be changed, and any that you do not understand or have inadequate information about can be left severely alone.

- As before, the illustration is of a typical CMOS-RAM, and there will invariably be some differences between this and the one fitted on your own motherboard.

The CMOS-RAM *Advanced BIOS features* set-up section contains no standard set of actions, and the typical examples here are taken from an Award BIOS. Others are likely to differ, though many of the important options will be the same. Some of these options can be used without the need for deeper understanding of the computer, but those which deal with memory allocations, particularly with ROM shadowing (see later) should be left strictly alone until you know what is involved on your machine, and when you are certain that your computer is stable. A typical set of items is illustrated in Figure 6.7.

The first item here is *Virus Warning*. This protects the parts of a hard drive (boot sector and FAT) that can be damaged by a virus, and the default setting is *Disabled*. This is because you cannot load an operating system (DOS or Windows) without modifying these parts of the hard drive. You can set this to *Enabled* (as illustrated) **after** Windows has been installed, but you will need to disable it again if you upgrade your Windows software, possibly also for some other program installations.

The two following items deal with *Internal* and *External* cache, meaning memory that is used as a temporary store for the microprocessor. These should both be set to *Enabled*, because the speed of the machine will be noticeably lower if you disable either of these. The *Quick Power On Self Test* should always be enabled to make booting faster by eliminating excessive testing. This testing is a hangover from the time when memory was considered unreliable.

The four options for first boot device are a feature of a modern BIOS, and the *First Boot Device* should be set to use the IDE hard drive (listed as HDD0) to boot from. The illustration shows the floppy

Figure 6.7 Typical CMOS-RAM Advanced BIOS settings

drive set as the second choice, and CD-ROM for the third choice, with Other Boot Device (such as network) disabled. By altering the First Boot Device to CD-ROM and disabling any other options, you can force the machine to install your operating system from a CD-ROM of the full version of Windows, as noted earlier.

- Some BIOSs use, in place of the numbered *Boot Device* lines, a *Boot Sequence* line that has the default of C;A and this will cause the machine to boot from the hard drive, using a floppy only if the hard drive cannot be used. This is a useful default, and you can change it to A;C if you want to test the machine without using the hard drive. There are several other boot sequences also, and the most useful of these is to place CD-ROM booting first so that you can install Windows directly to a new hard drive or partition from its CD-ROM rather than using a floppy. There is often an option to boot from a network if you are sharing an operating system among several machines (with the one containing boot information already running). Along with this, you can disable the action of seeking the floppy drive so that the machine does not activate the drive needlessly at each boot. Another floppy option is to allow the floppy to be used for reading only (the default is read/write).

The *Boot Up Floppy Seek* has been disabled in this example. This prevents waste of time searching for a floppy disk when you switch on.

The *Security Option* decides when you need to enter a password if you have opted for this. The default is *System*, prompting for the password on each boot. The alternative is *Set-up*, when a password is needed only when the CMOS Set-up is used. These settings are used only if you have opted (why?) to use passwording.

The illustration shows *APIC Mode Enabled*. APIC means Advanced Programmable Interrupt Controller, and as far as you are concerned it is an advantage to have this enabled, because it allows more devices to use the processor without the need to share time or resolve conflicts. Only disable this if you are requested to in an error (or other) message.

The page shown in the illustration of Figure 6.7 is not complete (because of the limitations of the CMOS-RAM display), and the scroll bar at the side indicates that it can be scrolled to reveal other options. Of these, the only one in this set you need to pay any attention to is Video BIOS Shadow, which should be enabled to speed up your video rate (essential if you want to use DVD editing for example). Shadowing means that data in (slow) ROM memory is copied to (faster) RAM memory, and the computer then uses the copy.

Some BIOSs add other features to this set. You may find that a *PS/2 Mouse Function Control* is normally set to *Auto*, allowing the system to detect the use of a PS/2 mouse automatically at boot time. This can be disabled if you use a serial mouse, but this option is now unusual. The *OS/2 Onboard Memory >64 M* item is also disabled by default. You can enable it if you are using the OS/2 operating system with more than 64 Mbyte of memory. The OS/2 operating system is only a faint recollection now, and all recent motherboards can cope with 512 Mbyte of memory when using Windows 98, Windows *Me* or Windows XP, more if you use Windows 2000 or the NTFS file option of Windows XP. The *System Boot up Num Lock Status* option should be enabled, so that the number-keypad on the right-hand side of the keyboard is set for numbers rather than its optional cursor keys. This avoids the need to have to press the *Num Lock* key after booting. The *Boot Up System Speed* setting is *High* by default and should not be altered.

Another set of BIOS options on other BIOS types deals with the *Typematic rate*. This is the rate at which a key action will repeat when a key is held down, and there are two factors, the time delay between pressing a key and starting the repeat action, and the rate at which the key action repeats once it has started. The Set-up options are to enable or disable the *Typematic* action, to set the delay, and to set the repeat rate. Typical default values are to have the action disabled, the delay set to a long 500 milliseconds (0.5 second) and the rate to a fast 150 characters per second. The time and rate settings have no effect if the Typematic action is disabled. Since Windows will override these settings and impose its own, there is no point in making the settings unless you plan to type data into MS-DOS programs, and these options no longer exist in many BIOS chips.

DANGER AREAS

The *advanced chipset features* set, Figure 6.8, of the Award BIOS, and comparable section of other BIOS settings, should be left at default settings unless you know what you are doing and have the necessary information such as the response time of DRAM. Most of us don't

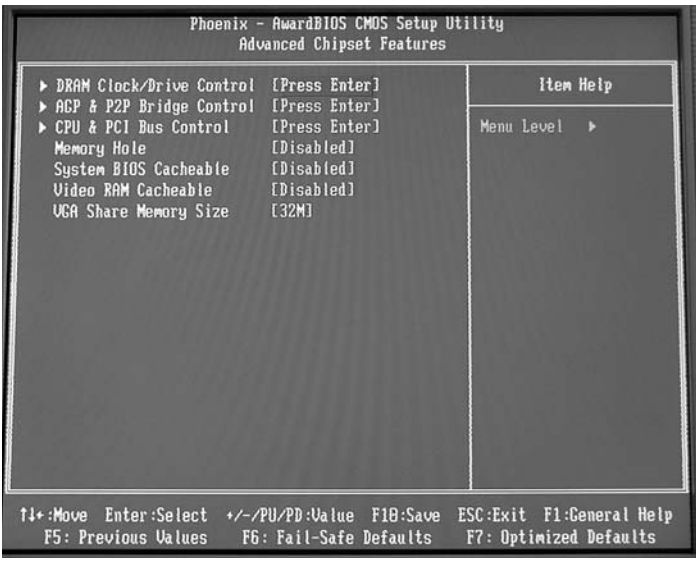

Figure 6.8 The Advanced Chipset display

have this information, and the normal option for modern BIOS is *By SPD*, meaning that the settings are read from a small ROM in each memory strip. In the illustration, the item *DRAM Clock/Drive Control* will expand out (when you select it and press Return/Enter) to show a sub-menu of items that will have been allocated values automatically.

These DRAM settings are optimum for your memory, and are best left alone unless you have information about alternatives. The same is true for the *AGP & P2P Bridge Control* settings and the *CPU & PCI Bus Control* settings. These settings are made available so that experts can wring the ultimate in speed from a computer, but any alterations made without knowing what they achieve can easily lead to disaster. When you are certain that your computer is stable with a large amount of memory in hand, you can enable the *System BIOS Cacheable* and *Video RAM Cacheable* items to improve running speed by using part of the memory as a cache. This is possible only if your operating system prevents the area of memory that is being used as a cache from being used by any programs. If your computer is totally stable, then altering these items to *Enabled* should not make it unstable, but if this does happen, you know that you need to revert to *Disabled*.

Figure 6.9 shows the Integrated Peripherals menu, dealing with the ports that are part of the motherboard, including IDE drive sockets. The example shows information for a Shuttle machine with integrated sound and graphics.

The first item in this set, as illustrated, is VIA OnChip IDE Device, and this will appear only if the VIA chipset is used on your motherboard, though other BIOSs may have a similar display. By all means select this first item and press Return/Enter to display its sub-menu, but the only item you should look out for is *Primary/Secondary Master/Slave UDMA*. If this appears, its setting should be Auto, so that DMA is enabled if the drives are suitable. If this option is Disabled, you should change this to Auto. Other items in this set, and in the *VIA OnChip PCI Device* and *Super IO Device* sets should be left alone. The other items from Init Display First onwards are shown for a system with an AGP graphics card and with keyboard and mouse of the PS2 type (not USB), and not using the ROM that is part of the local area network controller on the motherboard.

The Power Management setup, Figure 6.10, is a feature of all modern BIOSs, allowing the computer to be put into suspended animation and switched on by various actions (including modem inputs), or to have

Figure 6.9 The Integrated Peripherals menu

Figure 6.10 The Power Management menu

power-consuming items switched off when the machine has been idle for a time. Unless you are familiar with these systems, and have recovered from the shock of returning to a computer that appears totally dead (but springs to life when you press a key or touch the mouse) you may feel that you can do without these items. My own use of a computer means that it is never idle when I am with it, and I just switch off when I leave it.

The settings illustrated are the ones I have specified for my own use, but the defaults that appear may not be identical. If you prefer not to have power suspended automatically, this menu provides the means to disable all power management.

You should also be careful about using the *Power Management* options, and keep the default settings if you are in doubt. Just because an option appears in one of these sets does not mean that your motherboard can cope with it. It is reasonable to use the action that shuts down the hard drive after a period of inactivity, but only if you are using a modern version of Windows that supports power management features of this type. Be wary of shutting down the fan unless you are certain that the control system will protect against overheating.

- Power Management use can have unexpected consequences. For example, if you opt for your hard drive(s) to shut down after some specified time you may find that when you are trying to log on to a web site you are refused on the grounds that your *cookie* files are disabled. This is because the hard drive is not spinning and though you will awake it when you carry out any keyboard or mouse action (like clicking on a program or on a textfile) that needs the drive, requests for a file that are made by a remote Internet site will not start up your hard drive unless you have opted to have this type of action enabled. The point is that you might not connect the problem with its cause, and this is common with Power Management problems.

The PnP/PCI Configurations set, Figure 6.11, consists mainly of settings that are best left at their default values unless you have had a great deal of experience with bus systems (and you wouldn't be reading this if you had). The only reason for mentioning it is that you should check that the first item, *PNP OS Installed*, is set to *Yes*, because the default will often be *No*, and this slows down the actions of Windows. PNP means plug'n'play (though some call it plug and pray), and it is a part of all modern versions of Windows, meaning that when you connect a new device to the computer, it will be detected automatically

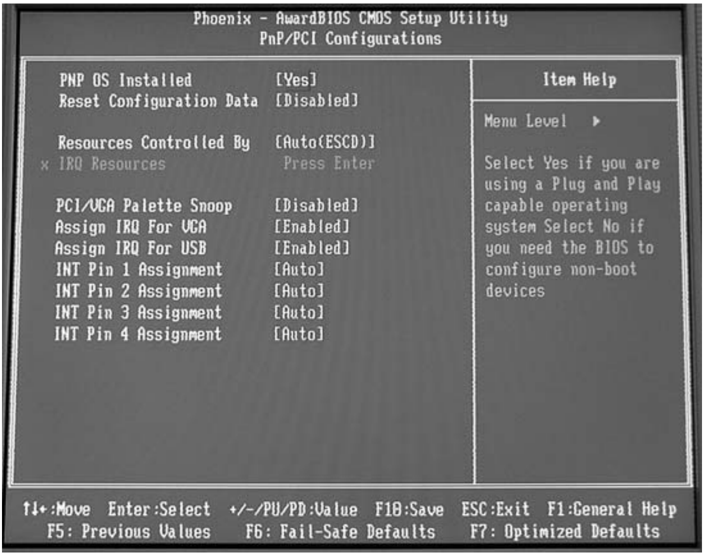

Figure 6.11 The PnP/PCI Configurations menu

when the computer is switched on and appropriate software drivers loaded.

Finally, modern motherboards contain a large number of sensors designed to detect overheating, particularly around the CPU, and modern fans are usually controlled by the outputs from these temperature monitoring systems, so that as the computer heats up, the fans run faster to compensate. Figure 6.12 shows a typical PC Health Status display, and it's better to accept the default values, which are sensible and safe ones, than to dabble with changes.

BUS MASTERING

Modern computers feature bus mastering, meaning that data can be transferred to and from hard drives and CD-ROM drives at a high speed without the need to make use of the main processor. This system is also called DMA, direct memory access, and its use can be detected in Windows Control Panel – System. Modern hard drives use a version referred to as Ultra DMA.

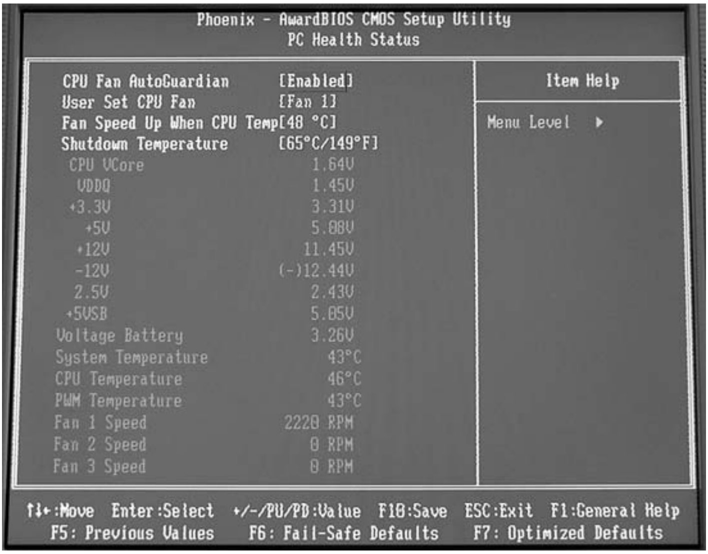

Figure 6.12 The PC Health Status display

All modern motherboards (but not all older motherboards) see to this automatically, and you may have to use a CD or floppy disk containing bus-mastering software. For some motherboards, this can be run only after Windows has been installed, and you will have to check with the documentation that you have. It is very important to use bus mastering, because in its absence the computer will run at a much slower rate than you would expect after upgrading.

- If your motherboard needs a floppy to install bus mastering, this can be a hint that this is a fairly old motherboard model. Modern motherboards usually come with a CD-ROM that will install bus mastering as part of the mainboard drivers.

FLASH BIOS

Many motherboards now use a *flash BIOS*. This is a BIOS chip that can be reprogrammed, so that you can download an up-to-date version of the BIOS and use it to replace the existing one. Normal operating voltages have no programming effect, but when a higher voltage is applied, data can be fed into the chip and will be retained.

- It sounds a risky business and my own personal view is that I would rather replace a complete motherboard than risk the damage that a faulty reprogramming of the BIOS could cause. The process is deliberately made difficult to avoid the possibility of your BIOS being corrupted by signals from a hacker over the Internet.

Reprogramming is definitely **not** for anyone who has not worked with MS-DOS, because the actions cannot be carried out with Windows running. Full instructions for reprogramming the flash BIOS should be included in your motherboard manual. If you don't understand the terms used or the procedure, **don't do it**!

For the sake of illustration, this is an outline of how the reprogramming is carried out on one well-known motherboard. You need to know the model name and version number of your motherboard, which is printed on a sticker on the board (typically on a slot). Make sure that you have gathered all the information you need, and prepare some blank formatted floppy disks.

1. Check the existing BIOS ID number which appears when you boot (while the Press DEL to enter SETUP notice is on screen). The last two digits of the string of numbers under this notice provide the BIOS ID number.
2. Download the new BIOS file from the motherboard manufacturer's web site.
3. Extract from the downloaded file a BIN file, and copy this to a bootable floppy disk along with the flash utility (EXE) program.
4. Set your computer to boot from a floppy, and use the disk you have just loaded with the BIN file.
5. Run the computer in DOS (no Windows) and execute the flash program from the floppy. Your motherboard manual should indicate the precise form of DOS command to carry out the reprogramming.

Chapter 7

Installing Windows

Versions

The main operating system, as far as most constructors are concerned, will be Windows, and it might as well be the latest version you can get your hands on. This, for business and networked users, is currently Windows XP Professional, but home users should go for the *Home Edition* which costs less and does all that a home user will need. If you feel that you do not want to use XP, then Windows *Me* will probably still be available for some time to come, though Microsoft does not usually support a Windows version for more than three years. You should not consider earlier versions, though a very cheap (or free) full (not upgrade) copy of Windows 98 SE is not to be sneezed at, not least because you can upgrade from it to later versions at a comparatively low price using the *Upgrade* version of Windows *Me* or XP.

New machines currently all come with a working copy of Windows XP Home Edition, and this is a version of Windows that looks nothing like Windows *Me*, owing more to Windows 2000 than any other earlier version, together with many additions that greatly improve stability and which provide more actions that previously were performed by other software (such as CD-writing). The snag with putting Windows XP on to a machine that you are building is that this version of

Windows will not work for more than 30 days until it has been *activated* by Microsoft. This is an anti-piracy move, and the activation can be carried out over the Internet (automatically), or by telephone. Windows XP is set up to detect changes in your hardware, so that it will resist being copied to another computer, but a side-effect of this is that changes to your hard drive, memory, or other internal hardware may trigger a request for reactivation. This is not such a problem as you may think, and some users have reported that reactivation has not been needed even for a hard drive change. The reactivation procedure following a change of hardware (as distinct from a change of computer) seems to be reasonably flexible.

- If you buy or construct a new computer using XP, you can transfer settings and files from an older machine to your new one, using network connections, CD-R, or floppies. Windows XP Home Edition features a file transfer wizard that selects the files and settings for you and makes the task much easier.

My preference is to use XP, because, when used with a firewall, it is so much better than anything that has been available for the home user before, but if you intend to use your computer as a test bed for equipment (so that you frequently change items internally) you might want to buy a full version of Windows *Me* and use that initially, because it is likely to be usable for several years to come, and you can always switch to XP (or its successor, currently known only by its codename *Longhorn*) later. The downside of XP is that it is much more vulnerable to virus attack than older versions unless you use the firewall software and (possibly) a virus checker as well.

- If there is no existing version of Windows on your hard drive (and for a new drive this is quite certain), you will need the CD-ROM for the OEM version of Windows, not the (cheaper) upgrade version. This comes with a floppy that will install MS-DOS, allow you to partition and format a hard drive, and make use of the CD-ROM drive. If you have an earlier full version of Windows 95 or 98, you can install this on the new hard drive and then use the upgrade version of Windows *Me* or XP Home.
- The setting up processes should ensure that you can boot the computer from its hard drive, and that the CD-ROM drive will be recognized, allowing you to install whatever version of Windows

you want to use. Remember that you can boot directly from the Windows XP CD-ROM only if your CMOS-RAM settings allow the choice of CD-ROM as the first boot drive.

Windows is a complete operating system that allows you to run both Windows and DOS programs, though a few (very old) DOS programs can be run only by baling out of Windows completely. You should think about whether you really want to continue using DOS programs at all, if Windows versions are available. Note that this does not mean that you can remove MS-DOS files, because Windows works through MS-DOS and some very important utilities such as Drive Image and Partition Magic bale out of Windows and use DOS when necessary. Some DVD player software also by-passes Windows and uses DOS directly so as to obtain faster processing speeds. Installing Windows does not erase MS-DOS from your hard drive but it reduces the number of DOS files and ensures that MS-DOS does not load in automatically when you start up the computer.

The more RAM memory your computer contains the better Windows *Me* or XP can use it, certainly as far as 512 Mbyte. A large amount of RAM greatly improves the ability of Windows to run several large programs simultaneously without reducing speed. For most machines, adding extended memory means buying DIMM, or other memory modules, and you must take care to install modules that are compatible with your computer. Before you add memory you need to check that the power supply on your computer is up to the task of supplying the memory – 512 Mbyte is usually tolerable, but some supplies may baulk at 1024 Mbyte.

The installation of a hard drive of adequate size is assumed – modern versions of Windows are simply not intended for machines with small (less than 5 Gbyte) hard drives. Even a moderate selection of Windows *Me* files will require about 720 Mbyte. A hard drive of several Gbyte is necessary if you are to be able to use modern programs along with Windows *Me*. Currently, 80 Gbyte is quite common on package-deal computers, partitioned into two 40 Gbyte sections for Windows XP.

In the course of installation, Windows will create *folders*, meaning portions of hard drive space that are reserved for storing files. The advantage of using folders is that files that belong together can be viewed together rather than in alphabetical order of all files or in the order in which they were installed. A list of all the files on a drive would be difficult to work with (there are several thousand files on an average hard drive), but a list of folders is much easier, especially with folders named *Programs*, *Books*, *Articles*, *Letters*, etc.

- Some Help notes refer to folders as *directories*, the older name that is still used by MS-DOS.

Windows makes extensive use of the mouse, and the fundamental mouse actions of pointing, clicking, double-clicking and dragging are all important. You should refer to the appropriate *Made Simple* book for your version of Windows if you are unaccustomed to these terms. The disabled user can dispense with mouse use, and can call up visual and audible prompts.

Problems

Because there are so many variations on the PC machine, using different video cards, keyboards, mice, modems, and other features, and so many programs that can reside in the memory, it is impossible to test a new operating system with every possible combination of machine and software. If you are using a straightforward 'clone' PC with straightforward business software (no games) it is likely that you will be able to run the Windows Set-up program and use Windows without problems.

The README files on the CD-ROM are intended to notify you of problems that have arisen since your version of Windows went into production, and you should check carefully for references to your machine or to software that might be running at the time when you install Windows. More recent notes are available from the Microsoft web sites, and your installation CD-ROM will contain a text file that notifies you of the web address.

During the long testing stage for any version of Windows, a large number of incompatibilities are found and dealt with, but because of the almost infinite number of combinations that can exist, it is impossible to say that Windows can be installed in **any** machine without **some** alterations. The README files contain notes on known problems, most of which deal with machines and software that are not available in the UK. Many of these problems can be solved by obtaining up-to-date drivers from the suppliers of hardware and/or software see Appendix C.

Windows *Me* installation

The following descriptions refer to a 'normal' installation of Windows *Me* and Windows XP Home. Normal means that your computer is not one that features as a problem device (usually one from a well-known manufacturer) in the README files, and you are not running any of the listed hardware or software that is known to cause problems. We'll devote most of this description to the *Me* installation because XP installation, though different initially, follows a similar routine and is, if anything, more automated.

- Note that you must deactivate any anti-virus programs or BIOS settings on your computer before you try to install a new version of Windows. The reason is that Windows installation carries out the same types of actions as a virus attack, so that it will trigger any anti-virus program into protecting against the changes that Windows installation must make. If your computer has a modem then there will not be any Internet connection while Windows is being installed, so there is no possibility that you will have a virus attack (unless you use a pirated copy of the Windows installation disk with a virus placed on it).

You can install Windows *Me* into a computer that currently is running either DOS, Windows 95 or Windows 98, even Windows 3.1. For a newly constructed machine, the installation will definitely be from DOS – even if you are installing on a new hard drive, the installing program will put MS-DOS in place and then add the remainder. Check that you have the correct version of the Windows *Me* CD-ROM for the installation you are going to make. The upgrade version is suitable only if you already use Windows (preferably Windows 98) and the full version is needed if you are working from DOS, particularly on a new hard drive.

- You can alter any of the installed options later, for example, to add a new printer or sound card to Windows, and even if you change the screen graphics card you do not need to go all the way through Set-up again in order to ensure that you have the correct files on your hard disk.

During installation, you will be prompted to insert a floppy to be made into a *Startup* disk (which used to be called a *System* disk).

You can also make a Startup disk later by using the *Add/Remove programs* option of the Control Panel. This disk can be used if, for any reason, you find that Windows *Me* does not start when the computer is switched on. When you use the Startup disk the computer will start in MS-DOS, so that you will need to use only MS-DOS commands until you can start Windows *Me*. This allows you to use FDISK and FORMAT commands to prepare a hard drive for use with the MS-DOS tracks that allow the system to be booted from the hard drive. You can also use diagnostics programs in the event of a hard drive that refuses to work. The system disk will also set up a temporary CD-ROM driver so that you can install Windows *Me* from the CD.

- It's wise to have several copies of the Startup Disk, because it can be used to set up any new drive for any later version of Windows also.

Once the hard drive has been formatted and has MS-DOS installed from the floppy, using the option to install CD-ROM drivers, insert the Windows *Me* CD. This will start automatically so that you can use the mouse to point to menu items and the ENTER or RETURN key to confirm your choice of action.

Once you have opted to continue the Set-up action, the screen will divide. The column on the left is called the *Explorer Bar*, and it will become a familiar feature of Windows *Me*. During installation, it will stay on screen during the actions that use a Windows display, and it will at this point show a set of icons with the labels:

Preparing to run set-up
Collecting Information about your computer
Copying Windows *Me* files to your computer
Restarting your computer
Setting up hardware and finalizing settings.

You will also see the display of *Estimated time remaining* which at the start will be 30–60 minutes. This estimate will become more precise as installation proceeds. As each process is executed, the text in this bar will become yellow.

The main installation process then starts with a search for drives. This is followed by a quick check of the C:\ drive, after which the Windows *Me* Set-up Wizard is prepared. The *License agreement* will appear, and you need to click the box marked *Accept* to continue (you need to scroll the box to see all of the text).

The next input that you need to provide is the 25-character *Product key*. This consists of five sets each of five letters and digits that are typed into five boxes. This key will be printed on a label on the CD case, and you should take a secure note of this code in case you lose it. It's not exactly something that you can commit to memory.

- If you lose this code you will be unable to reinstall Windows or to alter details of your present installation. Take several copies of the code.

The program called the *Set-up Wizard* will carry out some checks for existing files and for available disk space. You are then asked to establish your location, and you should find the name *United Kingdom* from the large list of countries – this is normally automatic when you are using a CD-ROM bought in the UK.

You now have to prepare a Startup disk (you can bypass this, but it is much better to make the disk now). You will need a formatted 1.4 Mbyte floppy. When you proceed, the action will be to collect files, and ask you to insert the floppy. When you do so you are reminded that this will delete any present content, and you are also reminded to prepare a label for the floppy. This floppy can be used to get your computer running under MS-DOS if for any reason (such as hard drive damage) your computer fails to start some day.

You will then be asked to remove the Startup disk and click *OK* to continue. The file copying action (from CD-ROM to Windows folders) will start, and will continue for ten or more minutes. A set of messages, seventeen in all, will appear during this process, and you can read these to find what advantages Windows *Me* will have for you. You are invited to take the *Discover Windows Me Tour*, when Windows is up and running, to learn more.

- When files have been copied you are reminded that you should register your copy. This can be done online (if you have a modem) or by post. Incidentally, several other manufacturers feature on-line registration, but for some it never seems to get through.

The next step involves restarting the computer, and if you are not present to click the *Restart Now* button, the process will start automatically after a 15-second interval. Following this there will be a lot of disk activity, and you will see the display return to a DOS screen (black screen with white lettering) at intervals. This takes some time, typically 10–20 minutes, and ends with the *Welcome to Windows Me* display. You need to keep the CD-ROM in its drive when you run this display, because the files are read from the CD rather than being placed on the hard drive. You are again reminded to register. That's it!

During installation, you can opt to save your existing System files if there is any possibility that you might want to return to things as they were. This is recommended if you have space on your hard drive, and if you have more than one hard drive you can specify which drive is used to store these files. The recovery files are called W9XUNDO.DAT and W9XUNDO.INI.

- For details of using Windows *Me* see the books on Windows *Me* from Newnes.

STARTUP DISK USE

If at some subsequent time you find that your hard drive fails, you will have to use the Startup disk. The *Multi-Config Start Menu* allows you to boot up your computer from the new Windows *Me* StartUp Disk using a boot menu that allows you to load drivers for the most common CD-ROM drives or optionally to perform a normal clean boot. After you have made your selection, the CONFIG.SYS file will load the appropriate CD-ROM driver (if selected) and then a 2 Mbyte RAMDrive. The RAMDrive (a portion of memory addressed like a drive) is used to store all the diagnostic tools necessary to check and remedy the most common problems. Because RAMDrive behaves like a drive, it will use a drive letter, usually D, so that your CD-ROM drive will for this time use the next available letter, usually E.

- Real-Mode CD-ROM support makes use of generic drivers that allow you the use of the CD-ROM under DOS when Windows cannot be used. Not all CD-ROM drives are supported by this action, and if yours does not work with these drivers, you must use the ones that came with your CD-ROM drive by running the installation files on the floppy that came with it.
- The RAMDrive is only temporary and will disappear when you restart your computer normally.

Windows Me features

Windows Me contains support for digital photography or scanner use. This allows uploading, with save, preview, rotate, and print actions without the need to use any other applications. You will, of course, need to use other applications if you want to edit your image files or to use OCR on images of printed documents.

Another pair of useful new features are *System File Protection* and *System Restore*. System File Protection makes it much more difficult to erase or change important files, and System Restore tracks any changes made to System files so that you can restore the system to an earlier configuration if problems arise.

Updating by way of the web has been made easier, and can be automatic if desired. You can also make use of the *Help and Support Centre*, the replacement for the older Windows type of System Information utility.

The Help system of Windows Me is outstandingly good, and in my opinion this alone would justify the upgrade from older versions. Figure 7.1 shows the appearance of the Help screen as it first appears.

Figure 7.1 The first Help screen of Windows Me

When you look at Windows *Me* for the first time and start Windows Explorer, it looks reassuringly similar to the appearance of Windows 98. Explorer is now more tightly integrated with Internet Explorer, and the Favourites menu has been reorganized so that you need to click on chevrons to see the full menu.

The most obvious change is to the Windows *Media Player*, Figure 7.2. This is now much more oriented to MP3 use, so that you do not need to download additional software to play MP3 music files. This introduces a new term – *skins*. Skins are files that determine a set of options for Media player appearance, playlist, etc. Windows *Me* places an icon for Media Player on the foot of the screen.

Figure 7.2 The default appearance of Media Player, which caters for sound or video

Another noticeable change is the Start–Shut Down action, which has a different form of panel. The options are now Shut Down or Restart, with Shut Down the default. Restart can be used by selecting it from the drop-down list.

The Accessories set now includes eleven games, and of the familiar contents (to users of previous versions) NotePad, WordPad, Paint and Calculator are unchanged from the Windows 98 versions. The Accessories set now includes the new item of *System Restore*. System Information now brings up a Help and Support panel.

Help and Support, Figure 7.3, takes longer to use than the older System Information of Windows 98. Each time you click on a different section, it takes time for refreshing the system information. If you use the *Problem Devices* section you may see a list with each item noted as Error Code 22. This does not imply that your computer has problems, only that the specified device is currently disabled.

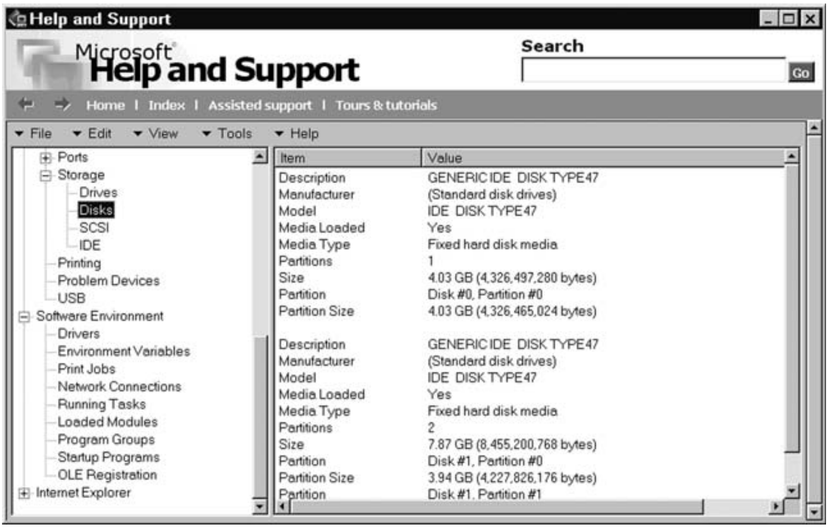

Figure 7.3 A typical display from Help and Support

Note that the Control Panel is greatly extended, but the default view shows only the commonly needed items. This same philosophy applies also to menus which can be personalized, meaning that each menu will hide the items that you don't often use. You can gain access to the less-used parts by clicking the down-pointing chevron at the foot of the menu. If you don't like this action you can revert to seeing the whole of each menu by clicking Start–Settings–Taskbar and Start Menu– General and then clear the *Use Personalized Menus* check box.

Installing Windows XP Home Edition upgrade

Before you even think of installing Windows XP Home, take a look (if you can) at the web site:

http://www.microsoft.com/hcl

which contains a long list of hardware that has been approved for use with XP. This list is split into types, and you will need to know the manufacturer and type designation of each piece of hardware. It's most unlikely that your monitor, motherboard, keyboard or mouse will be a problem, so you should look in particular for modem, printer and scanner, since these seem to cause the majority of problems. If your hardware does not appear on the list this does not mean that it cannot be used, but there is a chance that you might have to download new drivers for the device.

Problems are usually caused by older hardware or software, and you will have considerable difficulty if your modem is one of the hardware items that is not recognized. If this happens, do not try to install XP until you have checked with the modem manufacturer that you can download new software, or that there is a procedure for ensuring that the modem is recognized. Note that the list provided by Microsoft is not exhaustive, and some items that do not appear on the list may also cause problems. The approved list is mainly of items available in the USA, and there are many items we use in the UK that do not appear but which can be used. If you have bought modern components these should all be suitable, but older items, particularly modems, may not work with XP, and older software may need downloaded drivers.

- This hardware/software check is not an attempt by Microsoft to be awkward, simply a way of ensuring that everything runs smoothly. If Microsoft manufactured all PCs and PC hardware and software there would be no need for such checking, but because other manufacturers are so heavily involved there has to be some system for ensuring that what you buy to add to your machine will work correctly.
- You should not install peripherals that use drivers until Windows is up and running. This avoids any problems that might occur if a driver conflicted with Windows installation files. In addition, connection of a peripheral may trigger Windows into making an automatic

installation of a driver, and this can be very difficult to get rid of if you want to use the recommended manufacturer's driver later.

If you are about to install XP, make certain that you have made all the hardware changes to your computer that you intend to make for some time, because if you activate XP and then change the hardware you will need to activate XP again on the computer if you want to continue using XP. This alone is a good reason for not using XP on a machine that you are likely to upgrade in future. If you do not activate XP immediately, you can use it for a month (with daily warnings about activation) and make hardware changes, then activate it. The examples shown here have occurred during an upgrade installation from a computer running Windows *Me*, and you will find the procedure differs in some ways if you are installing from scratch, using a full version of XP Home Edition.

- Note that hardware changes mean internal fixed hardware such as graphics card, a network, hard drives, CD-ROM/DVD, and RAM, but not modems or devices connected through the USB ports.
- As a last resort, you can uninstall XP and revert to Windows *Me* or whatever earlier system was running before XP. This is not exactly a comfort if you installed XP as the first and only operating system on a new drive, but for an upgrade you will have this option unless you are short of hard drive space.

The installation of Windows XP Home Edition is started by inserting the disc into your CD-ROM drive, and Figure 7.4 shows the first screen display that appears. This offers the choices of *Install Windows XP*, *Perform additional tasks*, *Check compatibility*, and *Exit*. The additional tasks are more specialized, and you can usually ignore them when you make your first installation. Details of these tasks are illustrated in Figure 7.6, later.

The important first step is to check compatibility, because you need to know at this stage if any hardware or software on your computer is likely to cause problems later. This check is rigorous, and some items that trigger a listing as a problem may turn out to work perfectly, because the checking turns up anything that **might** be a problem. For example, your modem might trigger a warning because it is using a driver for an earlier version of Windows, but in the course of Windows XP installation a more suitable driver might be located and used.

Figure 7.4 The introductory installation screen

- When you use the *Compatibility Check* or the *Install Windows XP* option, you are given the choice of downloading additional Set-up files from a Microsoft web site. You can ignore this if you like, but I strongly advise carrying this out, because this ensures that the most up-to-date information is contained in the Set-up files, and this can avoid hardware and software problems that have been dealt with since the installation disc was issued. In my case, the download took about four minutes on a dial-up connection. This download is needed each time you click the actions that require updating of these files, because they cannot be stored on the CD and are not retained in memory after being used. At the time when this is done, the modem is still supported by the previous version of Windows, so it does not matter whether or not Windows XP can use it.

Figure 7.5 shows the *Upgrade Advisor* list that appeared on my computer after the compatibility check stage. Where an item is marked as not currently present, this can be because it is connected by USB and

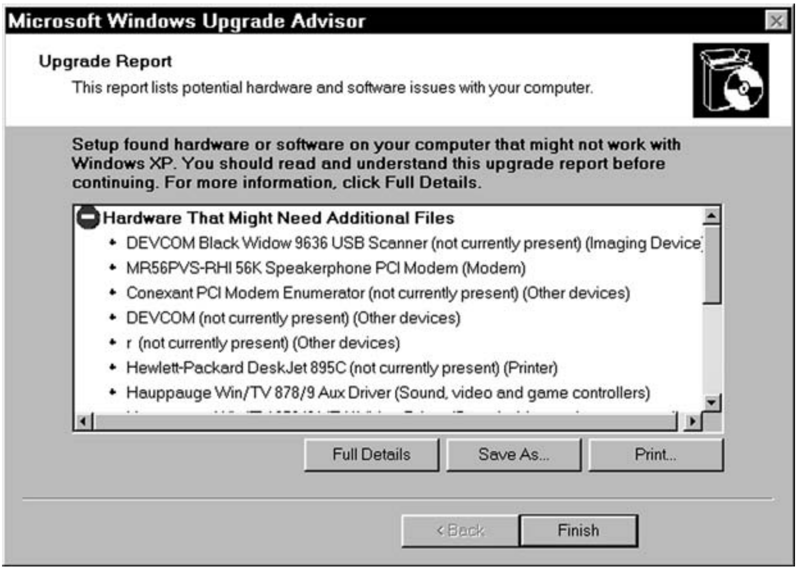

Figure 7.5 A typical Upgrade Advisor list

not switched on, or that it has been removed from the computer but has left a driver on the hard drive. This points to a failure of earlier versions of Windows, that so much software can be left on the hard drive after a device or software has been uninstalled.

This list needs to be checked over carefully. In the example, a device known as 'r' appears, and I haven't the faintest idea what that might be. Not shown in the illustration is a reference to a tape drive, though no tape drive had ever been fitted on this computer. This indicates that some tape drive software has remained on the hard drive which is now in its third computer. I bought a new modem, new scanner and abandoned the Hauppage TV card.

- I also had warnings that the ASPI Layer driver could not be loaded, but the checking continued when the warning box was deleted. This seems to have been triggered by Adaptech software that I once used for the CD writer drive.

Figure 7.6 shows the additional tasks list. The most important part of this for many users will be the option to transfer files and settings from an

Figure 7.6 The additional tasks panel

older computer, but you should also look at the release notes. This panel is also important if you are setting up a small-scale network at home.

So far, nothing has been done that affects your computer, and you are still running on your previous operating system (unless this is an installation of the full version of XP on to a new hard drive). You can make an exit from any of the panels that have appeared up to now, and return to the state your computer was in before you put in the XP installation disc.

To start the installation in earnest, go back to the initial panel (Figure 7.4) and click *Install Windows XP*. You will be asked again if you want to download new Set-up files, and you ought to take this step to ensure that you are using the most recent version of Set-up. Once the files have been downloaded, the Set-up action starts, and you have nothing to do with the procedure, which continues automatically (though watch out for warnings such as the ASPI layer warning noted earlier, because these will hold up installation until you acknowledge them). The installation is lengthy, at least an hour unless your system is very fast, and at times you may feel that nothing very much is happening.

Mostly, however, you will be aware of the hard drive working steadily, and the progress is shown as a list of main steps at the left-hand side of the screen, with details of progress on subsidiary steps shown as a bar display under the list. The main part of the screen lists the new features and facilities of XP. Your computer will be rebooted several times in the course of the automatic set-up actions.

Once the Set-up has been completed, there is a *Welcome* screen, and Windows XP starts. This is slow for the first start, but when you subsequently start, you will find that the start is much faster than it was for older versions. The first screen display, Figure 7.7 shows the menu that can be summoned by using the Start button. This is so very different in presentation from earlier versions of Windows that you should consider running the *Tour Windows XP* item that is offered as a way of becoming familiar with the system.

Figure 7.7 The new Start button menu, which appears after installation

- Note that there are now separate *Log off* and *Turn off Computer* buttons, replacing the *Shut Down* action of earlier versions.

Figure 7.8 shows the appearance of the new Windows Explorer. This is more familiar if you have used an earlier version of Windows, and, as in the earlier versions, you can customize it to your preferred version. I detest icons as a display, and prefer to see a list of filenames because it allows me to see a much larger set of files on one panel.

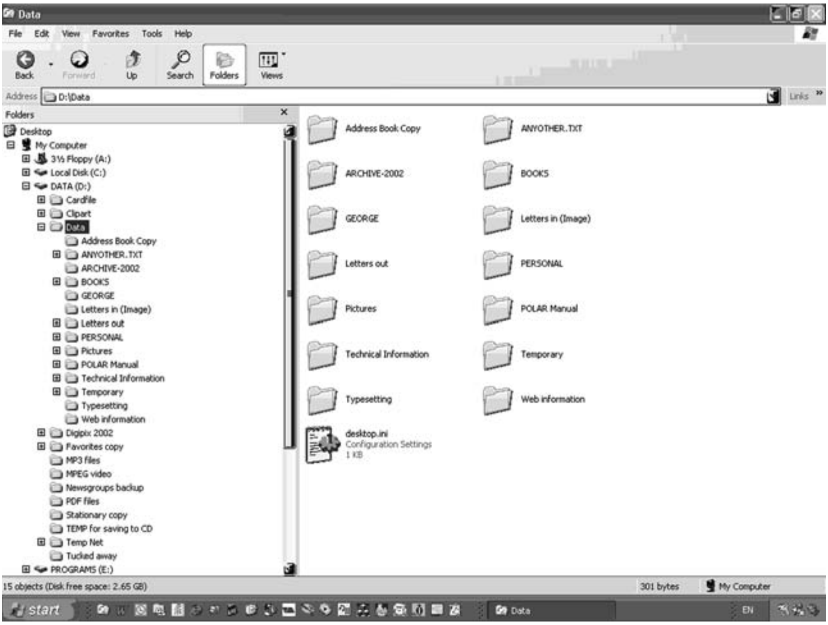

Figure 7.8 Windows Explorer display of XP

In general, the guiding principles of XP have been to make use easier, trying to avoid long and confusing lists. This can take some time to become used to, as, for example, the much reduced Control Panel which groups actions so that you need to think of the class of item before you can choose in detail. There is a new Internet Explorer, version 6.0, with improved security, including the option to set up a simple personal Firewall against hacking (see Chapter 11). The new option to write CDs is reached through the Media Player rather than through a new menu, and all of this is a good reason for taking the Tour before you start to use XP seriously.

- You have the option, once XP is installed, of converting all of your files to the more advanced NTFS format, replacing the FAT32 system used for earlier Windows versions. There are many advantages to using NTFS, such as the ability to use more memory, large files and much larger hard drive partitions or using large hard drives with just one partition. If, however, there is any possibility that you might need to revert to an earlier version of Windows you must not convert, because though files can be converted from FAT32 to NTFS there is no conversion available (from Microsoft) in the reverse direction. If you want to use NTFS, convert only after using XP for some time. Note that Partition Magic can convert NTFS files to FAT32.

Startup menu (*Me*)

The Startup menu is a list of options for starting the computer. You can go to this menu either by holding down the left-Ctrl key or by holding down the F8 key while you boot. This should bring up a menu (in MS-DOS). When you have entered the Startup menu you can use ordinary number keys for menu options, some of which are used for trouble-shooting, others for starting in MS-DOS.

You can use key 6 to run MS-DOS in Safe mode, which means that none of the CONFIG.SYS or AUTOEXEC.BAT file commands will be used. This is useful if you suspect that one of these commands is causing problems (as, for example, a faulty network command might) that prevent Windows *Me* from loading correctly.

The 3 key will start Windows *Me* in Safe mode, in which only the bare minimum of drivers will be run. This is enough to allow you to sort out many of the types of problem (usually with networks) that might prevent Windows *Me* from loading correctly. You should restart after sorting out the problems.

- You should enter Safe Mode if you are going to defragment your hard drive, because this helps to ensure that the drive is not used by other software during the defragmentation action.

There are also the options of using key 1, for normal start (seldom needed, since this is the default if you do not press the F8 key), and for logging the start steps using the C:\BOOTLOG file. This is of interest to specialists only, allowing the user to check at which point in loading and running Windows a fault has occurred.

- You can also start in MS-DOS by using the Startup floppy that will be made during Windows *Me* set-up.

When you leave Windows *Me* one of the options that you will see is to go to MS-DOS. This allows you to use MS-DOS in the normal way. You cannot, however, go from this to Windows *Me* without rebooting.

Windows XP has a very similar Startup menu, but there is no need to use Safe Mode for actions such as defragmentation.

Other applications

When you install Windows, this also installs a large number of Microsoft programs, several of which are likely to be useful. You will need to install other programs for specialist purposes, and some of these are indicated in the following chapter, but for general uses you could just about get by on the Microsoft set. For business uses, adding the Microsoft Office set would provide for (probably) more than you would ever need, and if I have to choose just two applications to add to a Windows installation I would pick Microsoft Word and JASC Software Paint Shop Pro. Word is a program that has gone through many versions and is now an extremely capable word processor that will perform a huge range of other tasks (elementary database and spreadsheet actions, for example) as well as advanced capabilities such as typesetting actions that at one time were the province of high-priced desktop publishing software. Word has in the past always been available as a separate item from the rest of the Office collection, and older versions such as Word 97 or Word 2000 are excellent value for money.

Paint Shop Pro is an image editor that also has gone through a number of versions and, like Word, has more functions than the average user will ever need. It's a good program for the beginner to graphics work, however, because it's easy to use and the results are very rewarding.

Just as one other extra, if you need an accounts program, I have found Microsoft Money excellent value for, well, money. I previously used another accounts program, but in recent years its upgrades became costly and I was able to convert to Microsoft Money with the minimum of disruption.

Chapter 8

Adding other cards and peripherals

Installing a printer

- The installation of a printer takes much the same form in any version of Windows, and the illustration here uses Windows *Me* as an example; the steps are much the same for XP provided that you have not been asked to download new drivers. My H-P 895Cxi printer was correctly recognized by XP and worked with no problems. A later installation of a Canon i560 required the drivers to be installed before the printer was connected (by USB).

With Windows installed and the computer checked out thoroughly and switched off, this is a good time to connect up a printer. There are two cable connections that you have to make. One is the usual mains power supply connection, and the normal pattern is to use a standard three-pin plug at one end, and either a Eurosocket or a miniature two-pin connector at the other (printer) end. Note that a few printers have the mains cable permanently fixed at the printer end, so that if you find that the mains supply is just a few inches further away than the cable will reach you will need to use an extension socket.

- Note that a few printers have a fixed cable and no switch at the printer end. These will have mains power whenever the cable is plugged in, and are usually arranged to go into a standby condition if they are not used for several minutes. You should not attempt to break the cable to connect a switch, and the best way to connect a printer of this type is by way of a switched socket strip fed from the same switched outlet as the computer. That way, the printer will always be switched off fully when the computer is switched off even if you forget the switch on the socket strip.

The other connection is the printer data cable. For older computers with no USB ports, this means the parallel data cable with the DS25 connector at the computer and the standard Centronics connection at the printer end. These cables are usually one metre long, and though you can buy longer cables, you should try to locate the printer so that this cable length will be adequate. All printers now use the USB type of connection, sometimes with no parallel option, which can be made or broken with the computer switched on and running.

- If you have sound enabled, a bell will ring each time a USB printer is put on line or any other device plugged into a USB socket.

Modern printers using the Centronics connection will need a *bi-directional* printer cable which can pass information back from the printer to the computer so that the printer can be completely driven by software. This type of software can, for example, give you an indication of how much ink remains in an inkjet cartridge. If your printer needs this type of cable, make sure that it is connected before you start the software installation for your printer, and the CMOS-ROM has been set up with ECP port enabled. Using USB connections relieves you of this worry, because the standard type of USB port allows information to pass both ways.

- Note that if you have a printer that uses a bi-directional type of parallel cable you should not attempt to connect and use a second printer that also employs this type of cable. You should also avoid the use of printer switching boxes.
- Another point to watch is that the Centronics plug at the printer end of the parallel cable must be inserted as far as it will go, and secured with the wire loops that are provided. Some printers are

very easily upset if this plug is not fully home or if it is disturbed during printing.

SELF-TEST

Almost every printer is capable of carrying out a self-test and printing a page without the need for any intervention by the computer. Find out from your printer manual how this is done – the usual action is to press a set of buttons simultaneously. For some printers that have no control panel on the printer itself you cannot carry out this action. A few printers need their data cable to be disconnected before a self-test can be run.

It is important to print a self-test sheet if the printer can do so. If a printer can produce a perfect copy of its test page (usually a sample of fonts) then a mechanical or electrical fault is unlikely to be the cause of the problem, which is more likely to arise from incorrect settings either at the printer or at the software. Remember, for example, that when you use the Windows printer manager the printer will not necessarily start printing immediately – it may wait until a queue forms or a 'print now' instruction is issued.

PRINTER PORT

Your printer is connected to the computer through a port, and the usual system in the past has been to use a Centronics parallel port, something that we have dealt with. New printers use a USB connector, sometimes with no parallel port option available, and if you use this method you will have to heed the advice in the printer manual, and disregard all that follows relating to the use of the parallel port.

The usual parallel port that is provided on many (but not all) computers is labelled LPT1 (an old abbreviation for line printer 1) and it is unusual to find that this is not installed – but it's the unusual that so often causes problems. Problems are more likely to arise if you are using a printer on another port, such as LPT2, LPT3, or LPT4.

Your port settings should appear briefly on the screen when your computer is switched on, but this display is often hidden if the video monitor has not warmed up in time or if the screen display is quickly replaced by the *Loading Windows* notice. If you have any doubts about the port setting, you need to know how to bring up the CMOS-RAM display.

This always requires some key or key combination to be pressed just as the computer is starting, and you may see a screen message such as:

Press Delete key to run SETUP

This varies from one computer to another, so that only the manual or the guide for the motherboard can be of assistance here. If you do not press the key(s) at the correct time there will be no action.

Once you can see the CMOS set-up screen you can check the LPT1 settings. This will show an address and the usual code here is either 03BC h or 0378 h, and an IRQ number which is normally 7. If this appears, then the port is correctly installed as LPT1 for your printer.

The reason for the different address codes is that some video cards and video chipsets make use of the address code 3BC h for their own purposes. Current examples of these makes are Matrox, ATI mach64, STBLMB Horizon, STB2MB Powergraph, or an Aries integrated PCI system. If you have any of these, the LPT1 port will be forced to use the address of 0378 h which is normally allocated to LPT1 on older machines.

- If you install other ports (for a second printer or for parallel port peripherals such as a scanner) the address for LPT2 will be 0278 and the IRQ number is 5. There may be problems in installing an LPT3 port if you have any of the video cards or chipsets noted above, because this port would normally use the 03BC h address. You should always use the Windows *Add Hardware* option of Control Panel if you put in other ports, so that conflicts can be avoided. Windows XP and Windows 2000 will detect potential problems like this in the course of installation.
- All of this indicates how much more satisfactory the use of USB is for peripherals. The only point to watch is that if your computer does not have enough USB ports and you install a USB hub to add more, some peripherals may not be able to use connections to the hub. This applies particularly to peripherals that make use of a power supply along the USB lines, so check carefully if you are going to buy a hub that it will be suitable for the peripherals you intend to add.
- Because USB can be plugged in and out with the computer switched on, it should not be necessary to have a large number of USB connection points as long as you have enough for ‘bare-minimum’ operation, because one device (not being used) can be unplugged to allow the connection of something else you want to use. A digital

camera connection, for example, need only be plugged in when you have pictures to download.

DRIVERS

A printer is not necessarily made useful simply by connecting it up to a port. Before you can print anything much you need to install printer drivers for Windows. Once the Windows driver is installed, you can print from any Windows application, such as word processors, spreadsheets, or accounts programs. One Windows driver is all that you need for one printer, but if you use MS-DOS programs you will need a separate printer driver for each application that you use running under MS-DOS.

- Some printers provide only the Windows drivers; others provide the Windows drivers with some MS-DOS drivers as well. Do not confuse a Windows driver with a *Windows printer* – a Windows printer is a laser printer, not very common nowadays, that makes use of the Windows memory of your computer instead of requiring additional memory to be installed inside the printer.

Installing your driver software for Windows can be very straightforward if your printer is a model that was in production before your version of Windows was released, because this make it almost certain that it will be listed in the built-in Windows driver set. Even if your printer is one that Windows does not list, however, the printer manufacturer will have provided a floppy or a CD-ROM with printer drivers. If all else fails, printer drivers can be downloaded over the Internet.

Driver installation starts with correct printer. You need to know the name of the manufacturer and the precise model number of the printer. For example, if you are installing a Hewlett-Packard Deskjet 895Cxi, it is not good enough to use the driver for any Deskjet model – you must look for the **precise** phrase if you want to have full control over the printer.

With everything connected up and switched on, get to the Printers window of Windows *Me* in the usual way by clicking on the *Start* button, then on *Settings* and *Printers*. The Windows Printer panel includes an icon labelled *New Printer*. Click on this icon to start a Wizard which will install your new printer.

A pair of lists will appear, Figure 8.1, one on the left-hand side of printer manufacturers and another on the right-hand side of models corresponding to the manufacturer whose name you have clicked. Once you have clicked manufacturer and model, you can proceed to the next part of the installation which will ask you to insert the CD-ROM (or floppies) that you used to install Windows. The driver software will be read from this source, and you can opt to print a trial page to ensure that the driver software will operate your printer correctly.

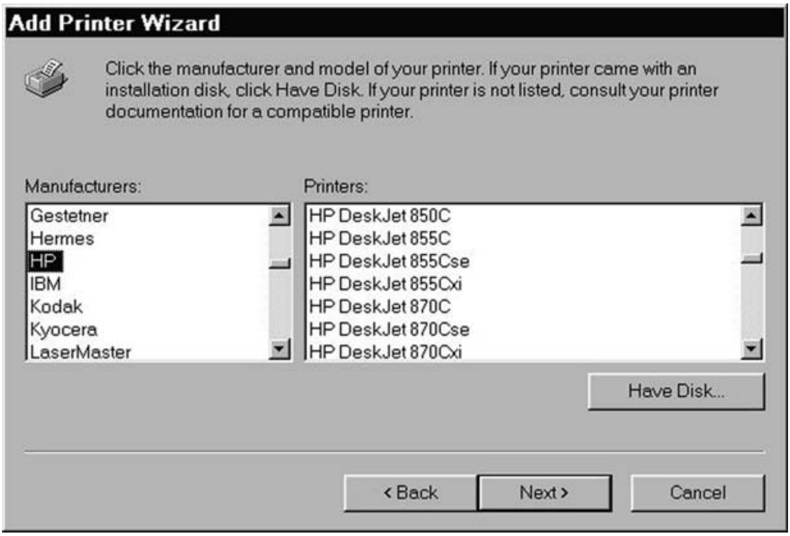

Figure 8.1 Installing a printer – this routine is the one used by Windows *Me*

A slightly different procedure is needed if your printer is one that is not listed. This is likely if the printer is a very new type that was not being manufactured when your version of Windows was issued, and you then need to use the software supplied by the printer manufacturer. In this case, you ignore the list, insert the floppy containing the drivers, and click the button marked *Have Disk*. You will then be guided by messages on the screen so that the driver is installed from the disk, and you will usually be asked to opt for printing a test page.

- Heed the advice that comes with the printer, and if this states that the software should be installed from a CD before you connect up the printer, you will save yourself a considerable amount of bother if you do as you are advised. This type of advice is more likely to apply to a new printer type being installed into a computer running Windows XP.

Mouse options

Once you have a computer running reliably, you might want to think about using something other than the standard type of mouse for pointing and selection. One popular alternative is the wheel mouse, which, as the name suggests, has a small wheel protruding from the top of the casing. This can be pressed to act as a third button whose actions can be selected by mouse software, or it can be rotated to scroll the screen as an alternative to clicking and dragging scrollbars. There are many such mice available, some with four buttons and a wheel so as to allow you to select from a wide range of options in addition to the normal left and right button click actions. The only snag is that some such mice use drivers that conflict with other software, but these conflicts are unusual.

Figure 8.2 A typical trackball

The other possibility is to dispense with a mouse and use a trackball instead, Figure 8.2. You can think of a trackball as an inverted mouse which remains in one place on your desk, so that it's ideal if you are limited for space next to the keyboard. It is used by rolling the ball with one finger or the palm of your hand, and clicking the buttons as required (and with the usual mouse effect). One advantage of using a trackball is that you can be certain that the ball will not move when you click a button (if you lift your hand off the ball when you click), so that there is no chance of clicking over the wrong place because the mouse has moved. The dragging action is rather more awkward than that of a mouse, at least until you get used to it. My own preference is for a trackball, particularly for graphics work.

Scanners

A scanner, Figure 8.3, is a device that reads documents by using an image sensor strip, and stores a digitized image as a file. This can be used as a form of copier, for editing graphics, for fax transmissions, or for reading text into a word processor without retyping. Scanners can be handheld, flatbed or roller-feed types, and you can also buy specialized types for scanning photographic negatives or slides. The handheld and roller types are now obsolete, apart from some handheld types used for scanning barcodes or business cards.

Scanners either will use an interface card (often an SCSI type on older scanners), or be connected through the parallel port (now unusual) or the USB port. Most modern scanners can be connected through the USB port, preferably USB-2.

- If you buy a parallel port scanner, now a rare item, it is preferable to buy an additional parallel port card as well, because it can be very

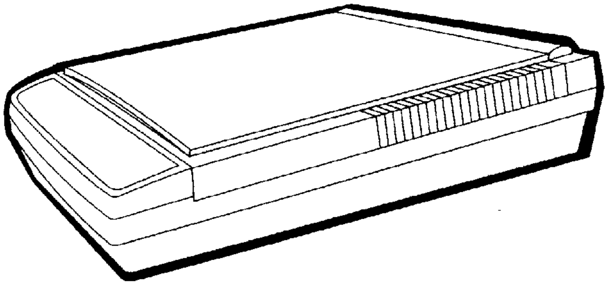

Figure 8.3 Outline of a typical flatbed scanner

inconvenient to have to disconnect the printer each time you need to use the scanner. The parallel-port type needs only connecting up, and installing its software. The card type will require you to open the computer to plug in the card, and then connecting the cable between the card and the scanner. The software can then be installed. If your hard drives already use an SCSI interface, you can install a scanner that uses SCSI without the need for any additional cards.

A flatbed scanner holds the page steady under a lid and scans it using a system very like the scanner of a photocopier. The quality is excellent, and all models allow for colour scanning. Automatic page feed can be used on some, which is particularly useful when OCR is being applied to a long document. These scanners can be costly, and those at the top end of the price range can be used for professional printing tasks, such as magazine illustrations. Low-priced models, for as little as £50, are a useful addition to the computer system and provide as much as is needed for hobby and small-business needs. Scanning is an essential part of the system for reducing office paperwork, in which each incoming document is scanned into a file and made available over the office network.

For copying a document, using the scanner as part of a photocopier, you need to be able to use both the scanner and the printer, so that if you are using a parallel port scanner you should have it connected to a different port. The printer and the scanner should both be switched on and the printer loaded with paper. Select the *Copy* action on the scanner software and specify the number of copies needed. If your printer is a good colour inkjet type, you can achieve very realistic colour copying in this way, and you can copy a set of photographs of normal size on one A4 sheet so that you can obtain a set of copies at a very low cost.

Graphics scanning is usually a default action, which brings up a graphics editor. When the document (usually one that contains or consists of a graphics image) is scanned, the image will appear on screen and can be edited like any other bit-mapped graphics image. The graphics software will also be able to save, load, or print the image.

The scanner can be used as the input for generating a fax message, provided that the computer is connected to a fax modem. When the software is run, the document can be scanned, and you will be asked to specify a fax number, or choose one from a list. The document will then be faxed to the recipient.

Leading OCR software is usually bundled with a scanner. OCR means optical character recognition, and refers to software that will recognize the graphics image of a character and convert this into the ASCII code for that character. In other words, OCR allows the scanner to be used as a text reader, providing an input to a word processor. This provides for a very high standard of text recognition, so that only a spell check is usually needed on the text after recognition. Problems can be experienced with very small character sizes, with italic text, tables, or with a document received by fax. You can usually opt to vary the resolution for OCR from 200 dots per inch, suitable for large type sizes, to 400 dots per inch, suitable for smaller text.

- Some scanners can be fitted with an add-on for scanning photographic transparencies (slides or negatives), and in some cases you can buy the transparency unit (or tranny) at a lower price when you buy the scanner. I have tried several types of transparency adapters, but had very poor results from them, and I much prefer to have a separate transparency scanner. Modern scanners, such as the HP 3670, incorporate a good transparency system and can be used with 35 mm slides or negatives.
- Scanning action depends on using a built-in light source. This is usually a cold-cathode type of striplamp, and it can be expensive (more than £20) to replace, despite being a mass-produced item used in photocopiers and fax machines. If your lamp fails, look on the Internet for replacement parts.

PRINTER/SCANNERS

Combination printer/scanners are available at attractive prices, allowing you to carry out both printing and scanning actions along with options for fax and for making copies of documents without the need to switch the computer on. These machines are usually connected using a USB link, with no parallel-port option, and some care is needed over selection of the machine, because the advantages of saving in space are often counterbalanced by some disadvantages:

1. the cost of ink cartridges (usually small capacity) can be high,
2. the printing may not be adequate if you want to print photographs,
3. there's more to go wrong.

If your requirements are not elaborate, space is limited, and your computer has USB ports, such a machine may be useful if you need both printing and scanning in small doses. Note, however, the prices of these combined machines range from remarkably cheap to quite expensive, and you should not expect a machine at the lower end of the price range to perform to the same specifications as one of the higher-value types.

- My own experience of one such low-cost machine was that it performed quite well, but could not print a document consisting of a set of labels (though a separate printer from the same manufacturer could). It also ate ink cartridges in large quantities and used a cartridge type that was not easily obtainable. The scanner portion, by contrast, was excellent. I wouldn't hold all this against all models, but it would make me think twice about buying one again unless I had a chance to try it out over a period.

Digital camera

The digital camera, Figure 8.4, is a more recent item that is now packaged with many makes of computer, often at a considerable discount.

Figure 8.4 A front and back view of a typical modern digital camera, the Fuji 2400 Zoom (courtesy of Fuji Corp.)

The principle is to use a light-sensitive matrix such as is incorporated in camcorders, but with software that will read the information and compress it into a file. This file of information can then be stored in the camera, using a memory card.

Connecting the camera by way of the USB port to the PC allows you to download the image files from the camera to a graphics editor on the PC, so that you can edit the pictures and then print them using a colour inkjet printer. A printer of good quality is essential, and for the best results, coated paper should be used. Prices of suitable printers and paper have dropped at the time of writing, but you have to shop around as you would for ink cartridges.

MODERN DIGITAL CAMERAS

The first generation of digital cameras worked at maximum resolutions of 640 × 480, a total of 307 200 pixels, and most of them used the serial COM port for transferring their files to the hard drive of the PC. Even at this comparatively low resolution and with JPG compression, the downloading of a set of image files to the PC's hard drive was a fairly lengthy operation, and when the modern *megapixel* (more than 1 000 000 pixels) cameras arrived, the need for faster downloading became imperative.

- Note that resolution isn't everything. Certainly the use of a camera with less than one megapixel of resolution will not be satisfactory if you want to make A4 sized prints on glossy paper, but now that cameras are being sold on the basis of having ever-increasing resolution it's time to remember that these very high resolutions are of more interest to people printing posters than those who simply want a good looking 7 × 5 print with an occasional A4 enlargement.

What is much more important is the amount of *compression* that is used. Compression is needed to make files that will fit into the comparatively small command of memory that is available for a camera. There are basically two types of compression for images. Non-lossy compression provides a compressed file that can be extended without any loss of the original data, you get back exactly the original file. Lossy compression, by contrast removes bits of the file that are least likely to be noticed, so that when you recover data from a file compressed in this way you do not recover all that you originally had.

Non-lossy compression is very unlikely to provide a small enough file for digital camera storage purposes, so that the lossy type of compression, such as the JPEG type, is always used. The greater the amount of compression that you use, the smaller the file but the down side is that there will be more of the image lost. This is not necessarily very noticeable on some images, it amounts to a loss of fine shades of colour and of some very fine detail. If, however, you intend to make large prints of your photographs then a very compressed image will provide a noticeably inferior picture. The effect of lossy compression is also very noticeable if you edit and save a file a few times, because some more information is lost each time you do this. If you have a valuable image that you might want to work on, convert the JPG file from the camera into a TIF file, using graphics software, and keep it in TIF format until you have completed editing work.

A few cameras allow you to store the raw pixel image file, or one that has been subjected to non-lossy conversion, but on the amount of memory that is supplied as standard this allows for only a few shots, possibly as few as two or three. At the other end of the scale, most cameras will permit large compression factors (such as $\times 24$) to be used, and they label this degree of packing as *coarse*, with the minimum amount of packing (around $\times 4$ to $\times 6$) called *fine*. If you want to make good-looking enlarged images, it is much more important to use fine packing than to have a high resolution. Storing your images at a packing of $\times 4$ with a 2 megapixel camera is much better than storing at a normal packing of $\times 10$ on a 3 megapixel camera.

The down side is that you need more memory in your camera. Typically, a 2 megapixel camera will come with a memory of around 8 Mbyte, which permits 12 shots at a resolution of 1280×960. Expanding the memory to 32 Mbyte allows you to use a compression of only 1:4 at this resolution, giving 50 shots which, blown up to A4 size, will look as good as anything you can get from a conventional film camera of the same price. Given that conventional film processing is not always of the finest quality, you can generally look forward to producing better shots than you would get with film, certainly better than you could get from any compact film camera. Don't even think about parting with serious money for a 32 Mbyte memory, because you will find that prices quoted in computer magazines, at computer fairs, and on the Internet, are very much lower (typically by a factor of 3 to 4) than you can get in High Street shops. Even 128 Mbyte memory cards are now reasonably priced. Figure 8.5

shows a typical camera memory card of the SmartMedia type, but different manufacturers favour different memory systems, and you will find others such as CompactFlash (now used very extensively), Secure Digital cards, Xd Picture cards (now favoured by Olympus and Fuji), Memory Stick (Sony), and Microdrive (a miniature hard drive).

- At the time of writing, manufacturers that had used SmartMedia cards were switching to the xd Picture card type of memory.

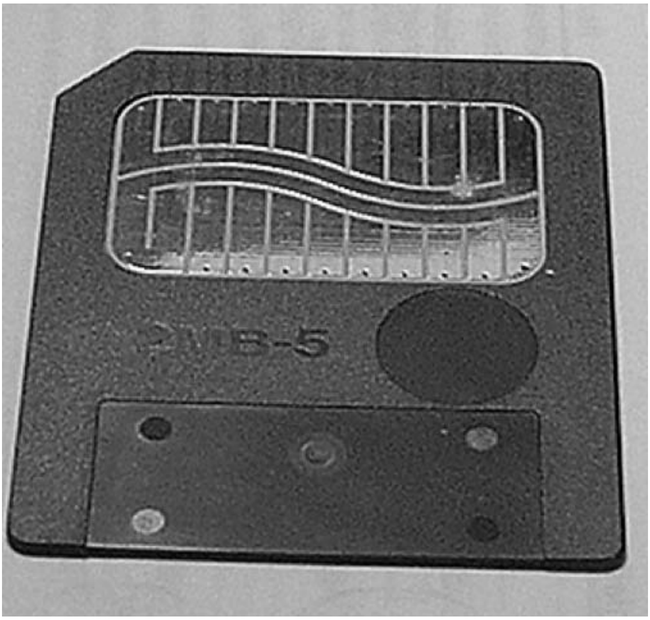

Figure 8.5 A typical SmartMedia memory card for a Fuji camera

The methods used to download these large image files, typically 640 Kb or more each shot, require fast transfer, and the most popular system now is to use a USB connection. This requires a special cable, supplied with the camera, and software. The software makes the computer treat the camera's memory as another drive, so that downloading consists simply of dragging the files from this new drive to another drive or folder on your hard drive.

- If you use Windows XP, you will find that Windows takes over, Figure 8.6, when you plug in the camera's data cable, allowing you to download the camera files and save them in your hard drive or print or edit as you wish, with a provision for deleting the files from the camera after downloading if you wish. If you are using Windows XP, do not install the downloading software that comes with the camera (in case of conflicts) unless you find that the Windows software is unsuitable for your camera.

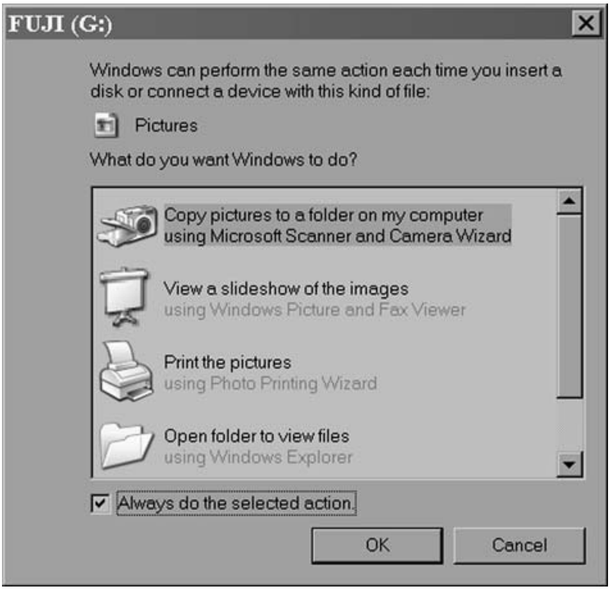

Figure 8.6 The Windows XP option menu that appears when a source of image data is plugged into a USB socket

This downloading is a very simple and reliable scheme, and I much prefer it to methods that require you to take the memory card out of the camera and place it into a reader connected to the parallel port or by a conventional USB link. This latter method can be fast, but it inevitably wears the contacts on the memory card, and eventually the contacts will become unreliable. This might take a long time, but I always prefer to plug in a memory card and leave it in place until I need a larger one.

There's another point that's not strictly related to computing but which needs to be known much more widely. Digital cameras obviously run using battery power, and the design is usually optimized to use the minimum of power for taking photographs. On older cameras that use a simple serial link, a considerable increase in supply power is needed for transferring images to the PC, and unless your digital camera uses rechargeable cells then I strongly recommend using a mains adapter to power the camera when you replay pictures to the PC. You can rely on such mains adapters costing about three times as much as you would pay for a mains supply from Maplin, but I would not like to take the risk of using a supply unit that was not approved by the camera manufacturer. Modern cameras that use a USB link can be powered from the link (unless it comes from an unpowered hub) and for many camera types you do not even need to switch on the camera.

If your camera uses standard alkaline cells, don't be tempted to use the new rechargeable alkaline types, because these simply cannot provide the amount of current that a digital camera requires for replaying signals, and in my experience they cannot even provide enough current to power the camera for taking photos. The cameras that permit the use of rechargeable cells will normally run on either nickel cadmium or (preferably) nickel hydride types, but it is more usual to have such cameras supplied with ordinary alkaline cells, leaving you to buy rechargeables and the recharging equipment for yourself.

When you buy a digital camera, you will normally find, in addition to any drivers that it needs, some editing equipment. If you are not particularly happy with the editing program that you get with the camera remember that you can use programs such as *Paint Shop Pro* (PSP) to edit and print your camera files. You do not need to make use of the digital camera downloading software within Paint Shop Pro unless you have one of the older cameras that makes use of the serial port. My own preference is to ignore any other software and make use of Paint Shop Pro because it is such a well-known and well-developed program that can perform all your editing tasks and also generate drawings for other types of illustration.

- That said, the software that came with my printer (Canon i560) is excellent, and I now use it rather than PSP unless substantial editing is needed.

The last part of work needed to produce a digital photograph is, of course, a suitable printer. You should use a printer that is stated as being suitable for photographic output, and you also need to use paper that will be suitable for your needs. You can use ordinary printing paper if you simply want to make a rough draft print to get an idea of what the final version will look like. For example you might want to make use of the PSP facility to print a page containing quite a large number of photos in thumbnail form so that you can decide which ones you want to print at higher quality. To make your final copies, you need good glossy paper, but this does not mean paying enormous high-street prices of the order of 50 pence or more per sheet. Shopping around should come up with packets of 50 A4 sheets for just under £10, for example, the glossy photo paper from CLP. The specification for this is 170 gsm (grams per square metre) and at the time of writing, a pack of 50 sheets is priced at £9.59 if you buy two packs. Take a look at the web site www.clp.co.uk for details of this and other offers on paper and other inkjet supplies. Look also at www.mouse2.co.uk for paper, memory cards, batteries, and accessories.

There is little point in paying a large sum for a camera with very high resolution unless you can print to the same standard, and you should note that the quoted resolution of an inkjet printer is usually applicable to monochrome printing only. For example, a printer that claims 700 or more dots per inch in mono may deliver only 300 dots per inch in colour. This will still produce pictures that look better in colour than in monochrome, because colour printing uses more ink tones, and very good results can be achieved from printers that use more than three colour heads.

Working with audio

Audio signals can be obtained from a radio tuner card, from an external tuner, from CDs, or from older types of recording systems such as vinyl LPs. You can also download music in compressed (MP3) format from the Internet, and there are several legal sources of such music and many illegal ones. The music industry, which makes colossal profits on CDs and DVDs is understandably relentless in trying to stamp out any means of acquiring music that approaches the actual value of the music on the disc. In particular, though CDs cost much less to produce than cassettes of the same music, every effort is made to maintain the price of CDs, and the same is applicable to DVDs (which cost much less to make than videos). In all that follows I shall assume that you are working legally with music that you have a right to copy (which pretty well excludes all commercially sold music). The main aim of using a computer for audio tracks is to convert analogue tracks from old LPs into digital format or to make new digital tracks on existing ones.

LP TO CD

Any LP collection by now must contain discs that are difficult to replace, because few LP stampings are now available. You might also have pre-LP recordings made on shellac and brittle as well as irreplaceable. Both of these types of recordings are analogue, which means that the pitch and volume of the sound is represented by the wavy track on the surface, something that cannot be reproduced perfectly other than by the master disc that was originally used to make the recording. Recording from these discs on to tape is a useful backup, but the quality of any copy made in this way can never be perfect, though with good equipment it can be almost indistinguishable from the original disc. You cannot, however, improve in any way on the disc contents, and that means that any scratches, crackles and pops in the replayed sound are faithfully reproduced, as are the other defects of hiss and rumble. If you have old recordings on tape you might also want to transcribe them to CD, particularly now that tape players on cars are becoming an endangered species.

That's where the computer comes in. You can connect an analogue disc player (or cassette player or radio tuner) to the input of a computer sound card, and so convert the sound into a digital file, one that can be recorded on CD. That, incidentally, is not simply a matter of copying the file to a CD. The quality of the conversion (called A to D) will determine how good the digital copy is, and if you are concerned with the highest possible quality you will need to spend as much on a suitable sound card as most of us spend on a complete computer. Most of us will settle, however, for a reasonable quality that sounds as far as we can tell as good as the original, and unless your sound card is a particularly poor one it will probably serve the purpose.

Be prepared for a fairly large file, amounting to about 10 Mbyte per minute of recorded sound. This assumes that you are converting the analogue sound into CD standard digital, because there would be little point in making the conversion unless you wanted to be able to burn the files to a CD and play the resulting disc on any CD player. You can, however, convert CD-quality files to compressed MP3 if you have a suitable player, and we'll look at that option later.

You need very little in the way of software if you want simply to transcribe the sound files, because whatever software you use for CD burning will usually have an option for creating CDs from audio files. The audio files that result from converting analogue sound into digital format are usually in the *.WAV format, and the CD burning program will convert these into the Trackxx.CDA format that is used on a CD. You can also burn your WAV files to a DVD if you have a really large number to save, but they cannot be replayed on a conventional CD player, only on a DVD player or through the DVD drive on your computer.

SOUND EDITING

Unless you have unusually unblemished vinyl discs or tapes, you are more likely to want to do some editing on your sound files before you burn the result to CDs or DVDs. At one time, the software that came with a sound card would include a wave editor that would display the sound as a wave shape, allowing you to identify the snap crackle and pop of a poor record surface as a sudden peak on the wave shape which could be selected and deleted. This was always a long arduous business, and modern software has considerably automated the task of finding and correcting such faults. Such software can be very expensive, but unless your needs are unusually stringent (in which case you are probably aware of all the software available) you can deal with all these requirements very satisfactorily with Pinnacle Clean-4 (formerly Steinberg Clean) which retails for around $50, including CD burner software.

Since practice with all the facilities that a wave editor offers is essential before you can make serious use of it, why not try a simpler freeware program first? Wavepad is a 350 Kbyte download from:

www.download.com

as the compressed file wp.zip. As usual, this should be placed in a folder of its own for unzipping and installing the Wavepad program.

When the program wavepad.exe runs you will see a screen that is mainly blank (for displaying a waveform) along with a set of menus. You can work with files of WAV, MP3 GSM or VDX formats (or directly from a CD), and you can cut or copy and paste sound selections in much the same way as these actions work on a word processor. You can also add effects, particularly noise reduction but also echo, silences, automatic gain control (reducing the volume of over-loud passages) and dynamic range compression (reducing the range between the softest and the loudest sounds), plus many other effects.

Editing begins with loading in the audio data, and this can take some considerable time for large MP3 files because these have to be expanded before they can be edited. A short WAV extract that plays for five minutes or so will load in a few seconds. Once a file has loaded, it is displayed on the main screen of Wavepad (Figure 8.7) and you can then make use of all the editing facilities of Wavepad.

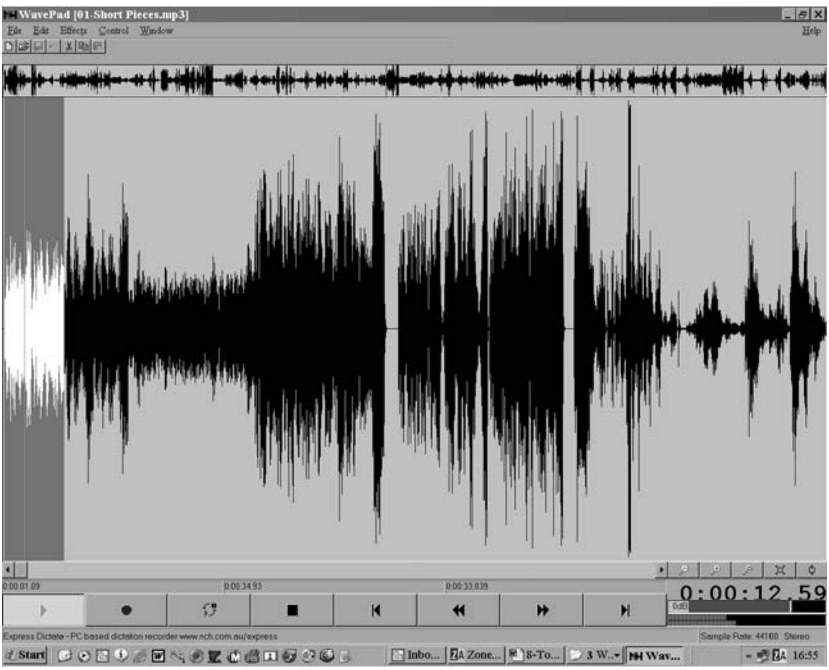

Figure 8.7 Showing Wavepad in action on an audio file

The illustration shows part of a waveform, with a piece at the left-hand side selected. All of a file or a selection can be played, allowing you to identify parts that you might want to work on in more detail. One action that is often needed is to trim the start or end of a piece to remove a long silence (because you did not start or stop the analogue source in time), and this is easily done using the *Edit* commands of *Trim Start*, *Trim End* or *Autotrim*. Other actions in the *Effects* menu operate on selected portions of the waveform (you can select all for a short piece, or for a longer piece if you have the time). One notable action is that you can speed up or slow down a piece of music without affecting the sound pitch (unlike altering the speed of a tape replay), though you may not necessarily like the results unless the percentage speed change is fairly small.

Wave editing is not a fast action even in a fast computer, so do not expect to wade through several dozen LP transcriptions in an hour or so – it's more realistic to allocate weeks of time if you want to make a good job of it all, no matter what software you are using.

CD COMPILATION

One common application for audio editing is to make a compilation, so that from a dozen or more CDs that you possess you gather a number of items that you particularly like and place them on one CD (often to play in the car or on a portable player). Strictly speaking, this is illegal copying, but you have, after all, bought the CDs originally and all you want to do is to listen to the individual tracks without the inconvenience of carting all the CDs around. This type of action does not require a wave editor, and most of the CD burning programs will cater for making a compilation of this type.

MP3 DISCS

MP3 discs make use of the redundancy in music data to compress digital music files by a factor of about eleven times, so that a CD can hold around eleven hours of music. This makes devices like CD autochangers redundant, and we are slowly seeing this penetrate to the car radio/CD player which are now featuring MP3 replay (I would settle for a cassette player if I could not have MP3 capability on a CD player).

Once again, this action does not need a wave editor (unless you want to make alterations), but few CD burners have MP3 conversion capabilities. One exception is the Ulead DVD MovieFactory software, mentioned later in this chapter.

There are, however, several freeware conversion programs (called CD rippers) that will read CD audio tracks and convert to MP3. One well-known program is Freerip from mgshareware.com which is a 1.19 Mbyte file in its downloaded form. Once you have converted the CD files from their native CDA format to MP3 format, you can use a CD burner to place them on to a CD. You need to choose your CD burner software with care, however, because some will convert the MP3 files back to CDA before burning, so that only a few of your MP3 tracks will be recorded. Once again, the Ulead software offers this option, as also do some others, but the 'big-name' CD burning programs will usually convert MP3 to CDA.

USB and Firewire peripherals

The adoption of the USB standard for all modern computers has allowed a great variety of add-on equipment which at one time would have required either a SCSI connection or the use of the parallel port. At one time, I used to build my computers with three parallel ports so that I did not have to share the printer port with other equipment. I still prefer to use the mouse and keyboard with the PS/2 connectors, but USB is preferred for all other connections such as my scanner and digital camera. The only snag with the original USB-1.1 ports is that they are not quite fast enough for the most exacting requirements, and

Figure 8.8 An external drive box, showing the Firewire ports and power socket

in this respect the adoption of USB-2 solves even these problems. Many modern machines offer 4–6 USB ports and also 2 Firewire ports.

One particularly useful way of expanding your computer is by adding a hard drive externally, using the USB or Firewire connection, Figure 8.8. The drive box itself costs around £50, and the only difficulty is finding a supplier, because these do not appear to be items that are stocked by many. Try RL Supplies (01923 896996), Micro Direct (www.microdirect.co.uk), Eclipse (www.eclipse computers.com or 08707 456000) or AUT (www.autdirect.co.uk) or you can enquire on the Internet for anyone who has these parts. External drive boxes for either 3½-inch or 2½-inch drives are available, and for the home constructor of a normal PC you would want the 3½-inch type. You may need to wait for several weeks for delivery of some models. Details of installation and use of these drive boxes are dealt with in Chapter 9.

The drive box contains a power supply, and has to be plugged into the mains as well as to the USB cable to the computer. You can then put any normal hard drive, CD-ROM or RW drive, or DVD writing drive into the box. If the hard drive is one that is already formatted and full of files, you can use it right away as if it were a drive that is part of your system. A drive letter is allocated when you switch on the external drive, and the new drive will appear in the Windows Explorer display. You can also put in a new unformatted drive and format this and use it as you wish.

One obvious application of this is that you can expand your hard disk provision considerably, though you need to remember that a hard drive used across an ordinary USB-1.1 link will not provide the speed that you would get from an IDE drive. This points to the use of such an external drive for backup, or for storing data that you can temporarily transfer to an internal drive when you need to have rapid access. Firewire and USB-2 links are considerably faster.

Another application is to upgrading your PC. One of the most painful parts of upgrading occurs when you need to replace your C: drive with a larger unit. This normally requires you to take out your old drive, and connect in a new one, partition it and format it, then install Windows and all your programs on it. This is very time-consuming, and if, like me, you tend to upgrade your computer very frequently, you might consider the use of a utility called *Drive Image* from PowerQuest software. This allows you to copy files from one disk to another so that the files on the new disk are arranged exactly as they are on the source disk. By contrast a normal copy simply takes the files and copies on with no regard to the exact position of any file on the disk.

- The snag here is that you cannot be certain until you try it that the transfer will work across to the external drive. One such drive I tried barred such copying, anther one permitted it.

If you have a new formatted drive on your external USB system, you can use drive image to transfer everything from your existing C: drive. Now when you remove the old C: drive and install the new drive that was previously in the USB housing, you will find that you can boot from this drive and use all the programs that have been transferred to it without the need for reinstallation. If you also like to alter the partitioning on the hard drives that you use, there is another product called Partition Magic, also from PowerQuest, that allows you to alter partitioning without losing data.

Obviously an external drive housing allows you to use anything that can be plugged into the standard IDE connector, and this includes CD-ROM drives and even CD-R/RW drives. Some caution is needed here, because the ordinary USB 1.1 connection may not be fast enough for some purposes, and there is always a risk of losing a CD-R because you are not supplying data fast enough. You should always check with the manufacturer of an external drive housing that it can be used for this type of equipment. At the time of writing, several manufacturers provide external CD rewriter and/or DVD writing drives that can be connected by USB-2 or Firewire.

Expanding IDE

An alternative to the use of an externally connected drive is an IDE expansion card. These are by no means expensive, and they allow you to connect several more hard drives into a system providing that you have the bays in which to fasten them. RL Supplies (01923 896996) offer the PCI UDMA-100 IDE controller cards at a price of only £19 plus VAT. One of these controllers allows you to add up to 4 additional EIDE devices which can be hard drives, zip drives, CD-RW, or DVD. At a slightly higher price you can buy a controller card that offers RAID facilities so that your data can be duplicated in such a way that the failure of one hard drive will not cause the loss of any data. The RAID facility is an added complication that may not appeal to the home computer user but which is very useful if your computer is used for business purposes. The same firm, incidentally, offers a large range of other interface cards for such purposes as Firewire, USB expansion, or audio/video capture.

Networking

Networking within your own home can offer a use for a retired computer or a way of checking what the kids are doing on their machine(s). This applies particularly to a spare machine with a reasonable amount of hard drive space. The scheme is to connect the spare computer to the main computer in a simple network. You can arrange things so that you have access to all the drives of the spare computer from the main machine, and you can, but only if you want, have access to the drives of the main computer from the spare computer. Though the spare computer can be kept in another room, it is easier to use this system if both machines are close to each other, because both must be switched on to make use of the file-sharing actions.

This can be a very useful way of backing up files from the main computer, storing files that are not immediately required, and of providing facilities that you need only occasionally on the main computer. Remember that the spare computer need only be switched on when it is needed, and with its intermittent use the hard drive will have a long life.

- Note that this also allows a printer to be shared, or for one machine to use either its own local printer or a printer that is connected to the other machine.

Obviously, anything like this requires both hardware and software, and the software for some types of networking is already incorporated into the later versions of Windows (95 onwards). The hardware can, at the simplest, consist only of a cable connecting the two computers. If you are content with a leisurely rate of data transfer, or for transfer over a distance of more than a metre or so, you can use a serial cable. For much faster transfer you can use a parallel cable, but this introduces a few complications. One is that the parallel cable is not the same as is used for a printer, but is differently connected, and with the same type of D-shaped plug at each end – a printer cable has a 25-pin D-plug at one end and a Centronics flat-connection plug at the other. The other point is that this system ties up the parallel port in each computer. If the spare computer is not connected to a printer, then this is of little consequence since there will be a parallel port free. On the main computer, however, which will be connected to a printer, a second parallel port is desirable. A third option is to use a special form of USB cable, but this is useful only if both computers have USB ports, and an older machine might not. Now that so many motherboards are being supplied with Ethernet sockets, this method of networking is no longer a luxury, and it can be considerably simpler than others. If you connect to broadband using a router with spare Ethernet connections you already have the capability of using this standardized and well-tried system if both (or all) computers have Ethernet ports.

If the two computers you want to link are not in the same room, and you do not feel inclined to work with long runs of cable (which can present difficulties), the options are to link through the telephone lines, through the power cables, or by short-range radio links. Using the telephone lines ties up two telephone points, and the ordinary telephone services cannot be used at the same time. Connection through the power lines is comparatively easy, but needs interfaces that are to approved standards – do not assume that a connector that is licensed to be used in the USA (at 115 volts) is suitable for use in the UK (at 240 volts). Suitable hardware is not easy to come by in the UK.

The most appropriate type of radio link for short distances is Bluetooth, but the longer-range WiFi (802.11 g) system is more heavily advertised and stocked by suppliers. Currently, Bluetooth is used mainly to link peripherals to a computer rather than for any form of networking and though Bluetooth and WiFi use the same frequency bands they are not compatible. There can also be compatibility problems with different versions of WiFi, and also of interference from other users and from the use of cordless digital phones (DECT standard) which use the same frequency band.

- Radio networking is a rapidly developing technology at the time of writing, and new schemes are announced almost monthly. It's only too easy to get locked into something that will become obsolete in a year's time, so I advise caution, particularly if your networking needs can be met by other methods.

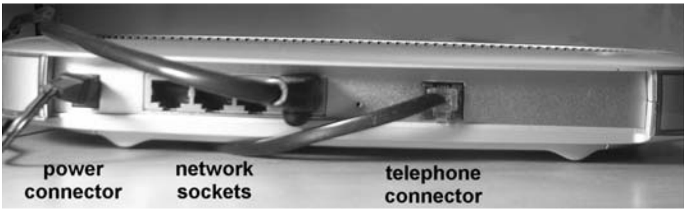

Figure 8.9 The rear of a Netgear router, showing connectors

If you need to buy networking cards for these methods of connecting computers you should seek assistance from a computer store that you trust. Once the hardware connections are made and both computers switched on, the Home Networking wizard of Windows *Me* or XP will set up the network for you. You do not need to have Windows *Me* or XP working on both computers, only the one that is designated as the server. The other computer, however, must be running Windows 95 or later.

If you are interested in both networking and broadband Internet access, the answer is to use a router (such as one of the excellent Netgear models) that allows a number of computers to be networked together through the Ethernet 10/100 system, Figure 8.9. This is attractive now that so many motherboards come with the Ethernet hardware and firmware built in.

Chapter 9

Working with video

Analogue and digital

Video, as far as the computer builder is concerned, means signals from broadcast TV, from video recorders, or from video cameras (*camcorders*). Many of these sources are currently *analogue*, meaning that the variations (amplitude and phase) of the electrical signal carry all the information on brightness and colour of each part of a picture. The disadvantage of any analogue system like this is that any form of interference that can change the amplitude or phase of the signal will cause distortion of the picture information. Interference, in this sense can mean interfering signals, such as can be caused by lightning or the action of electrical switches, or it can mean degradation of the signal caused by travelling through a long cable or through space.

By contrast, digital video, which has for a considerable time been used in TV studios and is now broadcast also, is almost immune from interference effects. Each part of a picture is represented by a set of numbers, and there are software routines that can check the validity of these numbers to ensure that the error rate is very low. Digital signals are now being transmitted, both for TV and radio, and digital camcorders are also available so that by the time this book is in print the need for any conversion from the older analogue system to digital will be less pressing, since the older analogue type of camcorder is now rapidly becoming obsolete. The main application now for analogue to digital video conversion is for making DVD copies of VCR recordings and for making DVD or VCD copies of analogue camcorder tapes that you still have (along with the old camcorder).

- For my money, if you have a number of old VCR tapes that you want to copy into digital format, the best way is to buy a DVD recorder to work alongside your TV, replacing the old VCR. This is not a cheap option, but it's much easier to use, and even provides a rough editing facility (to cut out unwanted scenes) for which the computer would need costly software. If you are thinking of replacing a VCR, consider a DVD recorder now that prices are rapidly dropping.
- At present, set-top boxes for Freeview digital TV have no output of digital signals, so that to save them in digital form means that you have to convert the analogue signals from the box back into digital, with inevitable loss of resolution. This might be a permanent situation, designed to ensure that you cannot make broadcast-grade copies of TV programs.

FRAME STRUCTURE

This is not a book on television techniques, and if you want to learn more about these topics you will need to consult more specialized works. There are, however, a few points that you need to know about the structure of TV pictures before you can fully understand their problems that arise when you work with video signals in your computer. You also need to know these points in order to be able to make intelligent choices of hardware and software. The most important of these points concerns frames and frame structure.

At present, a transmitted TV picture consists of a set of lines, and the variation of brightness and colour of each point in the lines makes up the picture. One complete set of lines is termed a *frame*, and in a moving picture there are differences from one frame to the next. In the European systems, the frames are repeated at the rate of 25 per second, but in the US system repetition rate is higher, 30 frames per second. This is just one of the reasons why US video tapes cannot normally be played on British machines.

When the modern system of TV transmission was being devised in the 1930s, it was important to have the picture information repeated at a fairly high rate, 50 sets of lines per second in the UK system. Unfortunately, it was not possible to transmit 50 complete frames per second (because of bandwidth considerations) and a system called *interlace* was introduced. For an interlaced picture, half of the lines of one frame are sent in 1/50th of the second and the other half are sent in the next 1/50th of the second so that the full frame takes up one 25th of a second. These half-frame units are called *fields*.

Interlacing is less relevant to digital pictures, and is not used at all on modern computer monitors because these are connected by cable and there is no problem of bandwidth as is found on transmitted pictures. The concept of a frame, however, as one complete picture unit, is important in all forms of video work, digital or analogue.

By using the frame as a unit, digital editors can allow perfect slow motion and still picture extraction, and also the ability to make a movie image out on a set of stills. In addition, the idea of a frame also provides for the enormous amount of data compression that can be employed on a digital picture.

For example, a conventional analogue TV transmission of a still picture means that all the information of the picture is being transmitted 25 times per second, taking up a considerable amount of bandwidth. For the duration of that still picture, all the information apart from that of the first frame is redundant. The digital equivalents would therefore transmit the frame information, hold it in memory and use it for as long as the picture remains unchanging.

Even when the picture changes, the change is not necessarily very large. For example, a person may walk across a landscape scene so that the landscape background remains unchanged and only the image of the person is shifted from one frame to the next. Once again, an analogue system would have to transmit all the information, redundant or otherwise, but the digital system can hold the unchanging background information and concentrate on sending only as much as changes from one frame to the next.

All digital video then, makes use of compression techniques that remove redundancy and also remove features that are almost unnoticeable. The removal of some parts of the picture means that this type of compression is lossy, even if the loss is not particularly noticeable. It is only by using lossy compression that we can achieve the low bandwidth that is now used for digital TV. The downside of lossy compression is that any editing action will repeat the losses. To edit a video picture, you have to undo the compression to work on the picture elements, and when you recompress it you will lose still more of the picture. After several edits, the degradation in the picture may be noticeable. This is one of the problems of working with digital video, and its effects are that very large files may be needed if you want to carry out editing on uncompressed files. You need to be aware that the consumer versions of Windows such as Windows *Me* and Windows XP Home, impose a limit of two gigabytes on file sizes, though the versions such as Windows NT, Windows 2000, and Windows XP will permit much larger files if you opt to use the NTFS file system in place of the older FAT system.

COLOUR

Until about 1952 television was available only in monochrome, black and white. Experiments with colour transmission had been tried on several occasions, but bitter experience convinced everyone that a colour system would be useless unless it was completely compatible with the black and white system. All broadcast colour systems therefore use a set of colour signals that are transmitted alongside the signals for the black and white image, and which add colour to that image. This does not add as much bandwidth as might be expected because colour is not visible in fine detail and so only patches of colour information need to be sent.

The original US system, NTSC named after the National Television Standards Committee, sends colour signals using a system that alters the amplitude and the phase of a radio signal, the subcarrier. This system originally had many problems caused by alterations in the subcarrier when the signal was reflected, and this gave rise to the nickname *never twice the same colour*. The system has been greatly improved since the early days but still relies on the same principles.

The early problems of the NTSC system led European nations to consider other possibilities, and the two solutions both involved sending one set of colour signals on even numbered fields and another set on the odd number fields, so that the colour information for one frame was the average of the colour information for the two fields of an interlaced picture. This reduced the vertical resolution of the colour picture, but since fine detail is not visible in colour, this made little difference to the perceived picture which still had the same fine detail in monochrome. The two European systems are the German PAL and the French SECAM. These differ in the way that the signals are transmitted and the PAL system is used in Britain and over most of Europe, with SECAM used in France, French colonies, and the former Soviet Union.

- These differences between European and US colour standards are another reason why video cassettes are not interchangeable between the two countries. Some video recorders and TV receivers however can display NTSC videos on a receiver that is primarily intended for PAL reception. You have to be careful when you use analogue to digital video converters that you have set the software for the correct video system, which is always PAL in the UK.

Analogue sources

Analogue sources of video signals include the analogue camcorder, VHS recorder, or live analogue TV. The most likely reason that you will have for working with digital video signals is the use of an analogue camcorder, and that is what we shall concentrate on in this book. You should, however, remember that these other sources can be treated in the same way.

If you have an analogue camcorder, it is likely that you have a store of tape cassettes of your treasured moving images. Some users transfer these files to VHS tape and reuse the camcorder cassettes, but this is not the best way to treat them because:

1. you get the best image quality only on a fresh camcorder tape,
2. each replay contributes to wearing out the camcorder mechanism,
3. the transfer from camcorder tape to VHS invariably causes a degradation of the image, even if you are using an S-VHS camcorder and a good VHS recorder,
4. each time you play a VHS tape, the image quality will deteriorate. This might not be noticeable on a movie that you look at once a year (why then bother to buy it?) but it will gradually affect home movies that you show frequently,

5. making another copy means repeating the painful business of linking the camera to the VHS recorder, setting up the recorder, and then controlling both until all the video has been copied.

There is another option, to digitize the moving images and store them on your hard drive or on a CD. The latter option also allows for making VCDs, video CDs, that can be played either on your computer or through a DVD player on your main TV. We'll deal with VCDs later. Like a CD, a VCD can be copied digitally, making a perfect copy with no need to make electrical connections. Another option is to record on DVD, but much of the currently-available software is not yet well geared up to the use of DVD recording drives at the time of writing. One exception I know is the Ulead DVD MovieFactory-3 editing software.

It would be great if such digitized images were of really high quality, like DVD images, but that's not possible, because DVDs are not made from VHS or camcorder videotape but from professional video tape or from film. The VHS process greatly reduces the resolution of a TV image, and the circuits that deliver the video information to a home TV receiver are also far from perfect, so that what appears on the screen from DVD can be noticeably sharper than anything you can get either from transmitted pictures or those from VHS videotape. The nearest you can get to such high quality is to make movies with an S-VHS camera and playback direct from the camera to the TV receiver (not on to VHS tape), or to use a digital camcorder with either direct playback, or storage on VCD or DVD.

Now that some DVD recorders are reasonably inexpensive (around £200 at the time of writing), using the computer to make digitized recordings is less attractive, particularly if your VCR is elderly and you were thinking of replacing it anyway. Using a capture card and editing software in your computer is, in my experience, a hassle, and though your discs may play well in Windows Media Player, there is no guarantee that they will look so good in a DVD player connected to a TV receiver. Some DVD players will not play VCDs and some DVD recorders, though they state they can play VCDs, do not cope well with them.

We'll look briefly at the use of digital camcorders later, but for now we'll concentrate on getting the best out of that stack of old analogue camcorder tapes without the need to load one into the camera and wire up to the TV each time you want to see one of the old tapes. In addition, the editing processes are much the same as they would be for editing digital camcorder video to DVD.

There are three steps in transferring video signals from an analogue camcorder or a VCR to VCDs. These are:

1. digitizing the video signals, usually to AVI (Audio-video interlace) files,
2. editing and conversion to MPEG-1 files,
3. 'burning' these MPEG-1 files to a blank CD-R in the format needed for DVD replay.

- Some hardware video capture cards allow you to carry out the first two steps together, producing MPEG-1 files directly from the camcorder input. This requires very fast processing, and such cards are expensive. I'll assume that if you had that much spare cash you would already have gone to a digital camcorder, and, like me, you have a stack of analogue tapes at hand and you want to keep the cost of conversion down. After all, if you invest in an expensive capture card, you'll have to replace it later with one for digital camcorder input when eventually you change to a digital camcorder.

The first part of the solution is to install a TV capture card. There are several models available, and they are nearly all suitable for the task of downloading video signals from a camcorder, digitizing the signals, and storing as a file. Some cards specialize in capture only, and a few of this type, as noted above, will store the digitized file with MPEG compression, so that it takes up minimal space on your hard drive (amounting to only about 10 Mb per minute of film running time). Others will digitize the signals and store either the raw digital video in AVI format (at up to 430 Mb per minute), or you can opt for some compression system such as Indeo 5 to reduce the size of files. Do not assume, however, that you will be able to use compression on the files as the images are captured – more of that later.

A typical low-cost interface card is the Hauppauge (pronounced hop-hog) WinTV Go! Card, Figure 9.1. This caters for video input or a TV signal from an aerial so that you can view and record TV programmes directly. I have used only the video input portion, and have tried both the supplied software and others, noted later.

Some care is needed regarding your computer resources. If you store raw video, you can be sure that the quality will be maintained throughout any editing actions, but the amount of hard drive space is discouraging, about 25 Gbyte for a one-hour film, and this does not allow for

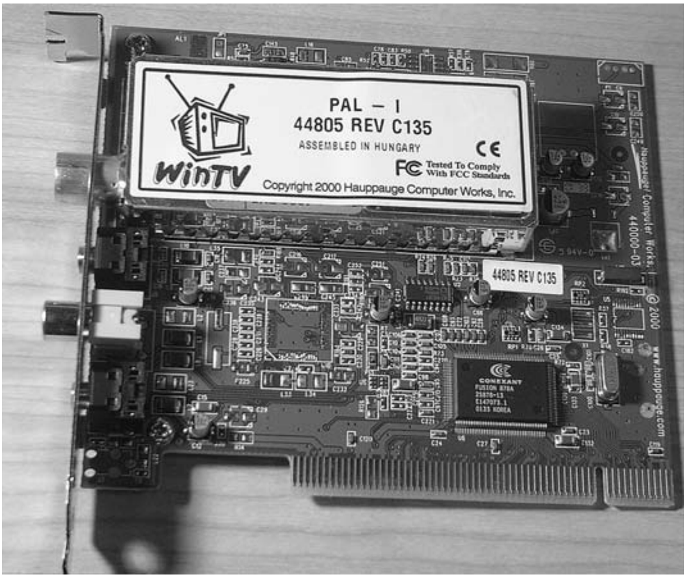

Figure 9.1 A low-cost Hauppauge video/TV input card

the creation of a temporary file while you are editing. Furthermore, Windows does not permit such large files unless you use XP with the option for the NTFS file system, and the limit for the older FAT filing system is 2 Gbyte (less for older versions of Windows).

The way that video capture software gets around this is to split a long video into segments that are each of 2 Gbyte or less, but for your home movies it's most unlikely that you'll want to get into such complications – most of your efforts will consist of fairly short clips (and you might want to edit a lot of longer ones down to a more manageable size). You should also be using a computer with a fairly large memory and a fast processing speed. Once you have edited each short clip and converted to the compressed mpg format, the clips can be combined into a movie that will play for a longer time.

One point that does make a considerable difference as far as video processing is concerned is the use of separate hard drives, one containing your Windows files and other programs, and another used only for the digital file data (though you can keep other data such as text files and still picture files on it as well). The important point is to separate the program material from the streaming video material. If you have only one hard drive this should be configured to a maximum possible working speed, and divided into two partitions, one of which is used for your video files but not for any program files. An ideal specification for hard drives is a rotational speed of 7200 rpm and the use of at least ATA-100 data transfer system with DMA.

Another option that software for capture cards will offer is compressed image files, either at the point of capture or later during editing. This is not usually MPEG compression, and the most common type that you will find offered is Intel's Indeo system. This is very effective in reducing file size, but it needs to be used with care, because too much compression can make motion look very jerky. This is not a feature of the compression system, it simply means that your computer is not up to carrying out the compression in the time available between frames of video information. If you capture using VirtualDub (see later), you can see the percentage figure for processor use on the screen, and if this is 100 per cent or close to 100 per cent, then you will have problems with jerky motion caused by frames being repeated to replace a frame that could not be captured in time. Time to upgrade your computer to a faster processing rate, perhaps.

Incidentally, if you are comparing image files looking for jerky motion, use a small image because uncompressed files can also look jerky if they are played full-screen (due to limitations on how fast the computer's graphics system will cope). Some software asks you to choose a quality setting on a 0 to 100 scale, but this is not the same as setting the compression, and you may find that a setting of 95 will still produce a lot of compression (more than 10 to 1).

Some software may offer compression systems that do not degrade the image, such as Brooktree YUV411. These certainly preserve quality, but the amount of compression is only twofold so that your files will need some 218 MB per minute of playing. The other Brooktree system, Brooktree ProSumer Video 32, gives a compression of about 7:1, but on my system produced problems with flickering colour bands between pictures. The Hauppage software options are for *File* and *Format*, and in the *File* menu you should set for *No Compression*. In the *Format* menu, as well as the 352 × 288 picture option you need for European PAL broadcasts (as distinct from US NTSC), you can specify the *BTYUV* option which gives the same 218 Mb as the Brooktree (abbreviated to BT) *YUV411* option, and the *YUV9* option works at around 170 Mb per minute.

- *Brooktree* refers to the makers of the chipset that many capture cards use.

Audio is another matter. The default is usually CD quality, but this is usually completely inappropriate for camcorder tape digitization. Most camcorders offer mono sound of about 11 kHz upper frequency limit, so that using 24 kHz, 16-bit sampling, and mono settings will be perfectly satisfactory (do not be tempted to save bandwidth by using 8-bit sampling for sound). If you are simply storing the files for replay on the PC you can compress the audio, but if you want to make VCDs that will play on a DVD player you **must not** use compressed audio. The reason is that you need to convert your video to MPEG files, and the MPEG compression system cannot work with an audio file that is already compressed (though it can work with a video file that is already compressed by a standard method like Indeo). There are utilities which will compress the audio parts of the file so that you can convert to MPEG.

- You are advised, when you come to edit digitized video, to separate the sound from the vision before you convert from AVI files into MPG files. This is not a simple way to work, but it can prevent problems that often arise on a VCD of intermittent image freezing and bursts of noise on the sound. You should check on the Internet for the advice for the software you are using.

Software for digitizing the video is not hard to come by. Even the cheapest interface cards will supply some form of capture software, often allowing you to capture video, stills, or separate audio. You will in any case need to load driver software for your interface card no matter what software you use to capture video. If you don't want to make use of the capture software that comes with the interface card there is a reasonable choice of other types. One obvious one is the Microsoft movie maker that is built into Windows *Me* and later. Another is an excellent shareware program called *VirtualDub* which allows editing of the resulting files and a huge variety of filter effects that can suppress noise, brighten the image, and many other effects.

Microsoft's *Movie Maker* is very impressive because, by recording separate video and sound files, it allows you to add a sound commentary to the existing sound, or to replace the existing sound. It also performs a very impressive degree of compression without causing the video to appear jerky when the picture moves. If you are making video files purely to replay on the computer then this system has a lot going for it, and it contains capture software that is of very good quality. The overwhelming snag of Version-1 is that the final system is not compatible with AVI or MPEG and though it is possible to convert from the Microsoft WMA type of file to MPEG, software for this purpose cannot be offered because of a veto imposed by Microsoft. Because the file format is not compatible with MPEG, you cannot record these files on to a CD and expect to be able to play them in a DVD player. For me that rules out the use of this otherwise useful program, but Version-2 is said to be much improved.

VirtualDub can be downloaded from the site:

http://www.virtualdub.org/index

The program installs into any modern version of Windows in the usual way, and you can run it from the desktop or from an icon on the toolbar as you choose. VirtualDub is an advanced editing program, but this does not require you to have to learn the more advanced methods simply to capture and work with video files.

When you launch VirtualDub the first screen you see is a simple one with a few menu items of *File, Edit, Video, Audio, Options, Tools* and *Help*. Figure 9.2 illustrates this (editing) screen with a video file being edited.

The file menu contains the item *Capture AVI*, and this is the one to click for capturing your video. When you do so a new menu appears containing the items of *File, Audio, Video, Capture,* and *Help*. You can capture the video simply by pressing the F7 key and starting the camcorder, and the capture stops when you press the Esc key. The audio menu allows you to specify audio compression and also the audio quality in terms of sampling rate and number of bits. For making VCD discs you will want to avoid audio compression, but you will wish to set sound playing and number of bits appropriate for the source of your sound. The video menu has a considerably larger number of options and the one that is of most interest is the compression set, which allows you to specify various types and extent of compression.

The *Format* item in the *Video* menu allows you to set the video dimensions, and for the PAL TV system used in the UK this should be 352×288. Once you have set the sound sampling rate and number of bits, video compression (if any) and the video format then you can

Figure 9.2 VirtualDub being used for editing

start experimenting with video capture. Since the purpose of this book is to show what can be done rather than to go into fine detail of using software, we'll leave it at that. Once you have captured some digital video, you can also use VirtualDub to edit it, cutting out unwanted portions, and using the filter options to correct picture faults. Much of this has to be learned by trial and error, and one of the useful things about video CDs is that you can burn the files on to CD-RW, try them out on a DVD player, then you erase and try other ideas. This lets you work on what can be a very steep learning curve at very little expense.

- Learning to make digital videos with CD-R discs is rather an expensive way of making coasters. This way, you can store the files on your hard disk, try them out on the CD-RW, and if they look okay you can burn on to CD-R. This way there is no waste.

We're leaping ahead of ourselves however. After you used the capture card what you have is a file that is still in the AVI format, taking up a large amount of space on your hard drive. You can still edit this file and you can, if you have enough space on the hard drive join one to another provided that you remain below the 2 Gbyte limit. A file in the AVI format can be played back in Windows media player, but not from a DVD drive, and to make a VCD that will played back on the DVD player, we need first to convert the AVI file into an MPEG file. Once again this is a job that needs software, and though there are some excellent commercial offerings, my personal preference is for a short, neat, and simple program called simply AVI2VCD. Starting this program brings up a simple panel that asks you to browse for the AVI file, and to provide the target file name and folder for the MPEG file. The conversion is not rapid, and you will have plenty of time to make and drink coffee before your MPEG file is finished. One oddity I have found is that the program tries to call up my modem, but if I close the dial-up networking panel then the conversion to MPEG goes ahead in a straightforward way.

- You are advised to separate the sound and the video into two files before conversion, and amalgamate them after. This is to avoid odd effects such as momentary freezing of vision or spluttering sound or loss of synchronization.

MPEG-1 EDITING

These processes of capturing analogue video are fairly straightforward, but you always have the awkwardness of working with very large AVI files. One way around this is to convert each file from AVI to MPEG just after capture, and then delete the AVI version. You can then use an MPEG editor to join files together, and to carry out other editing actions, notably actions such as making smooth dissolves and other transitional effects between scenes.

You can edit MPG files with the Womble MPEG Editor, which costs only $45 for MPEG-1 work (much more expensive for MPEG-2). You can download a sample version, which will carry out most of the actions other than saving an edited file from the web site:

http://www.womble.com

The advantage of this is that you are working with files that are smaller than the AVI files by a factor of about 45. This means that if you have converted, say, a large number of AVI files each lasting five minutes (and therefore each of a large size) into MPEG files, you can join them using the Womble editor into one large file that you can record as a

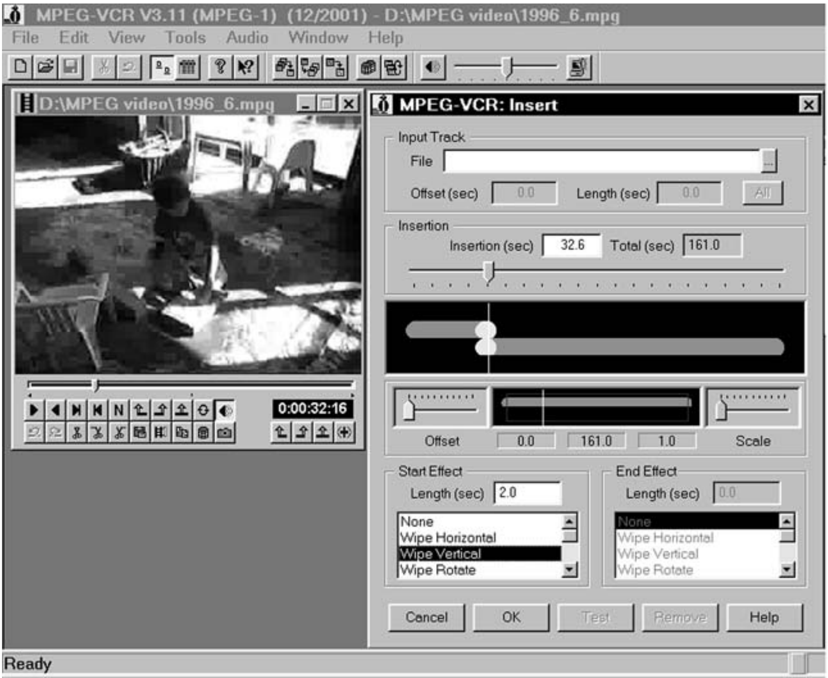

Figure 9.3 The Womble editor panel for transition effects

VCD. You can also use the Womble editor for editing sound, and you can insert a still picture into the video and hold it for as long as you like, an action that can be very useful for titling. The main glory of the Womble editor, however, is its ability to intercept transitions from one scene to another and there are effects selected by name as: *wipe horizontal, wipe vertical, wipe rotate, blend, zoom circle, keying title image, colour keying title image, beginning fade, ending fade*. Figure 9.3 illustrates the panel that provides these actions.

These are listed both as start and end effects, but the end effects are greyed out, and there is no indication on the Help pages how to use the set of end effects, nor how to use the *Offset* slider (which is inoperative). In this portion of Womble, a new file can be inserted anywhere in the video, allowing you to paste another portion at the end of an existing one and so make a longer piece of video. Finally, you can record the final effort in MPG format, and save it as a VCD.

VCD CREATION

Now you have a file that is very much smaller, about 650 Mbyte for a full hour of video. You can play this file using Windows media player, but the real aim is to put it on to VCD so that it will work on a DVD player. This obviously requires a CD writer drive, and one that has modern software. There is good software for CD writers available from Adaptec, and many CD writers now come with the excellent Nero software. I found a package called Click'N Burn from Starland of Plymouth and have found this very easy to use for all CD writing purposes, data, audio, or video, though I now use Ulead software.

The important point is that you simply cannot record the MPEG file directly onto the CD-R disc. This would not create a disc in the correct format that a DVD player will recognize, hence the need to have a special writing program. It's important to know also that you cannot make a multisession type of video CD in this way, but there's nothing wrong with burning a set of files in the order that you want to see them play, providing that it is all done in one session. In other words, you should save up your MPEG video files on the hard disk until you have enough to fill one VCD. It's so easy to select different files to play on the DVD machine that there should be no problem about mixing files with different topics.

- Incidentally, once you have recorded a VCD you can still replay your files on your PC, though not simply by clicking on the CD title. You have to use Windows Explorer to find the DAT portion of the recorded files and click on that to bring up media player and see the result.
- If you find that you can burn a perfectly good VCD on CD-RW, but that the same files on a CD-R give problems, the most likely cause is recording speed, because a CD burner will feed data faster to the CD-R than to CD-RW. The remedy is to set the burn speed for CD-R to the same as is used for CD-RW, usually around 12×, rather than at the full speed of the drive.

Digital camcorders

Digital camcorders are rapidly superseding the older analogue type, and one result of this has been to bring the prices of analogue camcorders down considerably. This might possibly encourage you to start your video experience with analogue, using conversion to VCD, rather than learn about video with an expensive digital camcorder. On the other hand you may decide that you would like to start video work right away with the digital camcorder, and another possibility is that you have had a considerable amount of experience with an analogue camcorder and you would like to change to digital. Prices for digital camcorders now start at around £200, which compares well with the price of an analogue camcorder plus the price of a digital video board (not needed for a digital camcorder).

Like an analogue camcorder, the digital camcorder records on tape, but instead of recording analogue images (signals whose electrical voltage carry information on intensity and colour), it records digital information in the form of a set of numbers that describes each portion of each picture frame. This digital information is not raw, it has been organized into frames and compressed and then stored on to the tape using the normal methods of video recording. The important point is that the output is already digital. A few models are now using a miniature DVD for recording.

The standard for a professional digital camcorder is a 720×480 image size, considerably more than the 352×288 that is used for analogue camcorders for the European PAL standard. The compression is not the MPEG type as used for transmitted pictures and for DVDs, and the system that is used aims for a constant processing rate of 3600 kilobytes per second. For 'average' pictures, this produces the same sized files as would be achieved by a compression of raw video files by a ratio of 5:1. The advantage of this system is that it allows file processing without the need to carry out expansion and recompression, so that when you copy digital video files from your camera to your hard drive there is no loss of data.

Many types of consumer digital camcorders use the Mini-DV standard. This format was first standardized in 1995 to provide more compression than was used for the professional system, hence the use of smaller tape formats and much smaller cameras. The image resolution is of the order of 500 lines and there is little discernible loss of quality when files are copied and edited. The alternative, pioneered by Sony, is a system called digital-8 which can make use of the older type of analogue Hi-8 video cassettes. Camcorders using digital-8 can also play back the analogue Hi-8 tapes that have been made on an older analogue camcorder but when the same tapes are used for digital recording they provide only two-thirds of the capacity as marked on the tape; in other words a 60 minute Hi-8 tape will provide only 40 minutes of digital recording. Note that some Sony camcorders will not play back analogue Hi-8 tapes even though they can use them for digital recording.

The downside of this is that you need to be able to transfer the information at the same high rate. When the first digital camcorders came onto the market, all that was available on a PC machine would be the serial port or the parallel port, neither of which was ideally suited for this type of data transfer. The Apple Mac, however, had a data transfer system called Firewire or iLink (more correctly IEEE 1394) which could cope with this data transfer rate. Firewire ports are now fitted on PC machines as standard, so that the digital editing of files from digital camcorders can now be carried out as easily on the PC as on the Mac.

For a machine that works under any version of Windows, the digital video from a Firewire link is stored in Microsoft's standard AVI type of file. There are, in fact two versions of the AVI file, type 1 stores all the digital video as one single stream of data, but type 2 separates the video and audio (sound) data. Most users will work with the type 1 file, but the second type is very similar to the Microsoft movie maker type of structure in which the sound can be edited separately from the video.

The original Microsoft specification for AVI files limited their size to a maximum of 4 Gbytes and the older consumer versions of Windows will not accept a file size greater than 2 Gbytes, which corresponds to about 9.5 min of digital video from a digital camcorder. The FAT32 file standard available from Windows 95 onwards will permit the use of up to 4 Gbyte files. The NTFS system in Windows NT and Windows 2000 allows files that are limited only by the size of hard disk or partition.

Once captured, files can be edited in the same way as has been mentioned earlier. These files can be recorded on CD, or on DVD if you have a DVD writing drive, see later in this chapter. Another option is to output the files through the Firewire connection to the camera so that the data is recorded back on tape. This is possible only if the Firewire ports in your camcorder will accept inputs as well as outputs. Because of French customs regulations, many camcorders sold in the UK have the Firewire output facility disabled, since this avoids the need to pay customs duty in France on a machine classed as a video recorder. This is yet another example of Euro-mess, and many enterprising owners of digital cameras have found sites on the Internet that show how this restriction can be avoided. It's quite likely that by the time you read this digital camcorders sold in the UK will no longer be bound by this ridiculous restriction.

Another point to look out for is the use of OHCI. This is the standard method for exchanging control signals by way of Firewire, so that the computer can control the tape actions (record, play, fast-wind) of the digital camera. If the camcorder supports this standard system and the computer software is suitable the camcorder can be regarded as another peripheral attached to the computer and controlled completely from it, just as a still camera can be connected as if it were another drive.

One warning is important. All of this technology is moving quite fast so that what seems an excellent and expensive system today may be a rather dull and outdated one tomorrow. At the time of writing, USB-2 was beginning to appear on systems with the aim of replacing Firewire, but the effect of this was being seen more on the use of external hard drives than on camcorders and it's likely we are some time away from seeing new digital camcorders with USB-2 rather than Firewire. As always, you should be guided by what your needs are, as distinct from wishes in the future. There is no way of making a design future-proof, but if you have not spent too much on equipment then you will leave some leeway for changes in the future.

WORKING WITH DVDs

The advent of comparatively low cost DVD recording drives, along with the DVD recorder that is the replacement of the old video cassette recorder for TV programmes, has made considerable differences to the way that we can now store data. The main formats for DVD recording, as far as the computer user is concerned, are the DVD+ and the DVD− types, and most of the currently-available drives allow you to use either type of media. The possession of a DVD recording drive opens the way to several uses of DVD that correspond to the ways that we have used CD-R in the past.

1. storage of digital data, permitting up to 4.7 GB to be stored on a single disc,
2. recording to a disc directly from a digital camcorder,
3. transfer of video data from VCD to DVD,
4. transfer of video data from DVD to VCD,

5. creation of slide-shows,
6. large-scale storage of music files using MP3.

When DVD recording drives first became available there was a shortage of good software, and it was normal to have to download or buy different applications software for different tasks. At the time of writing there is one reasonably-priced program that can carry out all these actions, and also acts as a DVD-burner so that you do not need separate software for saving your data, sound or movies to DVD or CD. This software is Ulead DVD Movie Factory-3, the standard version of which costs around £25, in my view the best £25 I have ever spent on software.

The use of a DVD recording drive for data means that you can in many cases save all of your data on one single backup disc. If your data is particularly valuable, you can make several backups that can be stored in different places so that even the disaster of a fire could ensure total safety of data. Any software designed for use with a DVD recording drive, including the software that is usually bundled with the drive, will allow you to save data files in this way and these can be read by any drive capable of dealing with the type of disc (DVD− or DVD+) that your recorder has used.

With digital camcorders now at prices that were formerly asked for the analogue type, it becomes increasingly important to be able to save digital data in a form that is easily replayed from a modern TV set up with a DVD player. Providing that your computer uses a fast processor, of the order of 2 GHz clock speed, and has FireWire ports provided, you can connect a digital camcorder to the computer and use suitable software to read the files into a buffer and then to the DVD. It is more likely, however, that you will wish to edit the role camera files, so that the use of a video editing program is a more likely intermediate step.

A video editing program is often bundled with a camcorder and sometimes also with a DVD recording drive. Some of these bundled programs are of very poor quality, and operations that you would imagine should be fairly simple, such as cutting out a piece of badly-shot material, can be remarkably awkward. Any good video editing program should be easy to use, instinctive in action, and permit all sorts of transitional effects (such as fading from one scene to another) without loss of sound synchronization. They should also cope well with recording the finished item to a DVD disc that will play in any DVD player or TV DVD recorder unit. The Ulead DVD Movie Factory-3 software copes with all these actions exceptionally well.

Transferring the video data from old VCD discs to modern DVD discs is not quite as simple as you might imagine. The files on a VCD are of the *.DAT format, and attempts to copy this are usually stopped with an error message reporting an MS-DOS fault. This is because of the file structure, and what is required is a program that will convert from the DVD format to the MPG type. There are several such programs, and one that is particularly useful is a piece of shareware called Isobuster. This can be downloaded (2.76 MB) from:

http://www.smart-projects.net/

With a VCD in the drive, you can start Isobuster and it will locate the VCD files which you can select for conversion to *.MPG format. In this format you can re-edit the files if necessary and then record on to DVD in the normal *.VOB format that is required for reading DVD discs.

- Some VCD discs that play reasonably well in a simple DVD player, appear very poor when played in a DVD recorder connected to a TV receiver. By carrying out the conversion from VCD to DVD, your video then becomes playable on any type of DVD system.

The opposite process, transfer of video from DVD to VCD, is not quite so commonly used, and should not be used as a method of pirating films on DVD. It makes use of software that can carry out additional compression on MPG files so that instead of requiring a full 4.7 GHz of storage space they can be reduced to around 700 MB, the capacity of a VCD. This compression, is, of course, carried out at the expense of quality so that the quality of the resulting film is roughly what you would expect from an analogue camcorder.

The creation of slideshows is an item that is offered by only a few applications, but it is a remarkably useful way of using a DVD to show a large number of images. If you have a set of scanned photographs or photographs taken using a digital camera, you can set them all into a slideshow format on a DVD disc so that when you insert the disc into a DVD player the images will appear one after another (with a time interval that you can determine when you create the disc) on a TV receiver. This is a 21st century version of the photo album with the difference that one disc can contain the equivalent of a very large number of photo albums and at a fraction of the weight if you discount the technology that is necessary to display it.

Finally you can use the DVD drive to record a huge number of music MP3 files on a single disc so that they can be replayed either through a TV receiver or through the computer as you wish. Once again, not all the DVD editing software permits this but if you have a large collection of music on MP3 it is well worth acquiring suitable software.

Part IV

Problems

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Chapter 10

Troubleshooting

We need to start here by explaining exactly what this chapter is about. There is no way that a book of this size could deal with all the problems that can arise on a computer. Because of the huge variety of hardware and software that can be put together, the possibilities for problems of incompatibility are almost endless. In addition, because some new item is available almost every day, any list of problems and solutions would be instantly out of date. The nearest we have to a problems database is the Microsoft Knowledge Base, relating to problems with Windows, and we will look at that later.

What I want to do in this chapter is to show methods of approaching problems by finding what sort of problem is involved and going to sources of information. A few problems are so general, so common, that we can mention them and their solutions in this chapter. Others are so unusual, so odd, that they can be solved only by reference to very specialized knowledge. It also entirely possible that you can have a problem that is unique to your set-up and which cannot be solved by anyone's existing knowledge, requiring a methodical approach to produce a set of suggestions, one of which might solve the problem.

Take a look now at how problems can be put into categories. The most obvious start is to use the categories *Hardware* and *Software*. These two are not so exclusive as you might think, because most hardware relies on software to work, but it's often possible to separate out problems that are surely those of hardware from those that are surely of software. We can take a further division on each of these by the categories *Installation* and *Use*. If any item, hardware or software, has been installed and has been used without problems for some time, then any problem that subsequently arises must be due to some change in either hardware or software. We can make yet another subdivision of the software section by classifying it as either *Windows* or *Applications*. The sense of this is that Windows is the largest piece of software that resides in a computer, and is the one that exerts control over other software and over the hardware, so that many of the problems that turn up on a computer are related to the Windows files which number many thousands. These divisions are summarized in Figure 10.1.

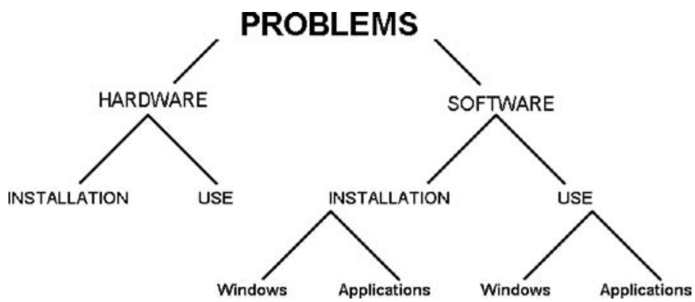

Figure 10.1 Classification of faults

We'll take a look now at how these categories of problems can affect you and how you would deal with them.

Hardware – installation

Hardware installation problems are of two types and the first type concerns problems of assembly of the machine itself, with the second type concerning the adding on of hardware items such as printers, scanners, monitors, and other devices. We'll start with the assembly of the machine itself.

Remember the point, made in Part I, that you should assemble only the bare minimum of a machine that you need to prove that it will work. This will consist of the casing and motherboard, with processor and memory and video card so that you will see from the monitor screen what is happening when you switch the machine on without any complications that might arise from problems with other cards (such as sound card, modem cards, digital video card, etc.). All that you need to attach to check out a computer is the monitor, keyboard and mouse.

The most common problem is that once the machine is assembled, nothing useful happens when you switch it on. One obvious point to check is the wiring to the power switch and, of course, that you have mains power applied to the connector at the back of the machine. Much less obvious is the seating of the memory strips, because unless these are making correct contact with their holder, the machine cannot make use of memory and therefore cannot start working. This is quite a common problem, because modern memory strips are of very tight fit in the holder and it's quite easy to assume that they are fitting perfectly when, in fact, one strip has popped slightly out of its holder at one side. If your computer is using only one strip then you have no memory and no possibility of using the machine. If you have two memory strips and one is not making contact then you'll find that you do not have as much memory reported as you expected even though the machine will work.

Failure to start at all is often the most alarming problem you encounter, and yet is probably the simplest to diagnose. The first action is to check every connection and every setting (if the motherboard makes use of the jumper settings). Almost always, you will find that somewhere or other a connection has not been made or has been disturbed. The connections to concentrate on are the wire leads, particularly between the motherboard and the power switch, and these notorious memory strips. It's very difficult to imagine that a processor would be badly connected, because there is not much chance of this happening.

It's not quite so simple if, after checking, you find that absolutely everything is correctly connected. If the connections are all perfect then the only thing that can stop the machine from operating correctly (assuming that mains power is available) is a faulty component, either power supply unit, motherboard, processor, or memory. This situation is fortunately rare, but it's the most difficult for a constructor to deal with. You are not likely to be able to carry out any tests to assess what has failed, and you are equally unlikely to have spare components that you can substitute for ones that you suspect are faulty. This is one compelling argument for buying the case, motherboard, and processor from one single reliable source that you can get back to easily if things don't work.

If there are no problems that prevent the machine from operating you should be able to start up and, by holding down the DEL key, bring up the CMOS-ROM screen that allows fine-tuning of the way that your computer will be used. Spend some time over this, as noted in Part III, and make sure that any option for virus detection is disabled, because you will not be able to install Windows if virus detection is active. The point about spending some time with the CMOS-ROM option is that it gives you the opportunity of finding if there is instability. If, during use of the CMOS-ROM screen, the whole screen goes black and the machine reboots, then you have serious instability and you have to look for the source of the problem. If the machine is not stable at this stage, there is no hope of it working in a stable way once you start pouring programs into it. Instability can have several causes, one of which is trying to run the processor at much too high speed, though this is most unlikely these days when motherboards will automatically adjust their settings to suit the processor that you have put in. It can be a very difficult problem to solve, and you may have to settle for running the processor at speeds well below its maximum. Possible causes are a faulty processor, problems with the voltage supplies on the motherboard or on the PSU, or faulty memory. It can be quite costly trying to investigate by substituting components which of these is likely to be at risk, and if you bought your memory and your processor from reliable sources then the finger of suspicion probably has to point at the motherboard itself.

If there are no problems with the machine in its bare minimum configuration, you can turn everything off and then install the operating system. You have to do this at this stage because there is no point in inserting any cards that require drivers until you have an operating system that can control the drivers.

Once you have the machine working in a stable state and Windows installed, you will probably have to install a set of drivers for the motherboard. Typically, these will include the drivers for the motherboard itself, and possibly a set of USB drivers also. If your motherboard incorporates video, there will be video drivers to install, and if there is also a built-in sound facility on the motherboard there will be drivers for this. These drivers are installed from a CD-ROM that is supplied along with the motherboard. Many modern motherboards also include networking hardware and there would be drivers for this also, which need not be installed unless you intend to connect up to a local network. This is not required if you are going to use the Internet through a dial-up connection, only if your computer is connected up to a router for broadband Internet or networked to one or more other computers directly.

Once you have an operating system running in a stable condition, you can start inserting any cards that need to be added. After adding each card, switch on and make sure that nothing silly happens. The usual course of events is that Windows will check that cards have been added and will load in software to suit. We'll look at what can go wrong with that process later. By adding the cards one at a time you make it much easier to determine if one card has caused problems.

Note on installations. Sometimes an installation stops with an error message stating that one particular file cannot be located. I have come across this problem several times, and the way around it is to copy all the files from the CD-ROM on to a folder in your hard drive and then set up from the folder, usually by clicking a file named *setup.exe*.

The monitor is the first item you will need to install after the basic machine is working. The older type of CRT monitor usually requires no specific installation, but some of the later types, particularly the flat LCD monitors, require drivers. If the monitor type is recognized by Windows then the drivers will be available and will probably be installed automatically by Windows. If the monitor is a new type with no drivers in Windows, it will be used with a Windows driver until you can load in something more suitable. You will be able to use the monitor, but not at its optimum working conditions. Some of the drivers that are supplied by the manufacturers of monitors are not approved for use with Windows, and you will get a message to this effect when you try to install them. You may be able to download more suitable drivers, or you may find that the unapproved drivers cause no problems. Windows XP will usually save the older drivers to replace unapproved drivers if anything goes wrong.

You will also need drivers for the graphics card if this has been added externally rather than incorporated into the motherboard. Once again, without such drivers you will be unable to use the full resolution of your monitor, and unless you have a very new type of graphics card you will normally find suitable drivers in the set provided with Windows. As before, if no Windows drivers are available, you can opt to load in drivers from a CD-ROM that came with the graphics card. If you find that your monitor refuses to display at the highest resolution it is capable of, it is almost certainly because the correct driver is not set up for graphics card. Another telltale sign is that Microsoft Word scrolls very slowly.

Adding other external hardware brings its own problems, and since a printer is the item that almost every user adds after buying or constructing a basic machine, this is where the majority of added hardware problems are likely to arise. At one time when printers were relatively simple machines it was most unusual to have any problem with the installation, but things have changed. I have always found in the past that there were few, if any, problems associated with connecting a new printer using a parallel cable, but even parallel cables now have problems. Most new printers require to be able to pass information (such as the state of ink tanks) back to the computer, and this requires a printer port and cable that will allow such two-way communication. If you are using the parallel port this may have to be set up in the CMOS-ROM as an ECP port, and you have to make certain that your printer cable is of the type that supports this ECP port. An old parallel printer cable made in the early 1990s will certainly not do this.

All printers now come with a USB connection, either alone or with the option of a parallel connection. I now much prefer to use USB, and either the original version (USB-1.1) or the second faster version (USB-2.0) is suitable for any USB printer. The cable is nowhere near as bulky as the parallel type, and it's particularly handy if you do not keep a printer on your desk permanently but prefer to plug it in when you want it. USB is also preferable if you have two printers, one for general document printing and one for high-quality photo printing, because with USB you can connect up the printer you want to use by plugging in the data cable without the need to switch off the computer.

The other item that many users want to install is a scanner. At one time, scanners plugged either into the parallel port, or into an adapter card, but it is much more common now to find a USB connection. This is usually straightforward, and as always you will need to load in drivers either from within Windows or from a CD-ROM provided by the manufacturer of the scanner. Unless you use the scanner daily, you can take advantage of the USB type of connection by keeping the scanner in a cupboard and plugging it in only when you need to use it, so avoiding clutter on your desk. The scanner will also need a mains connection and this should be unplugged or otherwise disconnected from the mains when the scanner is not in use.

- If you keep the mains supply to the scanner on, the life of the light in the scanner will be reduced. Replacement lamps are costly and difficult to install, so switch the scanner power on only when you are using the scanner.

External drives, either hard drives or CD/DVD drives, are now featuring increasingly in computer use, particularly for miniature machines with only one internal hard drive. These consist of a casing with a power supply that needs to be plugged into a mains, along with internal connections for a drive and external connections between the drive and the computer. The power supply should be switched, because it needs to be on only when the external drive is in use. The external data connections are usually either USB-2 or FireWire; any other form of connection is either too bulky or too slow. The typical unit of this type needs to have its driver software installed before you can make use of it, and this is done from a CD or floppy in the usual way. Once this has been done, you need to install a driver before the unit is connected to the computer. On a typical external drive, the casing is quickly detachable to reveal the internal tray to which the drive can be fitted in very much the same way as a drive is fitted into a bay on the computer. The casing is then reassembled, and the mains connection can be plugged in followed by the data connection, USB-2 or FireWire, to the computer.

When you want to use a drive of this type, then assuming that the data connection is made, switching the unit on will activate the driver so that Windows Explorer will show a new drive letter corresponding to the external drive. You can then use the external drive as if it were a portion of the computer for any actions that do not require the use of MS-DOS commands. The external drive activates an icon at the foot of the screen that reminds you that it is active, and requires you to shut down before you switch off the mains to the drive. This ensures that all data is safely recorded before the unit is shut off.

A digital camera, see Chapter 8, is another popular item of external peripheral that requires a driver for downloading data. Before you do so, check that you really need to, because the drivers that are present in Windows XP may very well do the job for you without the need to add any more software. This avoids any possible conflicts of drivers, particularly if you use more than one digital camera. The USB type of connection is commonly used, but the cable is often of a non-standard type, with a miniature type of connection at the camera end. Some cameras will automatically start up the reading software whenever the USB connection is made, others require the connection to be made and the camera switched on.

Either way, Windows XP will show a display inviting you to download the images from the camera to a folder of your choice, with the My documents – Pictures folder as a default. Some users prefer to transfer the images by making use of a socket that accepts the camera memory chip. I do not favour this system, because there is no certainty that your next camera will use the same form of memory (and some cameras now have memory built-in rather than detachable) and I always feel uneasy about plugging these chips in and out since each of these actions affects the contacts with the prospect that eventually connection will become difficult. I also dislike handling chips excessively.

Another hardware installation which has now become much more common is the connection to broadband services. Assuming that you are making use of a connection to a BT telephone line, as compared to exotic systems requiring a satellite dish, there are two main hardware items that can be used for connection. This connection is the type technically referred to as ADSL. The simplest type of connection uses an ADSL modem, and this is probably the type that you will prefer to use if your computer has no network port. Suppliers will, however, point out that an ADSL modem may not to be simple to set up with its drivers and offers no form of protection against hacking and viruses. Many of these modems are external, connecting through a USB port.

The alternative is to use a more sophisticated device, referred to as an ADSL router, which combines network routing along with ADSL modem actions, and usually contains a hardware form of firewall offering protection against external intrusion. The difference in price is not so very much, and the extra features offered by the ADSL router are so useful, that if your computer has an Ethernet port (as most modern computer motherboards do) then it is well worth while to install an ADSL router such as the Netgear DG834. This comes with all the necessary connecting cables, power supply unit, and instructions for installation, along with the telephone line filter that enables you to plug in a telephone and the line from the computer and use both together. You need to install filters also on any other telephones that you have in the house, though these can be of a simpler type that makes no provision for plugging in the computer.

It is important to note, however that you should not make the final ADSL connection until your telephone line has been modified by BT to provide ADSL service. Any attempt to get your router connected will be pointless until the line is ready, and this usually takes a few days after you have paid the fee for linking up. Another point you need to be aware of is that you will need to set your Internet Explorer – Tools – Internet Options – Connections panel so as to tick 'Never dial a connection' once you are linked up to ADSL, otherwise the computer will continue to hook up to your dial-up Internet number.

Hardware – use

If the installation of hardware has gone smoothly and the hardware has been in use for some time without problems, then it should be (theoretically) relatively simple to diagnose any difficulties that emerge subsequently by asking yourself what has changed. Most of these difficulties relate to either the mouse or to a printer, since these are the most common types of external hardware items.

The common mouse problem is erratic pointer movement, so that you may find yourself having to make several attempts to put the pointer where you want it. The most common cause of this type of problem is an accumulation of hard dirt on the skids of the mouse. Turn the mouse casing upside-down, Figure 10.2, and scrape each of the skids. It's quite surprising how much sticky dirt you can find adhering to the skids. They pick it up from your mouse mat or desktop, on which it is deposited from your hand as you rest it on the surface.

A mouse that has seen a lot of use may continue to give trouble after cleaning the skids, and the cause is almost certainly pieces of fibre wound round the rollers inside the mouse mechanism. Once again, these fibres are picked up from the mouse mat or desktop, and they cannot be removed so easily as dirt from the skids. You have to start by unfastening the ball holder so that the ball drops out, revealing the mechanism, Figure 10.3.

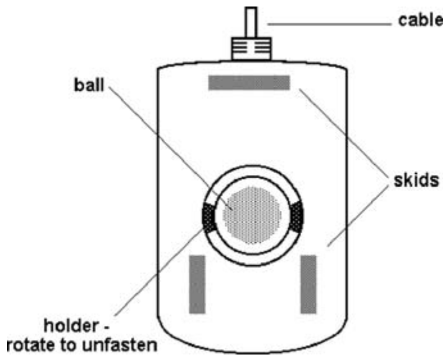

Figure 10.2 The mouse skids

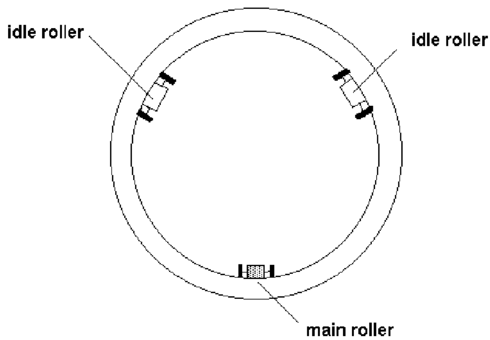

Figure 10.3 The roller mechanism in a mouse

Unless your mouse is one of the exotic varieties, the mechanism consists of three rollers, one of which sticks out more prominently, and these may be clogged with fibres, usually a mixture of fibre and greasy dirt. You will usually have to pick off the fibres using tweezers, and taking care not to disturb the roller on its shaft. A final clean using spectacle lens cleaning fluid (and the same treatment for the ball) should put your mouse back into perfect working order.

- There are exceptions. Most trackballs cannot have the ball removed, so that if a trackball starts misbehaving your only recourse is to change it (and buy a better model next time). Some mice use exotic mechanisms (infra-red beams, etc.) and also fail to respond to any efforts on your part. Note that if you use a cordless mouse or keyboard, you should check any documentation that came with it concerning cleaning. Remember also that such units will work only if your computer is equipped to receive the (infra-red or radio) signals from these units.

PRINTERS

As far as printer problems are concerned, in general the printer driver software will provide you with enough information to give you some idea of where the difficulty arises. The most common problems relate to ink cartridges and paper jams, and in either event you will see a notice on your screen to inform you of what has gone wrong.

This is not quite so simple as you might think, because you may very well get a message to tell you that there is a problem with an ink cartridge when you are quite certain that there is not, and some machines have a bad habit of reporting an empty ink cartridge when you have about enough ink for another hundred pages or so. There is no simple universal answer to problems of this sort, because you need to know how your own printer behaves and if it is a new printer then you are on a learning curve for some time.

One thing to watch out for is that some cartridges require a fair bit of force to clip them in. On a typical modern printer with four or more ink tanks, you should be able to see that all of the tanks are in line and have been clipped correctly into place. Once you have replaced tanks a few times you will have learned what has to be done to ensure that they are correctly positioned. On some machines, you cannot print if a tank is missing, whether you need that tank or not. On other machines you can notify the system that you are operating with a missing tank, and printing can continue without that tank, though you cannot print documents in a convincing black without a black tank, nor can you print a colour photograph effectively with one colour absent. If a print of a photograph appears with a very noticeable colour cast, typically blue or red, then the obvious solution is that one of your colour tanks is empty.

Paper jamming is less common than it used to be in the early days of printing, but it can still turn up now and again, particularly if you're using very thick paper. The paper handling of the different printers can vary quite considerably. Some machines, notably some of the old laser printers, have a very straight paper path from a (blank) pile at the back to the (printed) one at the front. Others bend the paper through an angle which can range from a mild obtuse angle to a complete 360°, and a few even flop the printed copy down on top of the blank sheets. On some printers, it is surprising that paper jamming is not more frequent, and you are very liable to find jamming on label sheets, because labels may become slightly detached when the paper is bent round, and this is an almost certain mechanism for jamming.

You cannot do much about the mechanism of your printer that forces the paper into its path, but you can help to avoid paper jamming in two ways. One is to shuffle the paper around before you place it into the machine, making certain that there are no sheets sticking together. Paper, as you buy it, has been cut down from larger sheets and the cutting process often leaves sheets that are slightly connected at the edges. Shuffling ensures that these connections are broken and that there is no chance of the printer picking up one sheet and trailing another along, often at a slight angle, behind it, causing a jam. The other point about paper jamming is that you need paper of reasonable quality, and this point will re-emerge later. A lot of paper sold as low price, general use, stock is perfectly fit for use with inkjet printers, but some is not and will persistently jam and give poor quality results. This is something you may have to sort out for yourself, and find a supplier of paper of the right quality at the right price.

You may also have to experiment for yourself with sources of ink cartridges. In general, if your printer is a Hewlett-Packard you need to be fussy about your cartridges because each ink cartridge comes with its set of inkjets. The Hewlett-Packard cartridges are always, in my experience, perfect, and I have had good results from some cartridges described as recycled or as compatible. I have also had cartridges of the recycled or compatible type which were totally useless and which had to be discarded right away. I have also experimented with refilling these cartridges, with poor and variable results, and I do not recommend this to any Hewlett-Packard user. The other side of this coin is that some of the Hewlett-Packard printers permit the use of large capacity cartridges which have a very long working life.

Other inkjet machines use separate jet heads and ink tanks. Replacements for these machines are usually of the ink tanks only, and I have had no problems with the use of compatible ink tanks or with the re-inking of existing tanks. If your main concern is with printing documents, then you need have no worries about buying compatible black ink tanks or by refilling an existing black ink tank. It's a different matter if you want to reproduce digital photographs, because you may find slight variations in colour between the original ink tanks and compatible replacements. Once again, it's up to you to decide from experience what gives you best value for money.

Some Epson printers use ink tanks that contain a chip, used to record the contents of the tank so that you can be notified when a tank is almost empty. You will find that advertisers will supply ink tanks of the chipped or (earlier) unchipped variety, either manufactured by Epson or compatibles, and there is a device and software available through the Internet for changing the contents of a chip if you want to refill a tank for yourself.

Apart from ink tanks and jamming paper, the main complaints about printing relate to horizontal lines, either white or black. White lines across your printed pages are caused by blocked jets on your printhead, and unless you can clear these jets the white lines will remain to plague you. This is not quite so much of a problem if your printer is a Hewlett-Packard, because the jets are renewed each time you put in a new cartridge and changing the cartridge will almost inevitably sort out the problem unless the new cartridge is also faulty. All printers use software that will provide for jets' cleaning, using higher pressure to push out each so that any blockage in the jets is cleared. This procedure is by no means guaranteed to clear a blocked jet, particularly if the blockage has occurred because the heads have dried up during a period of idleness when the printer has not been used.

Some printers stand up to long periods of idleness better than others, usually because the printheads are moved to a position in the printer where the jets are covered and less likely to dry out. Some users advocate keeping an idle printer in a cardboard box or one with a beaker of water to maintain a high moisture level. Others advocate using a spray of isopropyl alcohol (such as is used for cleaning spectacles) onto the jets, and dabbing on the jets lightly with a clean cloth. This latter method requires removal of the ink tanks and jets (separate units unless you use a Hewlett-Packard) and great care because touching the jets with your finger or with any metal object is likely to put them beyond use forever. Do not under any circumstances contemplate poking any object into a jet to clean it, because there is nothing you will ever find that would be small enough to enter a jet whose diameter is less than that of a human hair. For specific makes of printer, you will often find useful advice on clearing blocked jets from the web sites of suppliers of cartridges such as Jetica. I have, in the past, found that white lines from a Hewlett-Packard printer were dealt with simply by using better quality inkjet paper.

Black lines or coloured lines are quite a different problem, heavily related to the quality of paper that you have been using. These lines are caused by fibres from the paper sticking to the ends of the jets and, because they are saturated in ink, leaving trails of coloured ink behind them. The problems tend to be worse if your print requirements are for many documents in draft form at high speed, but the main source of the trouble is poor-quality paper. Most of the paper that you can buy, even the cheapest, gives no trouble provided that it is genuinely intended for use with inkjet printers, but some older varieties of paper that are intended for use with typewriters or with impact printers are totally unsuitable for inkjet use. Once again you have to decide for yourself what paper provides the best balance of printing quality measured against costs. As a rough guide, I have had excellent results from Ryman Copy Superior High White paper, which is as reasonably priced as anything you will find on the Internet when you take carriage charges into account.

This, of course, doesn't help if you still have the problem of black or coloured lines on your printing when you use good-quality paper. Once again, if you have a Hewlett-Packard printer then the simple remedy is to change to a new cartridge so that you have a new set of jets. For machines that use a fixed set of jets with interchangeable ink tanks, you have to remove the tanks and the jets and try to clean the jets as gently as possible, using isopropyl alcohol and a moist clean cloth without rubbing at the jets.

For these problems that involve either blockage or fibre adherence to the jets the ultimate solution is replacement of the jet heads. For machines that use separate heads and ink tanks, this means removing all the ink tanks and storing them so that they will not leak or dry out while you replace the head assembly. On most machines this is not a difficult procedure, but the head assembly is usually fairly expensive and not something that every shop will keep in stock. Order spares before you remove your existing jet heads from the printer.

- If a USB-connected printer (or any other USB device) simply refuses to work, and you can find no reason for it, check with another USB device that your USB ports are enabled. If your motherboard came with USB drivers, it's possible that some action (notably a re-installation of Windows) has removed these drivers and you will have to install them again. The USB reports in the Control Panel – System set usually show USB working even when the drivers have been zapped out.

Scanner problems are relatively few and uncommon. Beginners in the use of scanners often make the mistake of trying to scan using very high figures for resolution. This generates huge files which may be more than the hard drive capacity of a computer and which certainly will take a very large time to scan completely. You should use high resolution only if you are scanning an object that has a small area, something the size of a coin, for example. For a photograph of the usual $6'' \times 4''$ or $7'' \times 5''$ size, a resolution of 150 to 200 lines per inch is usually more appropriate. For optical character recognition on A4 documents, you may need to use 300 lines per inch to ensure really precise recognition of the characters. This latter case is not a problem because the large file is temporarily used and will be deleted once the recognition process has been carried out, but photographic files are usually ones that you wish to store in their original scanned form so it is pointless to make them so large that each one requires the full space of a CD-R to store. The tables, following, indicate the maximum sizes that you should use.

Table 10.1 Scanned file sizes for A4 24-bit colour

Resolution in dpi	Size of file in MB
75	1.5
150	6.2
300	24.7
600	98.7
1200	395
2400	1600
4800	6300
9600	25300

Table 10.2 Suggested settings – photographs

Purpose	Resolution (dpi)
Screen or Web, 256 colour or greyscale	75
Print at 300 dpi, colour or greyscale	100
Print at 600 dpi, colour or greyscale	150
Print at 1200 dpi, colour or greyscale	300

Table 10.3 Suggested settings – drawings

Purpose	Resolution (dpi)
Screen or Web, 256 colour, greyscale, or line drawing	75
Colour, greyscale or monochrome bitmap image	200
300 dpi printer colour, grey or monochrome image	300
600 dpi printer colour, grey or monochrome image	600
1200 dpi printer colour, grey or monochrome image	1200

Scanning of documents for OCR should preferably be done at 300 dpi, using a higher resolution for scanning small print or if an excessive number of errors is found in the scanned text.

- If you plug a peripheral that uses USB-2 into a USB 1.1 socket you may get an error message. Usually, this can be disregarded, and you will find that everything works normally.

A scanner will occasionally refuse to perform because somehow or other its drivers have been damaged, and the remedy for this is to re-install the drivers. Other than this, scanners usually have a remarkably long and trouble-free life and the only fatal problem that you are likely to come across is that the scanner lamp fails. This is a specialized form of fluorescent tube and can be fairly expensive to replace even if you can carry out the replacement yourself. Remember always to switch on power to the scanner only when it is in use.

External drives are also fairly trouble-free providing that there has been no damage to the drivers. Very often, if you have a Windows problem that requires re-installation of Windows you will find that some of your drivers are absent or unusable afterwards, and this applies also to USB drivers for printers and other devices. The remedy is, of course, to re-install these drivers. One of the advantages of using an external drive is that it is fairly easy to check if a problem is due to the drive, simply by removing the drive and substituting another one. This need not necessarily be an identical drive, if you find that an external hard drive is not working, you can take it out of the box and put in a spare CD-ROM drive and see if that works. If this substitute drive works then the problem has been with the drive that was there originally. One point to watch if you're using an external hard drive is that you must never switch off the drive until all the data that is pending in the memory buffer has been recorded. This means you should always use the switch-off procedure that checks that data has been recorded before switching off.

Software – installation – Windows

Windows installation places on your computer the largest set of software that it will ever have in place, and it makes sense to do so on a machine that is reasonably guaranteed to perform with stability. This means the machine in its most basic form, set up with processor, memory, and video output along with keyboard and mouse, but omitting any other add-on cards that you intend to use later, such as sound cards, TV input card, network cards, etc. By using only the basic form of machine you avoid any complications that might arise if Windows detects these add-ons and insists on trying to load drivers for each and every one of them at the onset.

Windows installation is normally trouble-free, but not every computer set-up can be classed as totally normal, and its possible to get into amazingly deep trouble with what you expect to be a perfectly straightforward installation. One common example occurs when you have built a new machine into which you have placed an existing hard drive in the hope of using its Windows and other applications on your new computer. This will *sometimes* work, particularly if the new machine is not very different from the older one, but more often you find that there are considerable difficulties that eventually lead to you needing to reformat the whole disk and start again. This is not to say that you should not try it, because the advantages are considerable, but that you should not be too disappointed if you feel that you have to reformat and re-install all the software.

What this amounts to is that there are two clear cases in which a Windows installation should be quite straightforward. One is the installation on to a new formatted hard drive, often referred to as a *clean installation*. This requires a full version of whatever Windows you want to install, rather than the upgrade version that you can use if you have Windows already running. The other straightforward installation is the upgrade of an existing version of Windows, using the Windows upgrade disc. Anything other than these two cases can (though not inevitably) cause difficulties, and if these difficulties make it impossible to seek help over the Internet (because you cannot use your modem) then your only option is to seek help directly from Microsoft UK by using the help line phone number 0870 60 10 100. This is not a speedy action, and you will have to provide information on your system, yourself, and the Windows installation disk that you are using. You may be required to carry out some actions (such as changes to the Registry) that you have never tried before, but these will be fully described to you, and you should preferably be sitting in front of your computer, switched on and running as far as possible, and close to your telephone. It is very much more difficult to follow advice if you simply make a note of what you have been told over the telephone and try it out later.

- If you can install Windows so that your modem is usable, it is normally easier to seek help using the Microsoft knowledge base.

It's unusual to find that a Windows clean installation totally fails to run, and if it does so it is usually because the computer cannot locate a file on the installation disk. You cannot remedy this by copying the disk, as recommended for installation failures of other software, because the actions you need are not available when Windows cannot be used. Your only remedy is to take the installation disk back to where you bought it and ask for a replacement. This may be difficult if you bought it at a very low price from an Internet supplier who does not answer your e-mails or show any interest in helping. Your chances are better if you are upgrading an existing Windows installation, because if the upgrade fails you can still make use of your modem to contact Microsoft over the Internet to seek an explanation for the problem.

In the past, many upgraders have hesitated to carry out a clean installation because of the amount of work required to reset all the details that were present in the old Windows set-up, such as Internet contact details, address book, Outlook files, etc. This objection does not apply to Windows XP, because there is a wizard available that will transfer files from your old computer into the new one just as if you had put them in slowly and laboriously for yourself. The program you need is the files and settings transfer wizard, and once you have installed XP you can find this in the Accessories – System Tools folder. The process is easy to follow with the guidance that you get: it consists of making a copy of the transfer program to a floppy disk, and inserting this into your old computer. This allows the old machine to locate the items that you want to copy (which you can specify – normally you will want to copy only settings rather than data files), and making a copy of these items either on another floppy or set of floppies, or on a CD-R if your old machine has this capability. You can then insert the disc or disks into your new machine and run the files and settings transfer wizard so that it will copy from these disks into the new machine. This cuts out all the tedious business of trying to get your new machine set up in the same way as the old one was, and for my money it makes Windows XP worthwhile just by itself.

If you are upgrading your older version of Windows on the same hard drive, the settings should remain as they were previously and the process is usually faster than a clean installation on a blank formatted drive. If you have built a machine that is new apart from a hard drive taken from an older machine which has its Windows built in, do not on any account attempt to install an upgrade of Windows until you are quite sure that the existing version works in your new machine. If your new machine contains the same type of hardware as the old one, there is a fair chance that the existing installation of Windows on the hard drive will still work. This is not so if the machine contains entirely different types of hardware, and it is these circumstances that are likely to force you to have to clear the hard drive and start with a clean installation, which also requires a full installation disk rather than an upgrade. In these circumstances, it's better to leave the old hard drive in the old machine, install a new hard drive on the new machine, and use the files and settings transfer wizard as described above.

- In any case, since the hard drive is a mechanical component with a limited life, it makes sense always to start upgrading a machine with a new hard drive unless the old drive was not all that old and you can't really afford to replace it.

Older versions of Windows such as Windows 98 and Windows *Me*, are still a good choice for the self-builder who does not necessarily want the most recent versions. One piece of recent good news is that Microsoft intends to continue supporting these two older versions until at least 2006. They have more immunity from some of the most recent viruses than Windows XP, they are cheaper to buy, and for many users it would be pointless to use XP unless you particularly required the hard drive NTFS filing system that allows very large files to be stored.

If you do decide to install Windows XP, remember that there are some precautions you should take before you start the installation. One important precaution is to check for the compatibility of all your hardware before you actually start installing XP. This check can be carried out from the XP installation disk if you are upgrading from an earlier version of Windows, but if you are creating a clean installation it is better to use your old machine to check the compatibility web site which is at:

http://www.microsoft.com/hcl/

and which has a huge list of approved hardware items. The problem with this is that many items that are available in the UK will not appear on this list though they are in fact compatible with XP. If you have just built a new machine using new components then you should have checked all the way through that the components you were fitting where compatible with XP and there should be no problems. If it happens that there is an incompatible component you will be informed about it as you install XP and the troublesome component will not be used until you can get a new driver that is approved for use with XP. Unfortunately, if the component that is causing the problem is your modem then it's rather difficult to download a new driver so you should be particularly careful to choose a modem that is compatible with Windows XP.

- It may be that you have some item of hardware or software that you must retain and that this item can never be XP compatible because the drivers are not obtainable (perhaps because the manufacturer is defunct). In that case the best advice is to stick with Windows 98 or Windows *Me* and forget about using XP altogether until such time as you can find a more modern replacement for your hardware or software item.

It's unusual to find that a Windows installation disk is not recognized, but it can happen, and one possible reason is that your CD-ROM (or DVD) drive is not working. If you are upgrading, then you can easily check this by putting in any other disk and ensuring that you can read its contents. If you're starting a clean installation, you will normally have loaded drivers for this drive from a Startup disk, which might be a floppy. If you are installing from the CD, using the CMOS-RAM option to make this your drive of first choice for installation, then any failure to read the disc is a disaster and you will have to seek assistance from Microsoft. It's always worth trying to clean the CD first, wiping it with a soft cloth from centre to outside and never round and round following the tracks. Never use any form of liquid cleaner on a CD, because this can clog it up and make it unreadable.

Once Windows is up and running, your first priority is to install any drivers for the motherboard. There will certainly be the drivers for the motherboard main chips, and there may be drivers for USB ports, and possibly for any onboard video and/or sound facilities. Do not install any drivers for the motherboard video or sound onboard chips if you intend to use external cards for these purposes, and the advice applies even more forcibly if your motherboard, like many modern ones, provides for network interfacing.

- If you opt to install drivers for network use simply because your motherboard has the facilities, you'll be prompted for set-up details on your network every time you switch on. If you are not connected to a network this is a considerable waste of time and you will have to use the Control panel – System facilities to disable the network card.

In the course of installing XP you will be asked to activate your copy. You need not do so during set-up, and it's often an advantage to spend some time checking that everything works first before you activate. Activation is most conveniently done online from Microsoft, and is automatic if you have a modem in your machine with access to the Internet. If you do not activate your copy, you will find that it stops working after 30 days (during which time you will be repeatedly reminded to carry out the activation). When Windows has been installed, you can activate by clicking Start – All programs – Activate Windows, and the process is quite rapid, consisting of a check of your hardware that is transmitted to Microsoft followed by downloading a code that cancels the 30 day limit. The aim of activation is to prevent a copy of XP being used on more than one computer at the same time without additional payment to Microsoft, and if you are using only one machine then this should cause no problems. There is also nothing to prevent you running Windows *Me* on one machine and XP on another, though if you build a new machine and try to use the same installation disk for XP on it then you will be in trouble. You can, however, make changes to a machine with an activated XP installation without being called upon to reactivate, and even if you have made some major changes and have to reactivate there is very little problem about doing so.

- If you are installing Windows XP on a machine which is purely for your own use you will automatically be granted an administrator account, meaning that you have full control over everything on the machine. If a machine is shared, you may want to have the administrator account used by one person only, accessible by password, and the documentation that comes with Windows XP shows you how to do this. You should not under any circumstances use a password for the administrator account unless you really need to, because if you forget this password there is nothing that can be done to recover your access to the administration facilities of your computer.

Software – installation – applications

Once Windows has been installed on the basic machine, and is running as you wish it, you can start the installation of other items. The first priority must be to shut the machine down, open the case, and install any cards that you wish to use. Before you do this, however, read the installation instructions for each of these cards with considerable care. Some require that you install the software first, and then put the card into the machine. Others require you to fasten the card into the machine first and add the software later. Do not assume that the procedure will be the same for two different cards, nor that you can simply do it your own way. If the card is fastened in place before the software is installed, Windows will look for suitable software when it starts, and this may make it difficult to install any software that comes along with the card. This is the main reason for any requirement to install the software before fastening in the card. For some cards, the software that Windows contains may be perfectly adequate and if there is none, you will be prompted to put in any software that came with the card so that this can be installed. The important point is to read the instructions and follow them to the letter.

The same rules apply when you want to install software for peripherals such as a printer or scanner. For older models of machines, there may be suitable drivers within Windows and it is perfectly adequate to plug-in the machine, start Windows, and allow Windows to install drivers for you. More modern peripherals are likely to have drivers that are not present in your Windows distribution disks, and you are normally required to install the software from its own distribution disk before you plug-in and switch on the device. Once again, this requires you to read the instructions, because you can get into a most almighty muddle if you don't do it the correct way.

- If you have done your own thing and find that things have gone wrong, the remedy is to uninstall the software, switch off the computer, unplug the peripheral, switch on again and install the software this time before connecting and switching on the peripheral.

One unpleasant problem that seems to be more common nowadays is an installation disk for software that appears to have lost a file. In five installations recently I found two that exhibited this problem, where the installation stopped with an error message about a file that could not be found on the installation CD. The first thing to do in a case like this is to check that the absent file is, or is not, on the CD, so you need to take a careful note of the name of the file. If the file is indeed not on the CD, then your only remedy is to return the CD to the suppliers and ask for a replacement, giving details of the missing file.

More usually, however, the file is present on the CD but your computer is unable to read it. This is a technical problem concerned with the way that computers read files from CDs and, happily, the way that computers read files from the hard drive is rather different. If you create a folder on your hard drive and then copy the whole contents of the installation CD to this folder, you will normally find that you can carry out the installation by clicking a program (usually called SETUP.EXE) so that this will run to carry out the installation. In my experience, this always solves the problem and the installation proceeds without any difficulties regarding finding files. If you have no shortage of hard drive space you can keep the folder in place in the event that you ever have to re-install these drivers. Stick a label on to the installation CD to remind you of what you had to do to carry out the installation.

- Carry out these installations one at a time, and check that the software is working as you would expect it to before you install anything else. If you do a large batch of installations and one application gives trouble, you cannot be certain whether or not this is due to something else you installed later.

For each installation of a piece of software, you may need to make some alterations to options before you make intensive use of the software. Most pieces of software have an *Options* item, usually located within a *File* menu or a *Tools* menu. These options are often arranged with a reasonable set of defaults, but unless you know what these defaults are you cannot be sure they are reasonable for you. One common option is for a 'splash screen' that appears each time you start up the software and which persists for several seconds before you can make any use of the software. You can usually change the default of showing this splash screen so that you save time on starting up your software. Other defaults are, typically, set-up conditions such as page sizes that you will want to check for yourself. For example, commercial programs that have a printed output will almost always use A4 as the default paper size for a user in the UK, but some freeware programs of US origin may specify other sizes.

- Attempting to install some software items may bring up messages to the effect that it may be incompatible with Windows XP. In some cases, this is simply because the software is more modern than your version of Windows XP and there may be no real problem, but it's always better to check with either Microsoft or the supplier of the software that it will operate correctly under Windows XP.

Some old programs, particularly games, were written making use of particular features of an older version of Windows that is not present in Windows XP. In some cases, it may be possible to convert these programs so that they will run on XP, using the *Program Compatibility Wizard*. The only other option is to change to a modern version of the program that is compatible with XP. If the program relies on an equally old piece of hardware, you may be able to update the program or update the hardware drivers, rather than have to update the hardware itself, though this may be the only choice left eventually. If the old program cannot be installed, you may have to run the Program Compatibility Wizard on the set-up file (usually called setup.exe) on the installation disk. If the program is already installed (usually because you already have it all on your hard drive when you are upgrading an older version of Windows to XP) then you can use the Program Compatibility Wizard to alter settings so that the program will run under XP.

To run the Program Compatibility Wizard, go to:

Start – All Programs – Accessories – Program Compatibility Wizard

and follow the instructions contained in the Wizard. You will be asked to locate the program, either from a list of programs, on the CD, or manually by browsing through your folders. The manual option consists of right-clicking the icon for the program and then clicking properties. For an older program, there will be one tab marked *Compatibility* and when you click this tab you can alter the compatibility settings. You can specify the version of Windows for which the program was designed, or you can alter the display settings (such as setting for 640 × 480 resolution or 256 colours), or you can alter text settings.

- The Compatibility tab is not an answer to everything, and it will appear only on the properties of older programs that are located on your hard drive, not on any external drive.

If the use of the Compatibility tab does not help, you may be able to find updated drivers or other assistance over the Internet, particularly from the web site of the manufacturer of the program. This may require you to download drivers or programs that will fix the problem.

- Because games generally make intensive use of the graphics card and/or sound card, it might help to have the most recent possible drivers for either or both of these cards.

If the manufacturer's site is not helpful, you may be able to get assistance from Windows update. One common problem is with games that use DirectX because your version of DirectX may not be suitable and you will need to download a more recent version.

- One odd item that sometimes crops up is failure of a program set-up to run, often with the message that it is not a valid Windows 32 application. This can happen when you have downloaded a zipped file into a folder that you have used for other downloads. What happens is that unzipping the file will extract a set-up program, but there may be another set-up program in the folder which is the one that happens to run, and is not appropriate for the software you want. The remedy for this type of problem is always to place a zip file in a folder of its own and extract all the zipped files to the same folder.

Another problem that often causes acres of correspondence in discussion groups is the installation of patches to Windows. XP in particular, because it was designed to make it easier for computers to be linked together, suffers more than the older Windows versions from security vulnerability, so that Microsoft has released a huge number of patches that can be downloaded and automatically installed. Most of these patches are useful (though when I log on the Windows Update it steadfastly refuses to recognize that any of the patches have been downloaded earlier). In some cases, however, a patch can turn out to have unforeseen effects, and one, listed as KB 835732, seems to have caused more problems than others. In my case, the effect was that though my broadband connection was running, all contact with my ISP was lost, but it would suddenly appear, along with a new entry in the Control Panel – Networks list, after some time. This behaviour ceased when I removed the patch, using Control Panel – Add/Remove Programs.

The moral is to designate a System Restore point before you download and run any patches (and before you install any other new software). This allows you to restore your computer to the state it was in before the new software was installed, and if you run into trouble after installing new software, using System Restore to a time before that installation will check if it was the new stuff that caused the problem. You can get to System Restore by using Start – All programs – Accessories – System Tools – System Restore. This initially shows a panel on which the option to restore to an earlier date is selected. The other option is *Create a restore point*, and if you click this one and then the *Next* button you will see a panel on which you can put a brief note before clicking the *Create* button.

To restore to earlier settings, leave the option to restore to an earlier date as it is and click the *Next* button. You will now see a panel, Figure 10.4, on which dates are marked. The dates shown in bold type are these for which there is a restore point, and by clicking a date and then the Next button you can carry out the restoration.

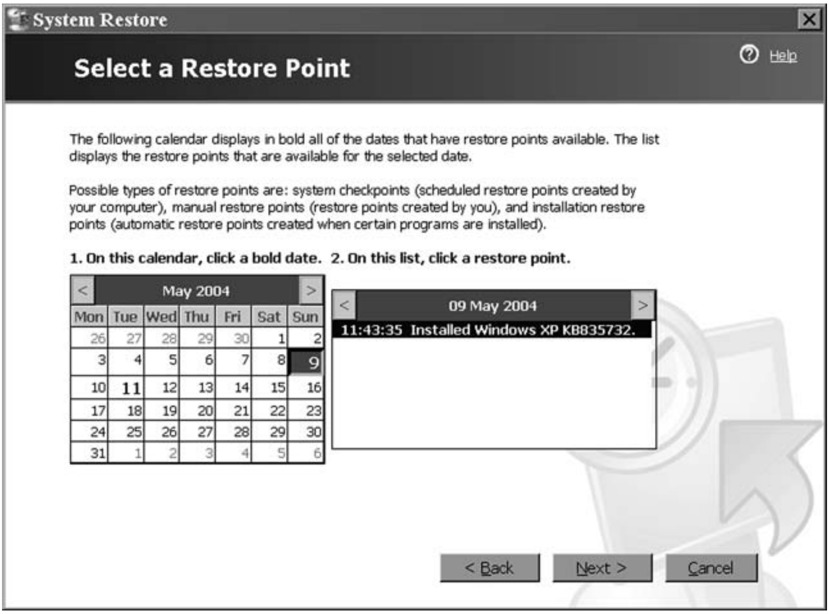

Figure 10.4 Using a restore point

Software – use – Windows

When it comes to problems of using Windows, the topic that most users will say is uppermost in their minds is that of a virus attack. Virus attacks are very much like terrorism, they strike fear into many more people than they actually affect. You can, however, be at risk, particularly if you have a broadband connection, and Chapter 11 deals with the problems of security in detail.

I have devoted quite a large amount of time and space to the virus problem, because it crops up right at the top of any list of problems that are reported about Windows. It is, nevertheless, more feared than experienced and there are other problems that can occur with Windows that can be more troublesome. In general, I would not recommend the use of any version of Windows earlier than Windows 98 second edition (98SE). I know that Windows 95 is still very commonly used for less demanding applications, and that it can be often quite trouble-free, but it does limit due to the use of older applications and it is liable to crash with loss of data and all running applications for reasons that can be very difficult to determine.

The later versions of Windows can still be crashed by a program that manages to run amok (and which is quite often a Microsoft program) but these versions of Windows allow such a program to be closed down without affecting others that you have running at the time. In other words a rogue program does not bring down Windows altogether. Windows XP goes one step further, and will deliver a message to Microsoft when a program causes trouble. You will still have to shut down the program, with loss of any unsaved data, but at least you will enable Microsoft to investigate the problem and suggest solutions (such as an update that you can download). The last four of these that I have had all related to Microsoft Word, probably because it's the program I use most often.

Windows XP also provides for a form of repair service, but this should not be used unless you have been advised to do so by Microsoft. The procedure is to alter your CMOS-RAM settings so that your computer will boot from a CD-ROM rather than from the hard drive, and you must then disable any antivirus program and any virus protection in the BIOS. You then insert the CD-ROM for Windows XP installation and boot the machine from this disc. You then need to select:

To repair a Windows XP installation using Recovery Console

and make this same selection the next time you are presented with options. When this runs it will carry out repairs to your Windows XP installation automatically and will then reboot the machine. At this point you need to stop, remove the CD-ROM, and alter the CMOS-RAM so the machine will now boot once again from the hard drive.

- This latter point is very important. If you do not remove the CD-ROM and alter the CMOS-RAM, you run the risk of doing a full reinstallation of Windows which will take time and which may result in you losing all or most of the settings that you had previously made. In particular, you will lose any Windows upgrades that you may have downloaded over the Internet.

Software – use – applications

The use of applications software is the prime cause of problems, and some types of applications are notorious for causing problems. Games programs of the violent action type head the list of causes of such ailments as locking up and preventing other programs from running. Most of these troublesome programs are well documented on the Internet and by closing down the game, switching off the computer, and restarting, you can use the Internet to find advice on how to avoid the problems that have plagued you. You will need to be specific about the title of the game and the version because there is a huge amount of information on troublesome games software and there seems no end to the new problems that new versions can bring to you. In general a solution may require you to download a patch and install it (typically by clicking on a file that you have downloaded) or to follow a procedure that may call for you to alter or delete an entry in the registry. If you are uncertain about any procedure that you are asked to carry out then you should seek additional help from the Internet; there are many excellent step-by-step articles regarding making changes to the registry. The most important instruction item in each of these is to save the registry (which is a data file) before you make any alterations, so that you can get back to where you were before if everything goes pear-shaped.

- Why use a computer for games? Keep the computer for serious uses and buy a Playstation (or equivalent) for the games.

Trailing a long way behind games software, video editing software is a fairly prolific source of problems, particularly if you are using such software for the first time. Microsoft's own video editing software, Windows Moviemaker, uses many of the techniques that you will find in other editing software, and has the merits of being free, though the first version is lacking in many of the refinements that you will find in editing software from suppliers such as Pinnacle. There is an update to Windows moviemaker that provides version 2, and which can be downloaded from the Microsoft update web site. This version is said to be considerably better than the earlier one, but it is not necessarily a simple upgrade and requires a considerable time to download if you are using a dial-up modem.

- Here I have to confess that I totally gave up on the upgrade. When I tried to use it, it gave the error message that it was not a valid Windows 32-bit application (though there was no conflict of setup.exe files), and several weeks of following advice from Microsoft to make changes in settings made no difference to this situation. I was then advised to use the Windows XP repair routine. This not only failed to help with the upgrades, it lost a large number of my settings and I was not inclined to pursue the matter much further.

One considerable advantage of version 1 Windows Moviemaker is that it can import video files from a DVD disc of any variety that your DVD drive can use (for example DVD + RW). Several other video editing programs will not recognize these files (extension VOB), and it's puzzling, because if you copy a VOB file to your hard drive and rename it to the extension MPG, it can be read by most of the video editing software. This is not invariably true, because some editors will read only the MPEG-1 type of file as used in VCDs but not the MPEG-2 type used for DVD. If you want to edit videos that you have recorded for yourself on DVD, do not buy any video editing software until you can be sure that it can read these files and write them. The Ulead DVD MovieFactory-3 software has in my experience given no problems.

As far as other application programs are concerned, apart from a few programs that are not widely used, serious problems are fairly unusual. It makes sense, however, to ensure that when a program fails you have some backup of any files that you have been working on, because when a program crashes it inevitably takes with it any data that you have been working on. Microsoft Word, along with some other programs in the Microsoft office group, provides for saving its document file automatically at intervals that you can select for yourself. This is done by using:

Tools – Options – Save

and ensuring that the *Save autorecovery* box is ticked, and a time interval entered into the space provided.

In the illustration, Figure 10.5, this time is shown as five minutes, ensuring that if the program should crash you would lose only the last five minutes of your work. The auto-recover action will replace your document as it was when last saved whenever you restart the program. In addition, when Microsoft Word crashes it will usually put up a small panel that invites you to click a button to send details of the

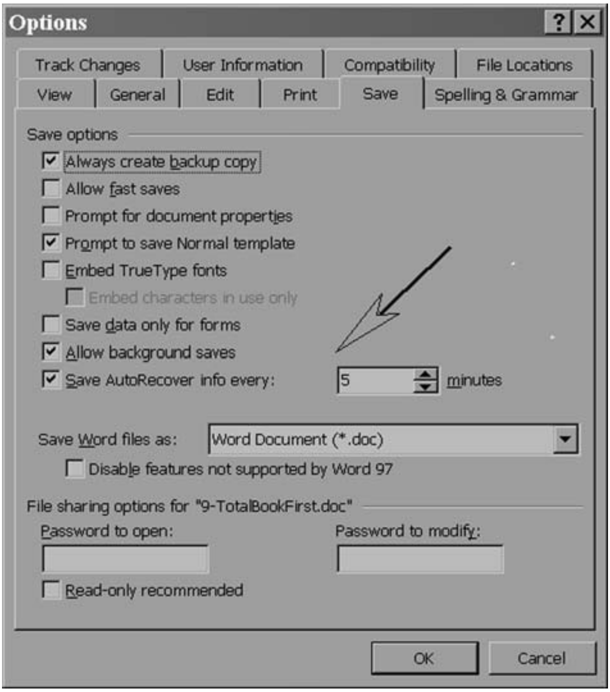

Figure 10.5 The Word autorecover option

state of your computer to Microsoft so that the events causing the crash may be analysed. As a result of this you may be able to download a file that will prevent this fault from recurring, either fairly soon after the fault is found or perhaps at a later date. In my own experience, Microsoft Word is most likely to crash when you have a large document, particularly if it contains illustrations, and when some layout changes are made such as altering the number of columns.

One minor annoyance of Microsoft Word is that it will occasionally report that its template file (normal.dot) has been corrupted. If you opt not to use this file, then Word will substitute a default version and you will lose various settings on the standard or formatting toolbars. These are, however, easy enough to replace. There is an option to attempt replacement of the normal.dot file, but your best path is to keep the spare copy of your preferred normal.dot under a different name (such as normal.my) and to shut down Word, rename this file as normal dot, and then restart Word.

An autorecover facility is even more useful for a graphics program, since you may have spent considerably more time constructing a graphics image than you would on a document, but not many graphics programs have this provision and you may simply have to train yourself to save the files at frequent intervals. If your graphics program provides for making a backup file at each save, you should ensure that this facility is always on because if the same file is corrupted you should be able to go to the previous backup and get something useful out of it. If you experience a crash, you should always try to note down the actions that led to the crash, and notify the originator of the program of what happened by contacting the web site. Very often, there will be an update available that you did not know about and which helps considerably for future work.

The ever-present problem of software for the PC machine is that there can be such a huge possible number of programs interacting with each other, making it almost impossible to ensure that crashes do not happen. You may find, for example, that you have a system that has been completely stable with a set of favourite programs that you frequently use, but crashes start to happen when you add another program to your working set. In many cases, it can be very difficult to pin down which of your previous programs is interacting with the new one, and any Internet inquiries should start with the manufacturer of the new program that caused the trouble to start.

Even quite insubstantial software changes can often have an unfortunate effect. For example, I am using the Naturally Speaking software to dictate this text into Microsoft Word, but if I install the supplied driver for the trackball that I'm using in place of a mouse then the dictation software no longer functions correctly (becoming much slower and refusing to carry out amendments). The cure is simple enough – I uninstalled the trackball driver and I am using the trackball with the standard Microsoft mouse driver instead. You might find, however, that interactions between programs totally prevent you from using one program, and in that case you need to check the web site of the manufacturer to find what information is available on these interactions. Remember, it is most unlikely that you are the only one to suffer from the problem.

THE REGISTRY

I have mentioned the Registry several times, and though Microsoft discourages users from dabbling with this piece of software, you need to know something about it in order to make repairs to your Windows system. I don't mean that you should attempt to determine for yourself what changes are needed, but you may be advised from Microsoft or in a magazine article that a Registry change can help to solve your problem and you need to know what you have to do.

The Registry is a large and complicated database file that is created by Windows during installation. The system has been used by versions of Windows starting with Windows 95, and it replaced an old method (a collection of files with the .PIF or .INI extensions) that was used previously. In this database is stored data concerning the hardware, software, users, and preferences for a single Windows PC with one or more users, or for any PC that is connected into a network. Changes to the Registry are usually made automatically when you install or uninstall programs, or when you make changes by way of the Control Panel.

- The Registry can also be changed manually, making use of a program called REGEDIT that is called up from the Start menu. If you make any alterations in this way, you must first make a complete backup of the Registry in some spare folder so that you can restore the Registry if your alterations have an adverse effect.
- You should always hide your Registry files (which in XP are located in C:\Windows\System32\Config folder) by ticking the box in Windows Explorer – Tools – Folder Options – Files – Hide protected operating system files. No attempt should be made to work on the Registry files directly; they are named USER.DAT and SYSTEM.DAT.

The Registry is constructed as a set of folders within folders for as great a depth as is needed. There are six main sections (or hives), and each section is devoted to a particular type of data. Each of these main sections contains items called *keys*, and each key can have a value or set of values, or it can contain other keys which can have values or further keys. The keys are the names for bits of information, and the values attached to a key contain the information that is stored in the Registry. Some values can be numbers, and these are classed either as binary or as Dword. Other values are names, and these are called *string values.*

There are five main sections in the Registry of Windows XP, labelled as HKEY_CLASSES_ROOT, HKEY_CURRENT_USER, HKEY_LOCAL_MACHINE, HKEY_USERS and HKEY_CURRENT_CONFIG. The HKEY term means hive-key. The information is often duplicated in more than one HKEY. Older version of Windows use six Hkeys, but the five noted above are the most important.

You can view, backup/restore and edit the Registry by using the REGEDIT utility that is provided with Windows. You start this editor using the Start – Run command. You need to type the name regedit into the space provided and then click the OK button. This brings up the panel illustrated in Figure 10.6.

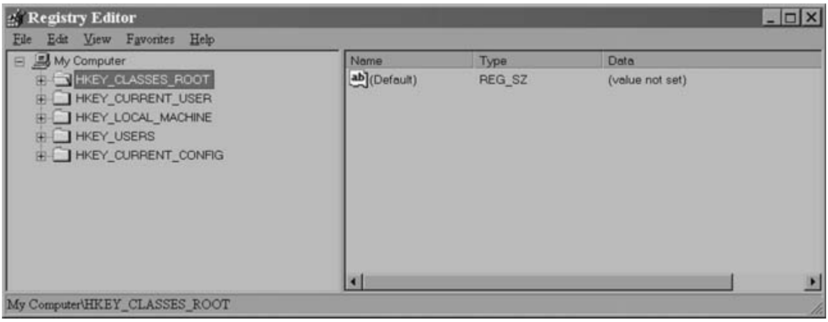

Figure 10.6 The Regedit panel as it appears first (Windows XP)

The Registry data is displayed in two panes set side by side. The left side shows the five main sections as sub-folders of My Computer. For each section, clicking the [+] symbol will display a set of keys for that section, and if a key has the [+] symbol next to it this indicates a further sub-key. Figure 10.7 shows the result of opening the HKEY_CURRENT_USER set and selecting Console.

A typical Registry data entry (right-hand pane) consists of three parts, the name, the data type and the data value. The editor provides for deleting or adding a key, and for changing name, type or values, so that you can put in new entries, delete old entries, or change values.

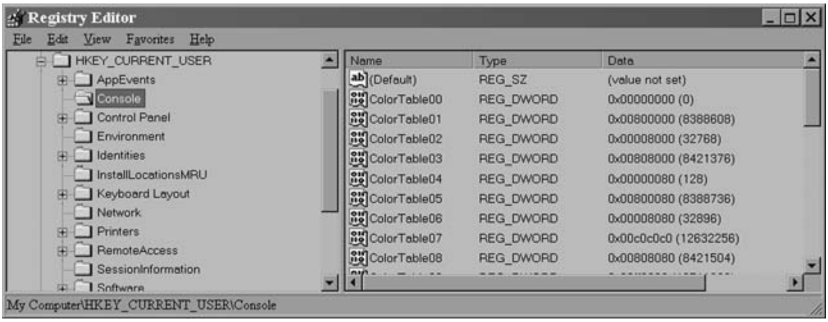

Figure 10.7 Displaying keys and data in Regedit

- You must realize that any alteration in the Registry can have disastrous results, so you must back up the Registry before making any changes that have been recommended to you by a competent authority. You should also preferably use System Restore to make a Restore Point.

Backing up the Registry is provided for in REGEDIT. Click File – Export and use the browsing panel that appears so that you can select a folder. Fill in a file name (such as REG01_06, indicating type of file and date) and then click the *Save* button. If you need to restore this version of the Register at any future time, you can use File – Import, locate the folder and click on the file, then on the *Open* button.

One Registry problem is that the size of the Registry tends to increase steadily as you use your computer, and many items that are redundant are not removed. This has led to several suppliers offering Registry cleaner software, one of which has in the past been supported by Microsoft. Though this support has now been withdrawn, RegCleaner 4.1a is still available and though intended for Windows 98 and 2000, appears to work on XP as well. Though the program makes its own backups, you should always export your Registry files before using this or any other Registry software.

Chapter 11

Security

Why?

Computer security is big news nowadays, but, like crime, it scares more people than it affects. The main scare is that your computer will suffer from a virus attack, meaning that a rogue program will be set loose inside your computer causing damage to files on the hard drive and possibly infecting other people that you pass disks to or contact by email. The good news is that you can make yourself almost immune to such problems, but you have to disable some parts of your trusting nature.

Before we get involved in computer security, let's look at two common non-computer confidence tricks. The first is simple, the pound coin glued to the pavement, while the perpetrator looks on from a safe distance to see how many passers-by try to lift it. It's a harmless but annoying trick, and that's true of quite a number of computer security problems. The key to it is that no-one forced you to try to pick up the coin.

The other one is more elaborate. On a wet night, your front door bell rings, and you look through the spyglass to see a well-dressed woman looking distressed. With the chain on, you open the door slightly and she explains that her car has broken down; can she phone her husband to come and pick her up. She offers to pay for the call.

This melts your hard heart, and you let her in. She dials a number, and you listen at a distance to what appears to be a long but genuine call for help. She ends the call, leaves a pound coin at the phone, and leaves. It's only later when the phone bill arrives that you find she dialled a premium rate number, and you have paid several hundred pounds for it. Needless to say, the premium number is one that she set up for the purpose of milking innocent mugs. Nothing illegal has happened, because you invited her into your house, and allowed her to use the phone. The remedy is to get on to BT, report the incident, and arrange for all premium rate numbers to be barred from your phone. That has its equivalent in computer terms of setting up a firewall.

The point of these fables is that a lot of computer virus attacks rely on confidence tricks, and if you are not careful, you will invite the virus into your computer. Forget all the Hollywood images of evil hackers bending over keyboards, busy trying to find a way into your machine. No one is really particularly interested in invading your machine specifically, but if you care to invite someone to do so there is probably someone around who will. The people who spend their time trying to crack their way into a computer are aiming at computers that are part of a large business organization, and they may have a lot to gain from getting an entry into these machines. These computers are connected permanently to the Internet, passing large amounts of data all the time, and this makes them more vulnerable for someone who knows how to get into them. Your computer, by contrast, is not permanently switched on, not permanently connected to the Internet and your identity, unless you happen to be famous, is not known to anyone who is looking for a computer to hack into.

To put all this into prospective, in all the years I have been building and using computers, I have never, until recently when I installed Windows XP, used anti-virus software and have never had a virus in any machine running the older versions of Windows up to Windows *Me*. This might be sheer luck, but I put it down to following these precepts:

- don't install anything from a floppy or CD whose origin is uncertain;
- use only a dial-up Internet connection, and use it in short bursts;
- download over the Internet only from Microsoft or manufacturers of hardware or other reputable sources;
- set your email software so that it shows the email header but does not show the text unless you request this;

- always reject emails from unknown sources;
- never open an attachment on the email unless you know what it is and who has sent it;
- never open an email with subject lines containing the messages: *Hi, Hello, Error, MAIL DELIVERY SYSTEM, Mail Transaction Failed, Returned Mail: Response, Error Server Report Test* unless you are absolutely sure that these are from a trusted source;
- never run any attachment with a file extension of .exe, .pif, .zip, or .scr, because these are the most common extensions for email virus programs.

With that out of the way, let's look at the sort of problems that we can clump together under the term of security.

Incoming data

A virus is a program, and unlike a biological virus which you can catch by inhaling particles in the air, your computer has to load and run that program in order to suffer from a virus. In other words, you catch a computer virus from software and if that software does not enter your machine then you don't get the virus. How, then, does unwanted software get into your machine?

One way is by disks, floppy or CD. Any reputable software that you buy from a reputable source should be on a disk that is warranted to be completely free of any form of virus. This is not to say that such disks will be free from programs you don't want, containing advertising material that may be quite difficult to remove from your computer, but at least there should be nothing that will cause any form of harm. The disks you must avoid are those that come from shady sources, particularly disks with handwritten labels that are passed around from one user to another. Even if these started life as a perfectly harmless bit of software, you have no way of knowing that it will end up harmless. The more tempting the description on the label, the more likely the contents of the disk are to be a virus, because the classic course of a confidence trick is to lead you to do something that with a little cool thought you might want to avoid.

- The name for this type of virus is Trojan Horse, a good description of how curiosity can overcome caution.

The simple remedy, which has kept many users free of virus attacks for 20 years or more, is to avoid any such disks. Following the old advice that if you can't be good be careful, the other option is to buy virus scanning software and run it on any such disk before you even think about loading the program. We'll look at virus software later in this chapter.

The other source of virus-ridden software is the Internet. There are millions of tempting programs available for download over the Internet, some free, others at a price. Most of them are no problem as far as virus contamination is concerned, but how can you tell? Normally, you can trust a program that comes from a well-known maker of computer hardware or software, such as program updates and drivers. As it happens, most of the programs you will want to download will fall into these categories. Another possibility is that you have loaded and used a program from a disk, certified free of viruses, that you received along with a computer magazine, and this program recommends a download. You should feel reasonably confident in this case, and you should also feel reasonably confident if a computer magazine or other reputable publication recommends the use of a web site for downloading a named piece of software. That's where trust has to end, however. Programs that you find by using a search engine on the Internet and which you know nothing else about must be held in some degree of suspicion, and you should not download such software unless you can get confirmation from a reputable source that it will be free of viruses, or unless you have a virus scanner that you can use to check the programs when they are downloaded.

- Another point here is that you should never download software that will run without further intervention from you, unless it is an upgrade to Windows that comes directly from Microsoft. When you download a program, Windows always gives you the option, Figure 11.1, of running the program directly or saving it to a file. Always save the program to a file, either on your hard drive or on a separate drive (such as a CD-R disc) if possible. It's then easy to use virus scanning software to check that the program will not be a virus risk.

There is another, more insidious, way of distributing a virus. The use of emails has grown very considerably since the idea began, and the form of emails has been greatly expanded from simple text to much more elaborate documents. Inevitably, this expansion has also made it

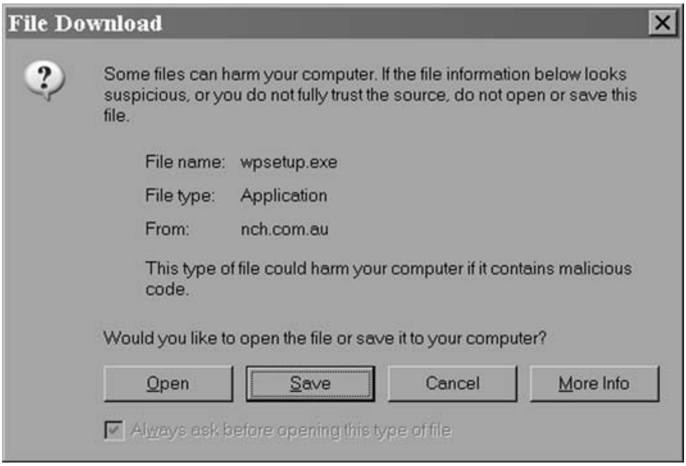

Figure 11.1 The File Download warning – always opt to save the downloaded file so that you can check it for a virus

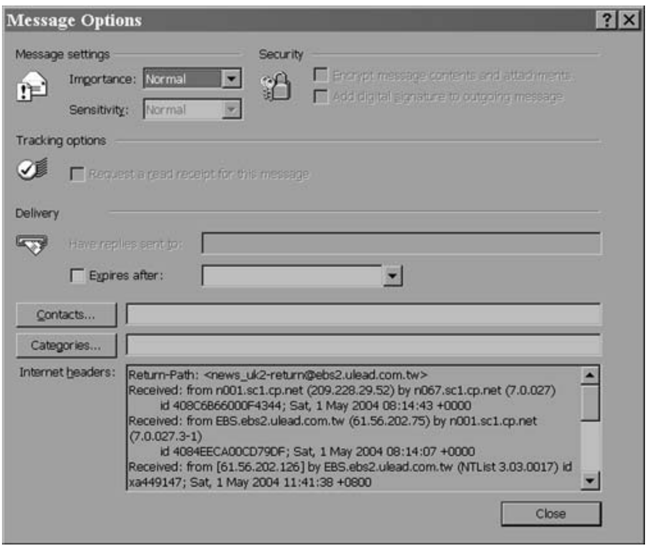

Figure 11.2 Using the Message Options panels of Outlook to examine message source and contents

possible to carry viruses by way of emails. The two main methods of doing this involve programs that run within an email that is in HTML format, and by way of attached documents.

Programs that run within HTML emails will run only if you open the email, and this is fairly easy to avoid. On Microsoft Outlook or Outlook Express, click the View menu, and make sure that the *Preview Pane* is **not** selected, nor the *Auto Preview* facility. When this is done your Outlook view consists only of email headers, not of email contents, and this ensures that any programs contained in HTML emails cannot run. This allows you to examine the header and decided whether you want to click on it to see the full contents or not. It should not be difficult to determine from the header whether the email is from someone you trust or not.

- If you want more information, right-click on the header, and then left-click on *Options*, which will result in a panel of information, Figure 11.2. This may be more information than you particularly want but at least it should give you some idea of what the message is about and whether or not it is something you want to get into. Look in particular at the section headed Internet headers, because that contains a line that starts content type and this will state text/HTML or other information that would indicate more than a simple text message.

You can also ensure (on Windows XP) quite a high degree of security on HTML texts by using the Tools – Options menu of Outlook and the *Security* tab, Figure 11.3.

In the *Secure Contents* portion of this tab you can specify what can or cannot be used in an HTML message, and it's fairly easy to specify a set of options that will prevent anything evil from being run. If you click the arrowhead at the *Zones* box and choose *Restricted Sites* and then *Zone Settings* and *Default* settings you will get a simple option for high, medium-high, medium-low or low security, Figure 11.4.

Make sure this is set to *High*, so that any program material (referred to as scripts, ActiveX controls and other names) will not run. You can see the full range of possibilities by clicking the *Custom Level* button, Figure 11.5.

You can, therefore, by using software that is built into Windows XP, ensure that you are not at a high risk simply by reading your email. There is, however, another way to get a virus in through an email,

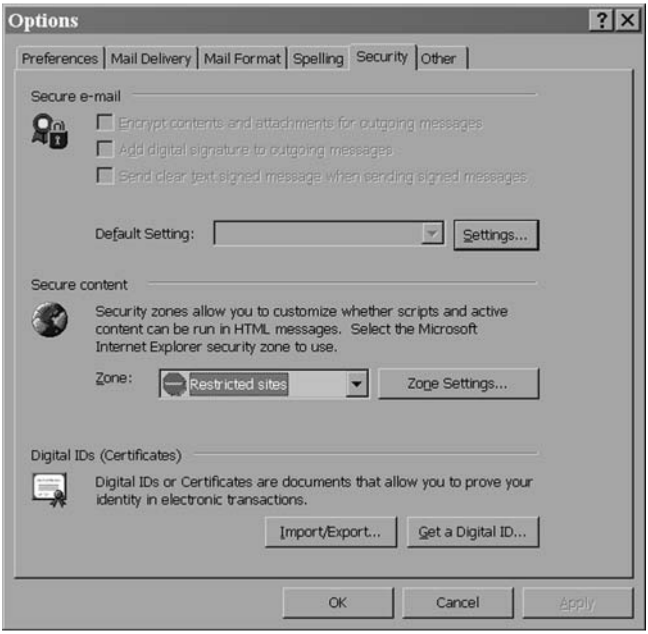

Figure 11.3 The Security tab of Outlook's Tools – Options

depending on your susceptibility to a confidence trick. This is by way of an *attachment*. Normally when you have an attachment to an email it is either something like a Microsoft Word document or perhaps a picture, and it is not of a harmful nature (unless your contacts send you very strange pictures or Word documents with a macro containing a virus). Emails containing viruses often have very intriguing titles, and if you click on the attachment that comes with it you will quite certainly launch the virus on your computer. What's worse, the virus action may be to read the contents of your contacts list and send a copy of the infected email to everyone on the list.

Once again, if you're really alert to these things you will look at the name of the attachment and know that the extension letters are not those of a document or a straightforward picture. For example, the extension letters exe, scr, pif are of those of attachments that will run a program of some sort when you click on them. Don't click, and preferably delete the whole email. For a DOC attachment, you can open it

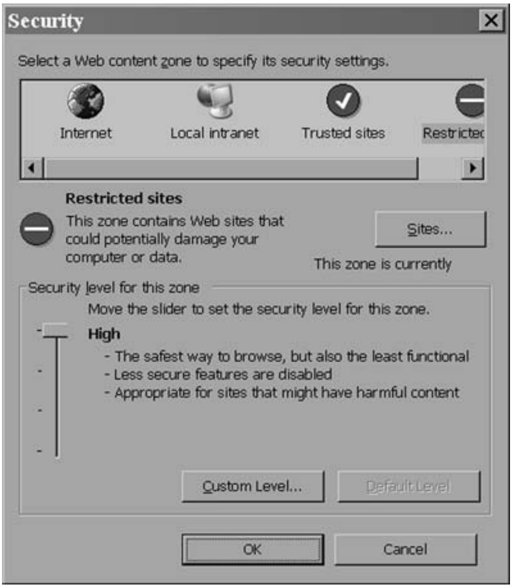

Figure 11.4 The Zone settings panel of Outlook

using Notepad initially so that you can see what it is about. If you are using Word 2000 or later, you can click Tools – Macro – Security to see a panel (Figure 11.6) that allows you to impose any of three levels of security on email attachments that contain macros.

- It's just possible that a friend may have sent you a screensaver (extension letters scr) and knowing who it is you could phone up to check that this was something quite harmless. On the other hand it may be that your friend has contracted a virus that has sent a copy of itself to everyone on this/our contact list and you are one of the contacts. If you have virus scanning software you can use it on the attachment, but if you haven't then don't click on it.

One of the problems about emails is that your email address becomes more widely known as time goes on. Unless you really need to, don't distribute your email address to people you don't know. Don't, for example, put your email address on a business card that can get into the hands of someone who would put it into a computer system where it

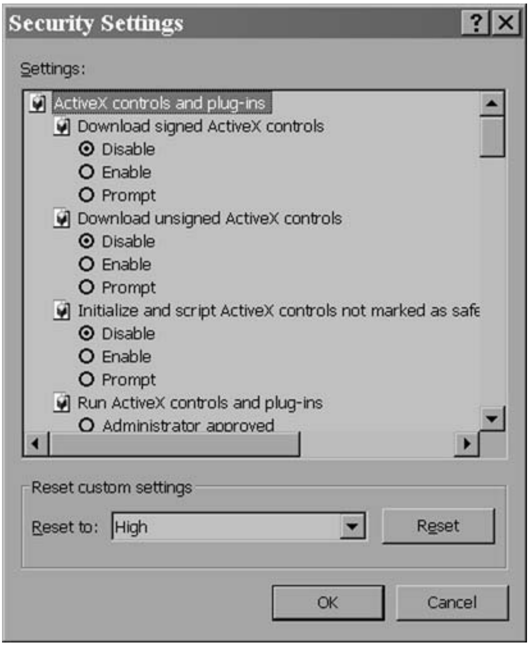

Figure 11.5 The Custom Level options

could be read by a data mining program (more of that later), and if you happen to have a web site, don't put your email address on that either.

Even with these precautions, you may find yourself getting a large amount of email every day, most of which is unwanted spam. This can take quite a large amount of time to sort out and one very valuable aid to it all is a little program called MailWasher. This operates by downloading the headers alone and giving you the chance to mark each one as a *friend*, *normal*, or *blacklist*. You can also download a list of well-known sources of spam to give a start to your blacklist. You should run MailWasher before you open Outlook so that all known sources of spam will be removed, and any suspicious emails can be bounced back. The merit of this is that the sender will never know if the email address that was chosen was really yours or not. The MailWasher program originates in New Zealand, and I recommend it highly. You can download it free of charge from:

www.mailwasher.net

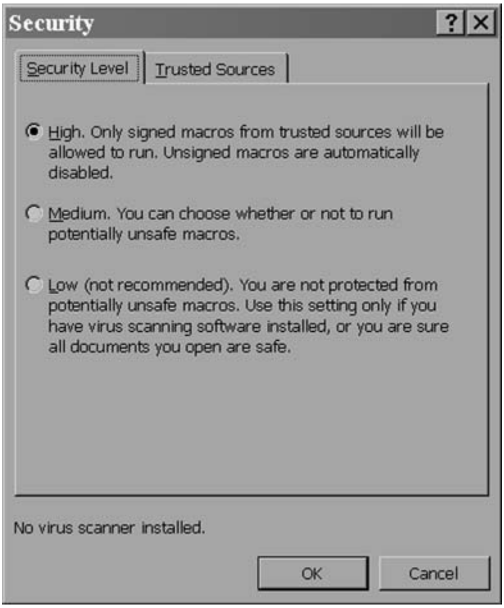

Figure 11.6 The Word 2000 attachment macro security panel

and when (not if) you decide that you can't live without it you can send a donation to the author (you are not asked to contribute much, and remember that the NZ $ is equivalent to 50 p sterling).

You can also protect against email viruses by using some types of firewalls, see later.

Outgoing data

Security isn't simply a matter of preventing unwanted programs from entering your computer. There's also a security aspect to what goes out of your computer. You might feel that you would not sit down and deliberately try to get access to a web site that would send you a virus but how would you know if there was a small program sitting inside your computer that contacted the Internet and did this thing for you? Another hazard, more common, is that the small program sitting inside your computer relays information about you to others which could be the prelude to a virus attack on your computer or, even worse, an attempt to gain access to your on-line bank account. Programs that gather information about you and transmit them are called *data miners* and though most of them are concerned with your preferences and use these to call down advertising rather than corrupt your programs or attack your bank account, it's still uncomfortable to feel that your information is not safe in your own computer.

This is a problem that can be dealt with by using a good firewall, something we'll look at later, but not all firewalls will deal with data mining programs though some virus checkers will certainly root them out. Here again, there is a useful free program that is very effective for getting rid of this sort of nuisance. It's called AdAware, from Lavasoft in Sweden, and it claims to detect and clearout 'datamining, aggressive advertising, parasites, scumware, keyloggers, selected traditional Trojans, dialers, malware, browser hijackers, and tracking components', which pretty well covers all the hazards other than viruses that can sit inside your computer undetected by you. You can download a copy from:

www.lavasoftusa.com

and set it up for yourself as you want it, Figure 11.7. You can set up AdAware so that it runs each time your computer is switched on or you can simply run the program as and when you wish. The same applies to updates of information which can be downloaded either automatically on manually as you want. The action of AdAware is to scan through all your files on the hard drive looking for data mining programs which are then 'put into quarantine', until such time as you want to delete them. The reason for the quarantine operation is to avoid the situation where you may have deleted something that you might still want to use. The action of quarantine is that you can recover a program from it but if you find that putting a program into quarantine does not affect your normal use of the computer then you can simply delete all of these quarantine programs without risk.

Security risk level

How much is your computer at risk? It's not quite so much a matter of what is fitted on your computer as the way that you make use of your computer. To illustrate that let's look at a few hypothetical cases.

Take as the first example someone who uses the computer only for document preparation, illustrations, and accounts. The computer has

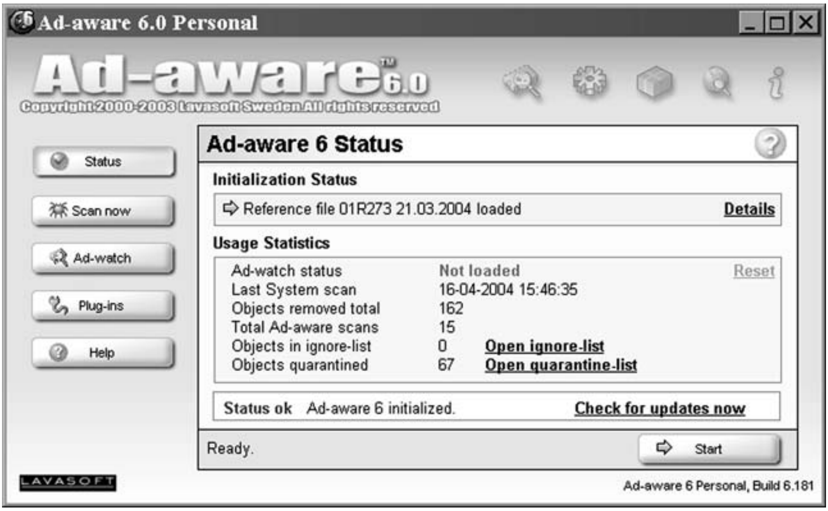

Figure 11.7 AdAware loaded and ready to run

no modem, and if it has it is not plugged into the telephone line. The user has bought all the software from reputable sources and has made no changes for several months. There is absolutely no risk to this computer and no point in buying expensive protection against viruses because this user is simply not at risk.

Consider a second example, someone who makes a fair bit of use of the Internet and email, using a dial-up modem for short periods only and running Windows *Me* or earlier. This user is cautious about what web sites are looked at and never accepts emails or disks from strangers. The risk is very low, and with sensible settings for the Internet browser and the email program the only precautions I would suggest are the use of MailWasher and AdAware.

Now let's look at a higher order of risk, someone who uses Windows XP with always-on broadband and searches the Internet fairly widely and does a fair bit of downloading of program material. Both the behaviour and the use of broadband require a bit of help in protection, and though sensible settings of browser and email program help, it's even better if a firewall is used. A virus scanner to check downloaded programs from uncertain sources might also be a useful precaution.

The highest order of risk is associated with the use of Windows XP or 2000, always-on broadband, careless surfing of the Internet, willingness to download programs from very doubtful sources, willingness to accept disks from very doubtful sources, and making a habit of using autopreview for emails and opening any attachments that come with emails. This sort of use requires a high degree of firewall and virus protection, together with a change in surfing habits.

Firewalls

We've talked quite a lot about firewalls, and now it's time to explain what they are and what they do. A firewall is a protective system, part of which can be hardware (built into the network device called a *router*), but more usually consisting of a set of programs designed to separate the users of one network (which might be simply your computer) from users on other networks (such as the Internet). A good firewall should screen your computer from anything but acceptable identifiable names and Internet addresses, and should also prevent any access to the Internet from your computer except from programs that you can approve and control.

The basic checks that a firewall performs are:

- where did the data come from and what port is it addressed to?
- do the rules allow data traffic through that port?
- does the data traffic violate any global rules?
- is the data traffic authorized by a program on your computer (Program Control settings)?

and the firewall software will determine from the results of these checks whether data will be allowed to enter your computer or not.

If your computer is in an office and is part of a large network, then the firewall will usually be in a separate computer through which all contacts to or from the outside will be made, with only approved contacts being used. For the home user, however, a much less strict routine will do because the tighter form of control would prevent you making use of the Internet the way you want to. A simple firewall is **not** a virus scanner, though it will protect against viruses that would otherwise come from sources that are unapproved.

Do you need one? There is no simple clear answer to that question. If you use a dial-up modem for Internet contacts, you make them short, you're careful, you adjust your computer browser settings and your email program settings for high security, then you may not need a firewall of any sort, or, at worst, a fairly simple one. Earlier versions of Windows are not so susceptible to problems of unwelcome intrusion for anyone who is careful about Internet and email contacts. Windows XP, however, is more vulnerable to outside attack, and to counter this, you can activate a simple form of firewall which comes as part of Windows. If you are running Windows XP and you haven't already activated the firewall, then do it as follows:

1. click *Start – Control Panel – Network connections*;
2. click the connection you are using (dial-up or broadband). Click on *Properties*;
3. click the *Advanced* tab, and click in the box marked '*Protect my computer and network by limiting or preventing access to this computer from the internet*';
4. this switches on the Windows XP firewall, Figure 11.8.
   - If you are using a broadband connection through a router (not a modem), you have to select the Local Area Connection in step 2 rather than the actual internet connection.
   - Don't activate the firewall if you are using virtual private networking between your computer and someone else's.

How do you know that you are protected? One obvious answer is to get somebody to try to hack into your computer, and there are agencies that can be trusted with the job of doing so. One such can be contacted on the web site:

http://scan.sygate.com/

and if you contact this web site you can request a scan specific to your computer that will probe all the usual weak points for unauthorized entry and send you a report on the results, usually in under a minute. My experience of this is that the windows XP firewall seemed to be completely effective as far as this test was concerned.

You can increase security if you have opted for broadband using a router. This is a slightly more expensive method of connecting to

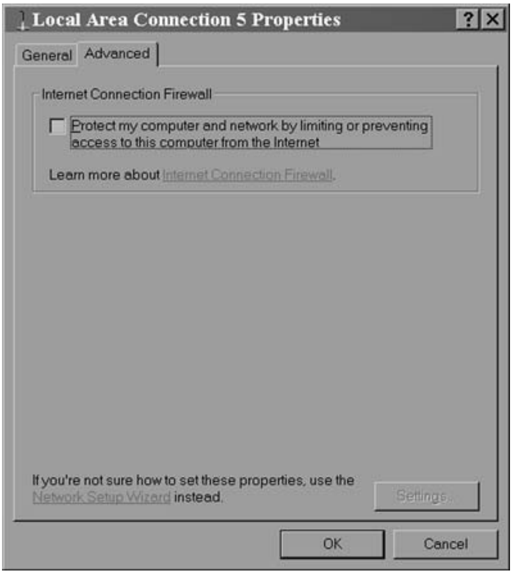

Figure 11.8 The control for switching the Windows XP firewall on or off

broadband than a simple ADSL modem, but if your computer is fitted with an Ethernet port, then the use of a router has several advantages. The home user can opt to use a router in the NATS format. NATS means Network Address Translation, and it uses just one Internet address number for all devices connected to the router. This prevents other Internet users from connecting into your computer without your permission, and using this system you have quite high security without a separate firewall.

The simpler forms of protection, however, apply only to incoming traffic, and they offer no protection against programs that contact the Internet, unknown to you, from your computer. They do not protect you, in addition, from the type of email that we have discussed that, through the use of HTML code or the use of an attachment can persuade you or force you to release a virus. If you want a higher degree of protection, you need a more effective firewall and possibly also some virus protection.

There are many sources of perfectly good firewalls, some at a very low price, or free, others requiring an initial payment and possibly also payment for upgrades. For the home user who is at a lower risk in any case, one highly recommended firewall is called Zonealarm, which exists in both free and (enhanced) paid-for versions. Zonealarm can be contacted at the web address:

http://www.zonealarm.com

and you can opt to download either the free version or the more enhanced Pro type. The free version is very well suited to the home user, but you have to be fairly persistent to be sure that this is the version you are downloading and you have to select this option to a series of panels. Once downloaded, you can run the program which has a name such as zlsSetup_45_538_001.exe (the number will vary for different versions) to start ZoneAlarm working. The program installs itself so that it will start running whenever you switch your computer on, an essential because a broadband connection is established also at this time. You should allow ZoneAlarm to set up using its default settings, which will be to check with you each time you use a program to connect to the Internet. Once you have been using the program for some time, it will know which programs are approved for Internet connection and you will be asked for confirmation only if some other program tries to make connection. That, of course, is the basis of the protection against unwanted Internet contacts. Figure 11.9 shows typical firewall settings of ZoneAlarm.

- Don't try to be too clever with the ZoneAlarm settings until you have had some experience of its use. In particular, trying to change your settings manually can often lead to you being locked out from some programs, usually browser and e-mail. In particular, be careful not to prohibit access for the actions described as 'Generic host process for Win32 Services'. If you find that you cannot use your browser and e-mail, the quickest way out for an inexperienced user of ZoneAlarm is to uninstall the program (using Control Panel Install/Uninstall) and set it up again.

ZoneAlarm also contains email protection, both for inbound and outbound email. The free version protects only against one inbound form of virus using the extension letters .vbs but this is certainly better

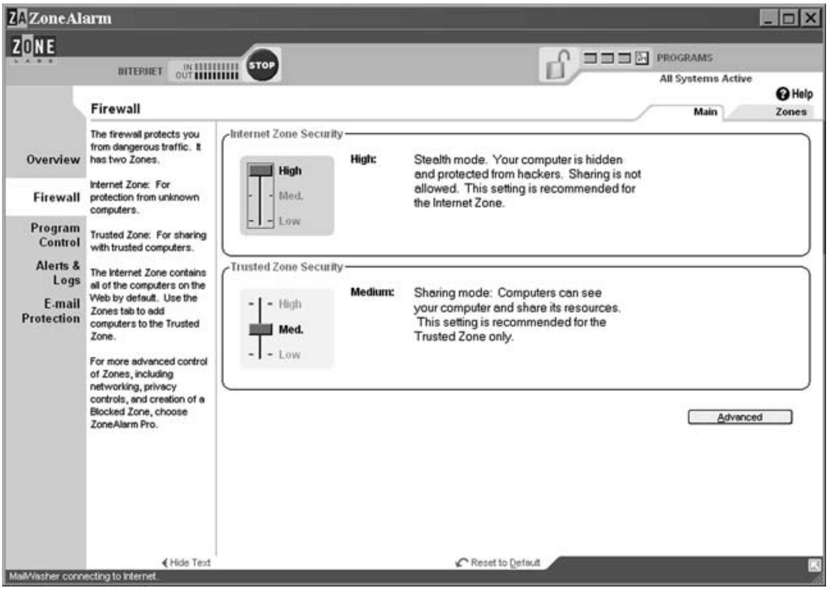

Figure 11.9 ZoneAlarm typical firewall settings

than no protection at all. The outbound protection, provided in ZoneAlarm Pro, will detect any attempt to send an unusually large number of emails or an email to an unusually large number of contacts, and questions if this is what you intend.

Virus scanners

Virus software is a double-edged sword as far as many computer users are concerned. It often comes fitted to computers whose use is such that they are never exposed to virus risks and it poses the problem of slowing down computer action, possibly requiring Internet access at frequent intervals, and preventing some actions, such as the installation or updating of Windows, until the program is disabled. You may never need virus software if you are particular about the way that you use the Internet and email; you will need it quite badly if you are careless with your Internet and email contacts.

- The well-known anti-virus programs are Norton and McAfee, and though they are reasonably priced, you may not need such a high degree of protection as to justify the cost.

There is one important protection against viruses that does not require any additional software because it is already built in to the ROM-BIOS of your computer. If you enter the CMOS-RAM as you switch on your computer, and switch to the advanced BIOS features, you will find almost certainly an item labelled as *virus warning* which by default is usually disabled. If you enable this then it will put up a warning message when any program takes to access the vital part of your hard drive (technically, the boot sector or hard disk partition table). This protection is disabled by default because if it is in place then you cannot install Windows without triggering the protection, but once you have your major software installed there is no reason why you should not enable this form of protection.

Useful as this may be, however, it does not allow you to scan a program file to check that it would be harmless to run, and it does not deal with other forms of viruses that leave these aspects of the hard drive untouched. If you feel that your use of the Internet and email services is such that you are in danger from viruses, you might consider a very useful free version of a virus checker that is extensively used and which can be updated as needed to deal with new viruses – the updating can be done automatically if you wish. The current version is AVG 6.0 for Windows, and it can be downloaded from the web site:

http://www.grisoft.com

AVG can provide resident protection, meaning that it will carry out a scan for intrusive viruses at all times when your computer is running. You can opt to scan manually if you know that you are not particularly liable to virus attack. Incoming e-mails are also scanned, and your outgoing e-mails are checked uncertified to be virus free. As is important for any form of virus scanner, you can update the virus database without additional charge, and this update can be made automatically, which is particularly useful for users of broadband. The system is easy to set up and use and will ensure that infected files do not cause any damage there is also a feature of a protected folder (the virus vaults) in which infected files can be kept safely. Figure 11.10 shows the initial screen of AVG.

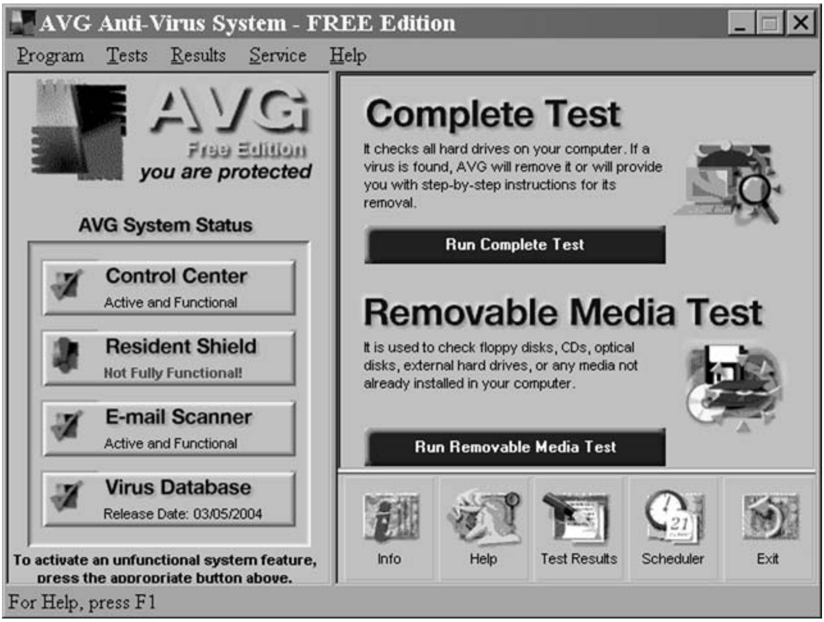

Figure 11.10 The initial set-up screen for AVG

Annoyances

The classic type of virus is a threat to your files and to your email contacts but there are lesser forms which, though comparatively harmless, can be nevertheless very annoying. One well-known type will establish itself as the home page of your browser so that when you try to contact the Internet you will see a page of links to commercial sites that you know you did not put in place for yourself. This type of annoyance is not so easily dealt with, because neither virus checkers nor programs to detect data mining programs seem to be able to deal with it. At the time of writing a short program called CWSHREDDER was very effective for dealing with this sort of thing, and it can be downloaded from any of several sites if you use a search engine for the name. No doubt that by the time this book is in print there will be new versions of the home page annoyance and an inquiry to a search engine will probably find some other program that will deal with it.

One feature of annoyances is that, in common with useful programs like virus checkers and firewalls, they automatically start to run when you switch your computer on. There are a couple of very useful free programs that are concerned with this aspect of protecting your computer. One is called *Startup Monitor*, and it will put up a small panel on your screen when a program tries to establish itself to run automatically, so that you have a chance to check whether you want to do this or not and stop it from running if necessary. The second program is the *Startup Control Panel*, which will examine your computer and find what programs start automatically. Only a few of these programs will be ones that are started automatically by Windows from the Startup folder, and some of them are essential to the normal running of Windows. There are methods by which you can list these programs from Windows itself, but these lack the useful information about which of them are essential and which are not.

To examine the automatically starting programs, you should download Mike Lin's Startup control panel from:

http://www.mlin.net/

and at the same time you should also download his *Startup Monitor* program. The downloaded *Startup Control Panel* file appears as StartupCPL.zip, and you should put this into a folder of its own so that you can extract the files and run the program. This puts a new item into your control panel, called Startup, and when you click on this, Figure 11.11, you will see a set of tabs dealing with different aspects of self starting programs in your computer. You can then choose which you would like to cease their action. Note that this is **not** the same as removing these programs, it simply ensures that they do not run automatically when the computer starts and you can reverse the process by using the Startup panel again.

The alternative to this provided by Microsoft appears in older versions of Windows as Accessories – System Tools – System Information – Tools – System Configuration Utility and is illustrated in Figure 11.12. This shows the Startup tab selected, with most of the items on the list not set to run. By default, all of these items will have their boxes ticked, and the illustrations points out that very few are really needed. Computer speed will be improved by reducing the number of automatically launched items.

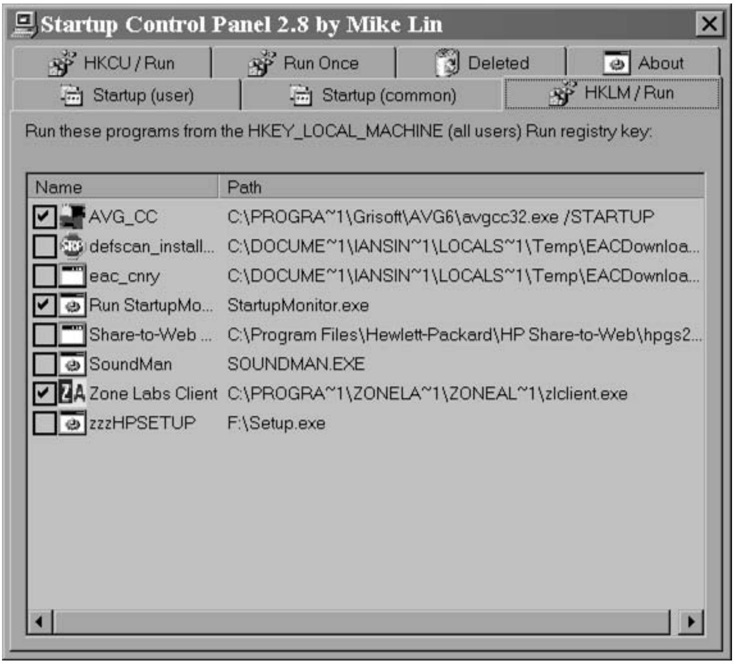

Figure 11.11 Mike Lin's Startup control panel

You can choose by clicking on the check boxes which programs you want to run automatically or not as may be the case. If you are using Windows XP click on *Start – Administrative Tools*, then on *Services (Local)* to see a list (Figure 11.13) of programs, detailing which are automatically started.

This allows you to change from automatic to manual by right-clicking the service and selecting properties. This gives a tab (Figure 11.14) containing the startup option so that you can choose automatic, manual or disabled as you please.

- Make a careful note of any changes you make, along with date and time, in case you find that your changes have caused new problems to arise. If you have any doubts about making such changes, make sure that *System Restore* will be able to restore things back to the way they were. To do this, Click Start – All Programs – Accessories – System

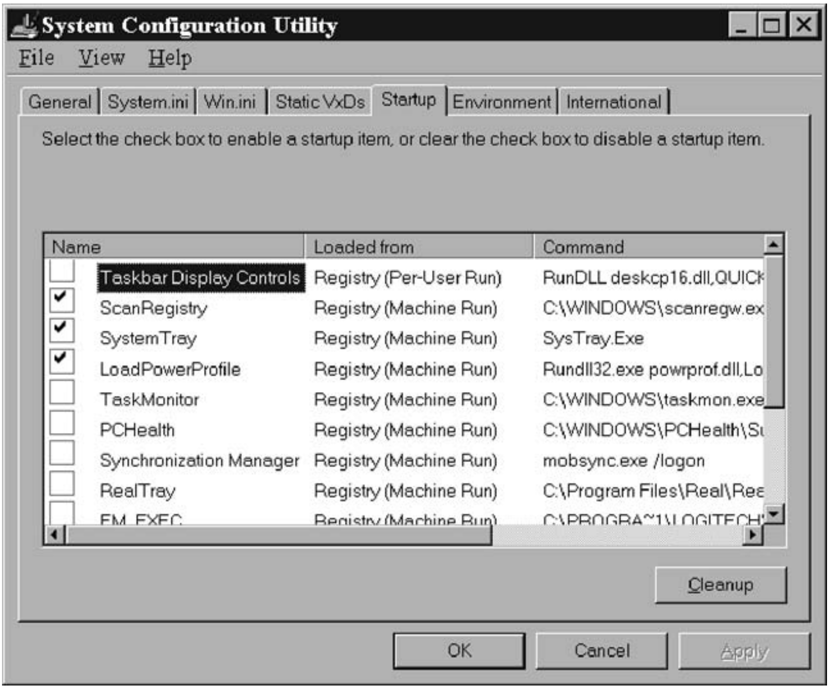

Figure 11.12 The Windows *Me* System Configuration Utility

Tools – System Restore and then on the item marked 'Create a restore point'. This will make a recording of the state of your computer, and if all goes horribly wrong you can use the System Restore command labelled as 'Restore my computer to an earlier time' to reset everything as it was before it all went wrong.

All in all, I prefer the simplicity of Mike Lin's Startup panel.

Pop-up removal

Finally, though it's not exactly a threat to security, there is the topic of pop-ups, these panels of advertisements that appear when you are

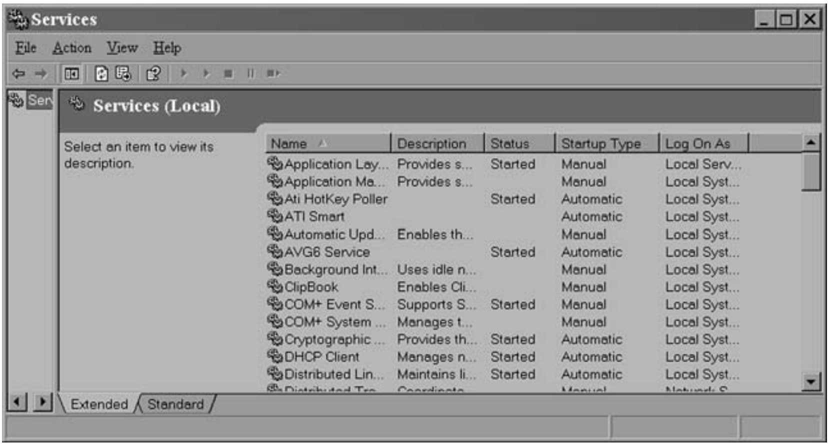

Figure 11.13 The XP list of programs that are automatically or manually started

Figure 11.14 Altering the startup options for a program

Figure 11.15 The Intellistopper toolbar for Internet Explorer

browsing some web sites. This is a form of 'annoyware' that can be very irritating and time-wasting, so any way of removing this type of nuisance is welcome, and there are several free programs that will do so. I have tried the Googlebar with success (a download from the Google search engine), though it vanished when I started a firewall that was provided with my broadband software. Another that I have tried with success is Intellistopper, downloaded from:

http://www.smartstopper.com

which adds a toolbar to Internet Explorer (Figure 11.15) that provides buttons for turning the action on and off, displaying a count of blocked pop-ups (and viewing them if you want to), telling a friend about Intellistopper, and searching (usually with Google).

If you find that a large number of pop-ups are being blocked, this usually indicates that you are connected to a web site that tries to track your use of the keyboard; an undesirable action that you should put an end to by leaving the site. The count of pop-ups continues while you have the browser running, and will be reset the next time you start Internet Explorer.

- On some types of pop-up stopper, you may find that clicking a link in a web site has no effect unless you hold down the Ctrl key at the same time. Check with the Help file for the stopper if this applies to the stopper you are using.

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Part V

Junior League Upgrading

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Chapter 12

Upgrading older machines

There is another form of upgrading that you might wish to consider for machines that are not exactly at the leading edge of modern computing. Though it is desirable, if you wish to use modern software, to have a machine that is constructed to modern standards with a fast processor, large hard drives, and adequate memory, you may feel that you can manage on a machine of lower capability, using older software. You might also consider such a machine as a gift to the child or grandchild so that they can use educational software, and not worry too much when they find that they can't run new fast games on it. You might feel that an old machine has given you good service, and that a modest upgrade is all that you need for the foreseeable future. If these are your needs, this chapter is designed to help. Since the techniques of upgrading are covered in other chapters, this can all be brief, but a few points are repeated for emphasis.

Assessing possibilities

You need to take a look first at what has to be upgraded. Upgrading a really old machine is simply quite impossible, so that if you have an ordinary PC of the 8086 or 8088 variety, and that includes the first

Amstrad models, any form of upgrading is out of the question. The same must now be said of the computers that use the 80386 or 80486 processors. The absolute minimum standard for even the most modest upgrading outlined in this chapter is a machine that uses the old Socket-7 motherboard with either a Pentium or AMD K6 processor. Let's look, to start with, at what we might be able to make use of in such a machine.

1. The motherboard, if it is of the Socket-7 type that was popular not so very long ago, may be able to support one of the faster processors, for example, an AMD K6 MMX type with a decently fast clock speed (such as 400 MHz), together with more memory and any cards that will extend its capabilities, such as a modem card and sound card. If you are upgrading a Pentium-1 machine, you should enquire to find if a faster Pentium chip could be fitted into the same motherboard, allowing you to reuse the old motherboard rather than buying a new one. The trouble with Pentium chips is that they went through a vogue for slot fitting, and slot-fitting motherboards are now difficult to find.
2. If the motherboard will not take a faster processor, the case may be usable if it will take one of the Baby AT sized boards that were in use a few years ago. Figure 12.1 shows the outline of a classic Baby AT board, and if this looks as if it would fit into your casing, then it will be possible to upgrade with a new motherboard. The point here is that the older types of motherboards had the processors soldered into place, so that there is no possibility of replacing the processor in such a motherboard.
3. The 3½-inch floppy drive can be used in an upgrade machine, provided that it is of the later 1.44 Mbyte type rather than older 720 Kbyte type. If the floppy drive is of the old 5¼-inch size, take it out and sling it. If there is no provision for a 3½-inch drive, the case cannot be used.
4. If there is a CD-ROM drive fitted, it may be usable provided that it is driven from an ATA connector, and not from a sound board or other unorthodox source. The CD-ROM will probably be a slow variety, but that's better than nothing.
5. The hard drive will probably be much too small for a modern version of Windows, and if it is connected through an interface card in one of the motherboard slots, then it is simply inappropriate for a modern machine. If you are lucky enough to have a hard drive of nearly 1 Gbyte, then it can probably be used, but remember that

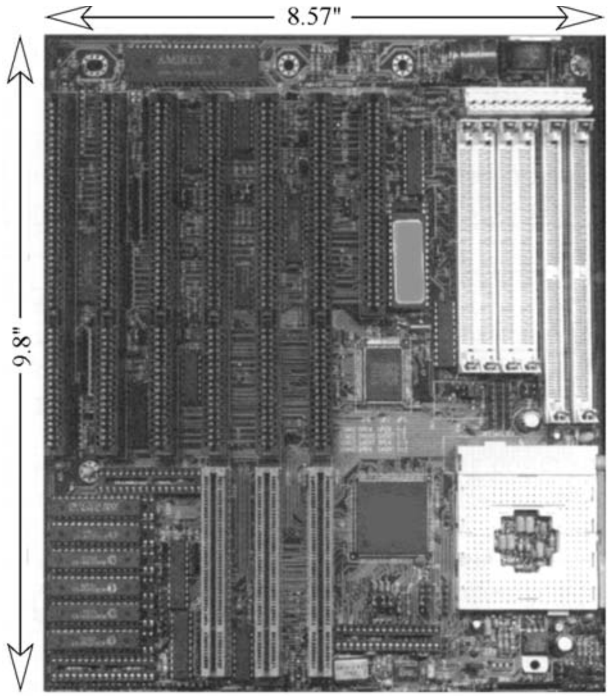

Figure 12.1 The outline of a Baby AT board

an old hard drive will have a large number of miles on the clock and may be near the end of its useful life.

6. Any sound board on the old machine is likely to connect through an ISA slot, but if your need for a sound is modest or zero, then it's good enough.
7. A modem on an old machine is not worth retaining because it will be a very old and slow variety, which cannot be used for Internet connection because ISPs now insist on fast modems.
8. The memory on an old machine will almost certainly be in SIMM units, but if there is enough of it and it can be used in the new motherboard then you **might** be able to recycle it.

All of this may sound rather pessimistic, but the technology has changed so much over the last five years, and older components have become so scarce, that it is almost impossible to do an upgrade on an old computer without a large number of replacements. Whether the work is worthwhile or not depends on your need for such a machine, and how many bits and pieces you can pick up from the junk box at a computer fair. The problem with such a source of components is that you seldom have any instructions or manuals so that you are thrown back on your own experience to decide for yourself what can be used. Stallholders at computer fairs are generally very helpful over such advice, but you have to remember that there is a limit to how much help you can expect for the low price that the items cost.

Some suppliers of old parts advertise in the weekly magazine *Micro Mart*, and regular advertisers include:

Name	Website	Phone	Notes
EZ Computers	www.ezcomputers.co.uk	01292 267267	Modern stuff as well
Sterling XS	www.sterlingxs.co.uk	01483 301331	Mostly complete machines
AUT	www.autdirect.co.uk	01702 382740	Huge supply of old bits
Saturn Computers Ltd.	www.6thPlanet.com	01189 733373	Complete or bits

The motherboard

The motherboard is the main board that contains the microprocessor, its support chips and the main system memory. Some older machines use the full-sized AT case rather than the Baby AT size, but this is an undesirable type of board because so much of it is inaccessible underneath the power supply unit. Figure 12.2 shows an example of a baby AT board designed to use a Socket-7 processor.

- The slots on the motherboard always face to the rear of the computer, and the keyboard connector must also be at the rear, but otherwise the position of components is not fixed, nor are the precise dimensions.

The problem is where to find a suitable baby AT board. You will not find such boards advertised in most of the computer magazines other than as clearance items, but you might be able to pick up such a board, possibly with a suitable processor, from suppliers such as AUT whose

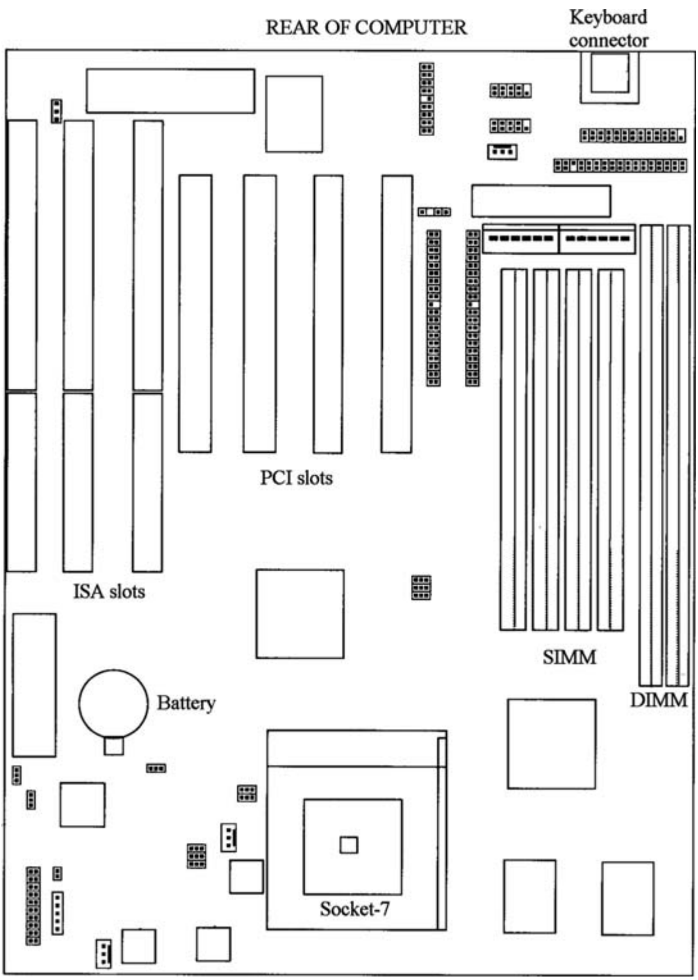

Figure 12.2 A Baby AT board for Socket-7 use

web site is www.autonline.co.uk. At the time of writing they could offer an AT motherboard with sound, and video and modem on board and an AMD 550 MHz processor with heatsink and fan for around £90. Figure 12.3 shows a typical Socket-7 processor.

- If you currently have Internet access, you can type in the name of the item you are looking for, being careful to specify a UK-based search

Figure 12.3 A typical AMD Socket-7 processor, courtesy of AMD Inc.

engine (such as www.google.co.uk) so that there are no excessive carriage charges involved.

One of the main problems about using a motherboard that is no longer in production is that if there is no documentation with it you may have considerable difficulty finding out about jumper settings, suitable chips, type of memory and so on. Once again, you may be able to find out something from the supplier, but if not, make use of the Internet and find if anyone has suitable information. The following web site can often provide links to manufacturers who will download manual information on motherboards, though there is no guarantee that the older models will still be supported:

http://www.motherboards.org/manuals.html

MOTHERBOARD PREPARATION

Jumpers are used on most Baby AT motherboards to switch actions in or out, or to allow for options; there is no software setting option.

Each jumper unit normally consists of a row of three small pins with a bridging clip, the jumper itself, which can be placed over two pins to provide two settings (sometimes three settings if the design provides for the jumper to be removed altogether). Jumper settings should be correct if you have bought a bare-bones system with the motherboard already installed in its case, and very often there is little chance of altering jumpers once the machine is fully assembled.

When you have read all the information on the motherboard and made notes about anything you need to watch out for, unpack the motherboard. The final wrapping will be of a material that is slightly electrically conducting, and when you take the motherboard out of this material you should lay the board down on this sheet of material to make an inspection. Touch the motherboard only at the edges at this stage, and try to keep your hands away from the metallic connections as far as possible at all times.

You will need to check any jumper settings very carefully before you place the new motherboard into the case. The small (and usually anonymous) manual or leaflet that comes with the motherboard will list the jumper settings, and these are often pre-set correctly, particularly if you have specified the type of processor chip you will be using. If they are not, it is not always clear what settings you ought to use, and you may need to enquire from the supplier of the board.

Another problem is that manuals usually show the pins numbered, but this numbering is not necessarily printed on the motherboard or, if it is printed, it is obscured by chips or other resident obstacles. The description that follows is of jumpers on a Socket-7 board of a few years ago. This is fairly typical of practice on Socket-7 boards, and most boards that you are likely to come across will provide for a similar list of jumpers.

TYPICAL JUMPERS

- You must always switch off the computer and allow a few minutes for voltages to decay to zero before you attempt to change jumpers. Always check jumper settings after you have made a change.

One jumper is used to control CMOS-RAM, and its default position keeps the CMOS-RAM cleared of any data. This will have to be reset to the working position before the motherboard is installed. Another jumper sets the voltage supply for DIMM memory, usually to 3.3 V, with the alternative, seldom needed, of 5 V.

Some boards have a jumper termed the *Function* jumper, and if this is used its settings are important. Typically these will allow three options labelled Normal, Configure and Recovery. In the *Normal* configuration, the BIOS uses the current CMOS-RAM settings (see later) for booting. In the *Configure* setting, the BIOS set-up will run and the screen will display a maintenance menu (this corresponds to the use of keys to activate the CMOS-RAM display). The *Recovery* option can be used only if you have inserted a floppy containing BIOS information and this data will be read and used.

A very important set of jumpers deals with CPU type and voltage. One jumper setting is for Pentium type, either P54C (dual voltage) or P55C (single voltage) types. Another set of jumpers will set the CPU (core) voltage to the required voltage within the set 2.5 V, 2.8 V, 2.9 V, 3.2 V, 3.3 V or 3.5 V. You need to set the jumpers for the type of chip and the exact voltage that your CPU chip needs.

That's easier said than done. Motherboard manuals are not always up to date, and a chip is often supplied with little or no data. A good rule is that the faster chips use lower voltages, so that if you are going to use a chip that runs at 300 MHz or more it is likely to use the lower range of voltage settings. In particular, if the chip is of the old MMX type it is likely to run at 2.8 volts, though some motherboards insist on using 3.2 volts. The sure sign of using too high a voltage is that Windows will not run correctly and even some DOS commands (like DIR) will not run correctly. If reducing the core voltage restores normal operation, you can be certain that the higher voltage setting is incorrect, whatever the documentation states.

- Note that AMD K6 processors of speeds from 300 MHz to 400 MHz, all specify a working voltage of 3.3 volts

The next important settings are the internal clock speed jumpers which are set for the type of processor you are using. The settings are usually graded as 1.5×/3.5×, 2.0×, 2.5× and 3.0, and the usual default is 2.0×. You will need to check the manual for the motherboard and any leaflets that come with the processor to know how to set this. Several modern motherboards can make this setting automatically by sensing the type of CPU that is inserted, and some jumper settings work differently with different processors. These internal speed jumpers allow you to overclock the CPU.

The other clock setting is labelled *External clock* and typically allows for bus speeds of 60 MHz, 66 MHz, 75 MHz, 83 MHz, and 100 MHz, often higher speeds also. The 66 MHz speed is the usual default for the slower Socket-7chips, and 100 MHz is used for the newer faster chips, including AMD K6. You will, once again, need to check carefully to find if you need to use a different speed.

- Remember that if you are using a 100 MHz (or faster) bus speed that your memory chips need to be of the faster type. This setting is sometimes referred to as the FSB (Front-side bus) speed. Motherboards for Pentium-III will need to provide a 133 MHz bus speed, and must use memory that is capable of operating at this speed. This speed capability extends to the other supporting chips, but if the motherboard can use 133 MHz it's almost certain that the chips that come on the motherboard can also.
- Note that the motherboard design fixes the maximum speed of CPU that you can use. Very few motherboards using Socket-7 provide for CPU speeds above 450 MHz.

Take your time, enquire if necessary, and do not install the motherboard into the case until you are totally satisfied that the jumper settings are correct. A familiar problem is that the documentation may tell you that the setting you want is to jumper pins 1 and 2, but there is no pin numbering on the motherboard. If you come across this problem, you will often find that you can deduce pin numbers by looking at other settings which you are fairly sure have been correctly pre-set. You may find, for example, that pin 1 is the pin closest to the end of the motherboard that contains the expansion slots.

Once the jumper settings have been dealt with and double-checked, you can install the CPU, unless this has already been done by the supplier. Normally, if you buy a board and a CPU by mail order, the CPU will have been inserted and the jumpers set, except for the CMOS-RAM jumper. If you buy the motherboard and processor separately (at a computer fair, for example), you will have to insert the CPU for yourself and also check that the jumper settings are correct.

SOCKET INSERTION

The procedure for inserting a CPU into a Socket-7 is much the same as it is for the later Socket-A. Before inserting the CPU check that it is the type you ordered, and note which corner has an identification such as a pin missing, a notch, and a white dot. Some heatsinks come with a small tube of heatsink grease (Electrolube) that helps in heat transfer, and you can order this separately from Maplins stores. Only a thin film is needed, and you should not have grease oozing out from between the fan and the chip. You can get away with omitting the grease on the slower chips such as the 166MMX type, but not on the faster chips.

The procedures for fitting the processor and heatsink/fan are much the same for Socket-7 boards as for the later types such as Socket-A (AMD) or Socket-487 (Intel). Pull the lever away from the body of the Socket-7 on the motherboard and then pull it upwards, Figure 12.4. A CPU for Socket-7 has a notched corner with a white dot to identify its pin 1 position, and this needs to be placed at

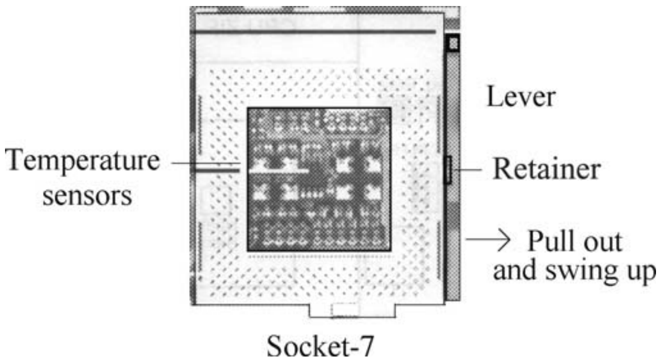

Figure 12.4 The view over an empty Socket-7 holder

the corner of the socket that has a hole missing and a figure 1 stamped on the socket. The CPU should drop into place, any resistance probably indicates that it is the wrong way round. Once the CPU chip has been dropped in you can replace the lever so that the chip is locked in place.

You can then fit the cooling fan, Figure 12.5. This item clips over the top of the chip, and the clips are very strong because they have to keep the fan in very close contact with the chip. You will need to support the motherboard with your fingers to avoid excessive flexing when you press down the clips on the fan.

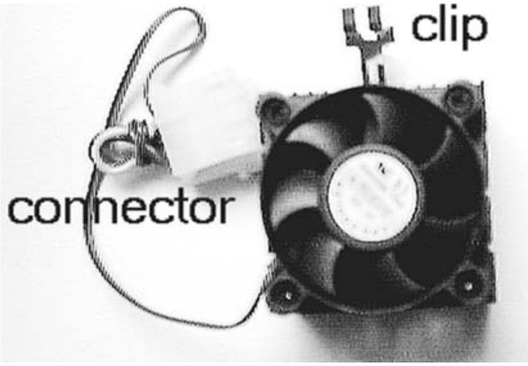

Figure 12.5 A typical fan for Socket-7 use, connecting to the PSU leads

MEMORY

Following these settings of jumpers and CPU insertion you will need to install memory, and on all modern Baby AT motherboards this is usually done using DIMMs. These are used in much the same way as the earlier EDO SIMMs, and the obvious difference is that the DIMM uses a much larger number of pins, 168 as contrasted with the 72 of a SIMM. A DIMM is also easier to install because it can be inserted directly and clipped in – the older SIMMs had to be inserted and then turned to lock them in place. The modern DDR DIMM boards cannot be used – they have 184 pins.

- By this time you will have sorted out which of the many varieties of memory chips your motherboard can use and bought the appropriate type. Be careful if your motherboard seems to accept both SIMM and DIMM units, because it may not be able to accept mixtures of both. If it can accept mixtures, you may be able to reuse some of the SIMMs from the old motherboard. SIMM boards usually had to be installed in pairs.

Connections are made to the DIMM just as they are to expansion cards, using an edge-connector, a set of tiny metal tongues on the card which engage in springs on the holder. The DIMM is clipped in by spring-loaded holders at each end. Suitable DIMMs come in sizes from 16 Mbyte to 256 Mbyte, and you can use a DIMM singly, so that you could use, for example, a single 64 Mbyte DIMM for this amount of memory, and subsequently add to your memory by adding another DIMM of any size.

EDO SIMMs come in sizes from 8 Mbyte per SIMM to 128 Mbyte per SIMM, and they must be installed in pairs. You are not likely to be using SIMMs except for upgrading an existing motherboard that is otherwise satisfactory. If you want to mix SIMMs and DIMMs you need to check with your motherboard documentation that this can be done. You may be able to use only one specific DIMM socket if SIMMs are present, but many modern motherboards do not accept SIMMs at all.

MOTHERBOARD INSERTION

Once the CPU and memory units have been inserted, the motherboard can be mounted into the casing, but don't rush into this task. Very often when a Baby AT motherboard is in place, part of it lies under the power supply unit, and because of this the PSU is often supplied separately, not connected in. The later ATX layout is much better in this respect, and nothing needs to be removed for easy access.

For installing a Baby AT board, don't connect in the PSU at this stage, and if the casing has come with its PSU fastened into place, check with the motherboard locating point to see if any of the motherboard will be covered by the PSU. If it is, as is normal, you must remove the PSU by unscrewing the three small bolts at the rear of the case and the three underneath. If your PSU uses a different number of bolts, make a note of this. A miniature socket set is useful for these bolts.

- It is particularly difficult to plug in the power connectors to the Baby AT board if the PSU is in place, and you may also have difficulties with the IDE connectors and the ports.

With the PSU laid temporarily out of the way, you can now concentrate on the motherboard mountings. Metal cases for the PC have their locating fasteners located in standardized positions, and motherboards are provided with matching location holes, so that it is very unusual to find that there are any problems in fitting a new motherboard into a new case.

Do not expect, however, that a new motherboard will have exactly as many mounting holes as there are fasteners on the casing, or that all of the mounting holes will be in the same places. Remember, though, that a motherboard should **never** be drilled because the connecting tracks on the surface are not necessarily the only tracks that exist; most boards are laminated with tracks between layers. Drilling through any of these tracks would be a very expensive mistake.

The fitting methods vary, but the most popular systems use either a brass pillar at each fixing position or a plastic clip at some positions. The brass connectors are screwed into threaded holes in a case and the motherboard is bolted in turn to the pillars; the plastic clips that fit into slots in the case are pushed into the holes in the motherboard and then slotted in place.

There should be at least one brass pillar fixing that is used to earth the motherboard electrically to the casing. Quite often, only two screwed fittings are used, with the rest being either clips or simply resting points. The motherboard must be well supported under the slots, because this is where pressure is exerted on it when cards are plugged in. If there are no supporting pillars in this region you may be able to get hold of polypropylene pillars of the correct size and glue them to the floor of the casing – do not under any circumstances glue anything to the motherboard itself.

When you have the motherboard in place, check everything again. It is remarkably easy to plug in jumpers with only one pin making contact, for example, and when you come to make other plug and socket connections this is also a hazard to look out for. If the paperwork that came with the motherboard did not have a sketch of the motherboard, this is the time to make one for yourself that shows where the board is mounted and where the jumpers are. Remember that it is often very difficult to alter jumpers once a motherboard has been fitted in place, particularly if the jumpers are underneath the power supply box.

On a Baby AT board that contains connectors for power input and for disk drives, you should consider fitting the PSU cable connectors, Figure 12.6, at this point, because they can be very difficult to reach when the PSU box is in place. In addition, you can support the motherboard more easily with the PSU box out, and ensure that the plugs are correctly inserted. This does not absolve you from checking these plugs again afterwards, because in the course of connecting up these plugs

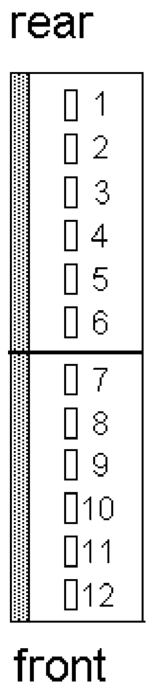

Figure 12.6 The connector type used for the power socket on a Baby-AT board

can (and do) work loose, cause problems with hard drive and CD-ROM use.

You now need to re-install the PSU box if you removed it earlier. If you are fitting a PSU that came separately packaged the first requirement is to check that you have all the mounting bolts – these are usually American UNF or M5 metric types which are not easy to replace, certainly not at your local ironmonger or DIY store. The second point is that the PSU has to be slid rather carefully into the casing, ensuring that the weight of the PSU does not rest on the motherboard. This is more difficult if the older design is used with a switch at the side. The thick and stiff set of cables from the PSU makes this task of fitting more difficult than you might expect. The shape of the PSU box allows part of the motherboard to lie underneath it without touching the components on the motherboard. Once the mains switch is located, it is easy to position the PSU so that all the screw holes line up, and the bolts can be put in place, finger-tight at first.

As you tighten the bolts, check that the mains switch, if it is on the PSU box, can be operated easily. Some casing slots are a tight fit for the switch, and if the PSU mountings are a fraction out of line the switch will jam or be stiff. This can usually be avoided by moving the PSU slightly on its mountings as you tighten the bolts, but you may need to file the slot to get a perfect fit. If this is needed, take the PSU out again, and file with the outside of the slot pointing down, avoiding any filings landing on the motherboard. Tap the casing afterwards to remove any lurking filings – just one filing bridging tracks can cause puzzling symptoms that cannot be detected by any automatic checking system. Most modern casings have a main switch that is on the end of a cable and which plugs into the front of the casing.

ADDING DRIVES

We need to look at the installation of a hard drive first, because on a flip-lid casing it is normal to keep the hard drive in the lowest of the drive bays of a set, making it inaccessible once the floppy drive has been fitted. The tower type of AT casing often provides a bay at the back of the case for the main (or only) hard drive, making this easier to get to without removing anything else.

Do not assume that a drive will be provided with mounting brackets at exactly the same places as the drive-bay, though these positions are usually standard on PC clones. An adapter will be needed if you want to put a 3½-inch hard drive into a 5¼-inch bay, but modern cases should be well provided with 3½-inch drive bays. You should enquire when you order or buy the drive what provisions are made for mounting it on the style of casing you are using. Make sure that all mounting bolts and connecting cables are supplied with the drive.

The drive bay has slots at the sides to allow for to and fro adjustment of a drive and two sets are usually provided at different heights in the bay. These should fit the hard drive in a 3½-inch bay without any problems and also fit a 5¼-inch bay using an adapter plate. Hard drives must be mounted to the bay or the adapter plate by way of small bolts fitting into their threaded mounting-pads. This is important because these pads act to cushion the drive against shock. Any drive that has external access should be adjusted so that its front panel is flush with the front panel of the casing.

In no circumstances should you consider drilling the casing of a hard drive in order to mount it in any other way. You should also handle a hard drive by its casing, not holding its weight on any other points. In particular, avoid handling the connector strips at the rear of the drive or any of the exposed electronic circuits. Read any documents that come with the hard drive to find if there are any prohibitions on the use of mounting holes – sometimes you are instructed to use only the outer set of holes.

The 5¼-inch type of hard drive, usually large capacity drives, will fit into any bay of this size with no need for adapters. The 3½-inch drives use underside mountings as well as side mountings, which makes it easier to attach them if the side fastenings are difficult to reach. If you have problems, Meccano brackets and strips can usually ensure that you get the drive unit firmly fastened. In a desperate situation, there is nothing wrong with fastening the drive to a metal plate and sticking this to the casing with self-adhesive foam pads. Maplin supply very useful side-plates for fitting a 3½-inch drive into a 5¼-inch bay.

DRIVE INSTALLATION

You will almost certainly have to replace the hard drive of an older machine. This presents two important problems. One is that the motherboard BIOS may not be able to cope with large hard drives. The other is that you will not be able to find any small hard drives. Don't be tempted to buy a second-hand hard drive, because you have no idea what its life might be, and a hard drive failure can be frustrating and expensive. With luck you should be able to find a hard drive of modest capacity (5 gigabytes or less), which will come with software that allows the BIOS to recognize it and to make use of all, or most of, its capacity. Don't rush into buying a new hard drive unless you are quite certain that you can use it with your motherboard.

Before you start, check the drive package to make sure you have all of the mounting bolts, any adapter that is needed, cables (if not already on the computer) and instructions. Check that you have the necessary tools – a Philips screwdriver (possibly a plain-head type) and a pair of tweezers are usually needed.

The bolts are usually either 6-32 UNC × 0.31 (5/16″) or metric M4 × 0.7-6 H, but some drives use M3 × 0.5. UK suppliers use millimetre sizing for the length so that the size will show 5 rather than

0.5 or 6 in place of 0.6. The frame of the drive may be stamped with M for metric or S for UNC. If you need spare UNC bolts you will need to contact a specialist supplier, but the M4 metric types can be bought from electronics suppliers such as the well-known Maplin or RS Components.

At this stage, check that any jumpers or switches are correctly set. Once the drive is in place these will be impossible to reach. Use tweezers to manipulate these devices. It is not always obvious from the accompanying instructions what settings are needed, and though drives are often set ready for use in a standard type of machine you cannot rely on this. Jumpers will quite certainly need to be set if you intend to use more than one hard drive.

Unpack the drive carefully and read any accompanying manual carefully, particularly to check any prohibitions on drive fastening or mounting positions. No drive should ever be mounted with its front panel facing down, but most drives can be placed flat, or on either side. Check that any adapter plate fits into the mounting bay on the casing and that all bolts and cable adapters (see later) are provided.

The hard drive is usually placed as the lowest in a set of drives on a desktop casing, and in a position nearest to the motherboard in a tower casing. Check also that the drive data cable will reach from the EIDE connector on the motherboard to the drive – you may need to put the IDE board in a different slot if the cable is short (as they often are).

Fasten the 3½-inch drive to its bay or adapter, using the small bolts that are provided to bolt into the mounting pads. Tighten these up evenly and not excessively. If an adapter is used, bolt this into its bay. Check that you can still place a floppy drive above the hard drive unit, if this is where it will be put. This latter point is important, because floppy drives have an exposed flywheel on the underside, and the slightest contact against this flywheel will prevent the floppy drive motor from spinning. There should be no such problems if the 3½-inch floppy drive is being mounted sideways in a bay specially provided for this purpose, because such a bay is usually well clear of any others.

Installation is not a particularly skilled operation, though experience with a Meccano set as a child is helpful. Problems arise only if the mounting pads on the drive do not correspond with openings in the bay, or you have no adapter for a 3½-inch or 2½-inch drive, or an unsuitable adapter, or you manage to lose a mounting-bolt. A mounting-bolt that falls inside the drive casing or the computer casing can usually be shaken out or picked out with tweezers. Do **not** use a magnet to retrieve a bolt from a disk drive casing. Do **not** attempt to make use of other bolts, particularly longer bolts or bolts which need a lot of effort to tighten (because they are ruining the threads in the drive). It is better to mount a drive with only three bolts rather than to add one bolt of the wrong type.

EIDE/ATA INTERFACE

Now connect up the cables to the drive(s). There are two sets of cables required for any hard drive, the power cable and the data cable. The power cable is a simple four-strand type with a four-way connector (some drives use only two connections of the four). This connector is made so that it can be plugged in only one way round. For details of these connectors see Chapter 5.

The same power cable is used for floppy drives and for hard drives, and modern AT machines usually provide four or five plugs on the cable. The plug is a tight fit into the socket and usually locks into place. The socket for the power plug is obvious but some disk drives need an adapter which should be supplied.

The data cable, illustrated earlier, that connects to the IDE drive is of the flat 40-strand type. This plugs into the matching connector on the motherboard at one end and into the drive at the other, with no complications. Look for one strand of the cable being marked, often with a black, striped or red, line, to indicate pin 1 connection. This makes it easier to locate the connector the correct way round. Do not assume that one particular way round (such as cable-entry down) will always be correct, or that a second hard drive will have its pin 1 position the same way round as your first hard drive.

ADDING AN OLD PRINTER

If you are adding an old second-hand printer to an equally old computer and you cannot find your printer listed and there is no disk of driver software (for a second-hand printer, perhaps), your options are limited. One is to make use of an emulation or a substitution. Despite the huge number of makes and models of printers that you see advertised, there are remarkably few manufacturers of the basic mechanisms or *engines* as they are called. An inkjet printer of uncertain origin will probably use an engine from either Canon or Hewlett-Packard, so that installing a driver for a model from one of these manufacturers will allow you to get printing, even if some actions are not supported.

- You can usually get the printer to provide text, but you may find problems with graphics and colour if you are not using the correct driver. It's easier to find a suitable driver for monochrome printers.

Finding what model to emulate is not quite so easy. If there is any paperwork with your printer it may refer to an emulation such as to the H-P DeskJet 500C or to the IBM ProPrinter. Laser printers can often make use of a driver from the Hewlett-Packard LaserJet series. If you cannot find useful information with the printer, try contacting the manufacturer, either by post or (much better) over their Internet web site. You can also try News groups on the Net to find if anyone else in the World has experience of your problems. It's highly likely that you will get information on the printer, where to find drivers, what to watch for and how to sort out trouble.

Once you have downloaded a driver to a floppy, you can proceed with installation using the *Have Disk* option button. You are now ready to print out data from Windows as required.

And finally…

Apart from processor, motherboard and memory, much of the work of upgrading an old machine follows along the same lines as for upgrading a more modern one. The difference is that even a modest upgrade of an old machine requires rather more work, particularly searching for information and for parts, than the upgrading of a more modern unit. With perseverance however you should be able to upgrade any of the older machines we have been talking about to something close to a 500 MHz type that can give a reasonable performance, with suitable software, even nowadays.

The question now is what software to use. If you have a complete installation of Windows 98 second edition, there's no reason why you shouldn't make use of that. I have found that Windows *Me* works very well on an older machine, even one that used a comparatively slow Pentium1 166 chip. If you avoid any software that requires very fast processing (such as voice dictation or video editing) then you can get a good working life from your upgraded machine.

What happens in the end of its life is quite another matter, because there must be a limit to the number of the AT boards and other matching components that will still be around in a few years time. This is why the main thrust of this book has been to working with a modern ATX case and motherboard that allows for continual upgrading over the coming years.

Appendix A

Glossary of terms

This is a small glossary that applies particularly to terms used in Windows and MS-DOS 6.0. For a full explanation of terms used in computing, see *Collins Dictionary of Computing* by Ian Sinclair.

Active icon The Windows Icon that has been clicked on and whose menu will appear on the next click.

Active printer The printer that will print out from your Windows work when you click the printer icon or use the File – Print menu. Only one printer is active at a time, though several printers can be installed.

Active window The window in which you can make entries and select items. Other windows can display on the screen but do not respond to the use of keys until you switch to one of them. Programs can, however, continue to run inside an *inactive* window, carrying out actions such as searching and sorting which do not require your attention.

ADSL *Asymmetrical Digital Subscriber Line*, a method of using a normal BT telephone line for broadband data signals that can be much faster in one direction (downloading) than the other (uploading), by using one set of frequencies for voice signals and another set for digital signals. The system requires good quality lines of no more than 6 km length, with suitable equipment at the telephone exchange.

Application A program or suite of programs for a particular purpose such as a spreadsheet, word processor, desktop publisher, CAD program, etc.

Application icon A Windows icon representing a program that appears in a Toolbar line on main screen display, normally at the top or the foot of the screen though it can be moved elsewhere. Clicking on one of these items will start the program running.

Associate To nominate a file name extension as one created by an application, so that TXT might be associated with a word processor, SKD with a CAD program, PUB with a DTP program and so on.

Athlon A very fast processor, particularly the later XP version, from AMD, using the same Socket-A fitting as Duron chips. A later type of Athlon (Athlon-64) used 64-bit processing, see also Opteron.

Attribute One of a set of marker bits in a filename which can make the file read-only (the R attribute), archive (A, changed but not copied), system (S, essential to operation of computer) or hidden (H, not normally appearing in a folder listing). These settings can be made from MS-DOS, not from Windows. You can use the View – Folder options of Explorer to choose whether or not to see System and/or Hidden files.

AUTOEXEC.BAT file A file of text commands that is placed on the disk drive that the computer boots from, and which sets up various items before MS-DOS programs are run. You can usually dispense with this file if you use only Windows.

Background 1. The colour of the screen page of a document or drawing. 2. The screen that is visible outside the current active window. 3. An inactive window or an icon whose program can be working without attention from the keyboard or mouse. A program working in the background can be sorting or searching data or exchanging text or other files with another computer.

Backup Any system for storing data over a long period, not part of the main computer system. This includes floppy disks, data tapes, detachable hard drives and writeable CDs or DVDs.

Binary file A file of coded numbers that are meaningless when printed or displayed but which convey information to a suitable program. A program is always in binary file form, but some program control files such as CONFIG.SYS, AUTOEXEC.BAT and WIN.INI are in ordinary readable text form.

BIOS Acronym for *basic input output system*, meaning a small file stored in the ROM that contains a few routines that allow elementary control over the computer, providing limited keyboard (sometimes also mouse) input and monitor output. The BIOS provides just enough facilities to allow the main operating system to be loaded.

Bitmap A graphics image that is stored in the form of numbers that represent the intensity and colour of each part of the screen. A simple colour bitmap requires a lot of disk space, typically 1 Mbyte or more, for a screen. Other forms of file for graphics such as TIF or JPG compress this information considerably (if there are 500 consecutive red dots, for example, you need store only the information for one red dot along with the number of these dots).

Bluetooth A standardized method of linking a computer with its (close) peripherals using digital radio signals so that no connecting wires are needed.

Boot To start up the computer either from a system disk or from a hard disk. The act of booting always checks and clears the memory.

Branch A folder which is connected to the main (root) folder or which is a sub-folder of another folder.

Broadband A faster method of connecting to the Internet, ranging in speed from 150 Kb/s to 2 Mb/s and using telephone lines with the ADSL system. Using broadband on BT lines requires a special modem or router and filters connected to each telephone to prevent interaction when both telephones and computers are using the line.

Built-in font A font which is permanently contained in a printer and which can be used by any software, but mainly by MS-DOS. The view of text on the screen will not necessarily correspond to the appearance when printed unless the screen can use an identical font. You should preferably use TrueType fonts from any Windows software.

Burnproof drive A CD-R/RW or DVD recorder drive that will ensure that data is fed at a steady rate, so eliminating problems that lead to a recorded CD-R or recordable DVD being useless (a *coaster*).

Cache A portion of memory used for temporary storage. A set of instruction codes to the processor can be read from normal memory or from disk into fast cache memory and fed to the processor at a much higher rate than could otherwise be achieved. The point of a cache is that it can be filled while the processor is otherwise engaged.

Cartridge A plug-in container unit, such as the ink cartridge of an inkjet printer, the toner cartridge of a laser printer or a tape cartridge used for backup.

Cascade A set of windows that overlap but allow each title to be displayed so that it is possible to click on the top line of any one. Also applied to menus when one menu allows another to be opened with the first still visible.

Celeron A trademark used for the lower cost version of Pentium chips. Older Celeron chips used the Socket 370 fitting which was not the same as that for the Pentium. Later Celerons used the standard 478-pin Pentium type of socket so that the same motherboard could be used for either chip.

Check box A small square box icon that can contain an X or be blank; used in Windows to switch an option on or off.

Click The action of quickly pressing and releasing the button (usually the left-hand button) on the mouse. Clicking with the right-hand mouse button will usually bring up a menu whose content depends on the position of the cursor.

Clicking on name/icon The action of placing a Windows cursor on a name or icon and then clicking the mouse button.

Clipboard The temporary storage for text or graphics used by Windows to copy data from one application to another, or from one part of an application to another.

Close To end the use of a window, either by double clicking on the control menu box, or by clicking on the control menu box and selecting *Close* from the menu.

Coaster A CD-R or recordable DVD disc that has not recorded correctly and so cannot be used for any computing, audio, or video purpose.

Colour depth The number of bits used in a graphics program to represent the colour of each pixel. Typically, 24 bits are used, but 32 or 36 can be used for very high-grade images.

COM 1. Abbreviation for Communication used to indicate a serial port. The COM ports are numbered as COM1, COM2, etc. 2. An extension for a short type of program file (longer programs use the EXE extension).

Command An instruction word that can be typed into the Start – Run box to start an MS-DOS entry panel.

Command button The OK or Cancel word enclosed in a rectangular box and used to confirm or cancel a selection.

Communications settings The settings of speed and other factors that are needed to make serial transfer of files possible.

CONFIG.SYS file A file of text commands that imposes various settings on the computer before any program, even MS-DOS itself; can be loaded. Changes to the CONFIG.SYS file have no effect until the machine is rebooted. You do not need to make use of CONFIG.SYS when you work solely with Windows, but the file should not be deleted.

Confirmation message A warning message that appears when you have chosen an action that might destroy files. You will be asked to confirm that you really intend to go ahead. Some confirmation messages can be turned off or restricted.

Control menu The menu that is available for each Windows application, allowing you to move the window, minimize, close, expand, etc.

Control menu icon The small icon at the left of the Windows title bar which is used to bring up the control menu (single click) or close the program (double click).

Copy To place a copy of some selected text or images on to the Clipboard for pasting into another program or file. This leaves the original unchanged, unlike the *Cut* action.

Ctrl-Alt-Del The key combination that can be used to escape from a Windows program that appears to have locked up. Repeating the action will reboot the computer. You can use Ctrl-Alt-Del also to find out what programs are currently running under Windows, with the option to stop an action or reboot the computer.

Cut To select a piece of text or graphics and transfer it to the Clipboard, removing it from the current window. Compare Copy.

Default A choice that is already made for you, usually of the most likely option that will be needed. You need only confirm a default, but can make another choice if you want to.

Desktop The full screen that appears when you start Windows on which all the windows, icons and menu boxes will appear as you make use of Windows.

Desktop pattern A pattern or colour that appears on the Windows desktop background so that you can distinguish the background more easily.

Dialog box A box that contains messages, or which requires you to type an answer to a question that appears in the box.

Digitizer Any device that converts information into number code form. A digital camera and a scanner are both devices that will digitize an image, and a graphics table can digitize a drawing. In this sense a keyboard is also a digitizer for alphabetical and numerical characters.

Disc A compact disc such as a CD-ROM or DVD, whose data tracks can be used for text, sound or graphics. Multimedia programs are distributed in this form, which is also used for collections of graphic images and for other large programs. DVD has much higher storage capacity and is used primarily for video images or backing up large amounts of data.

Disk A magnetic disk, usually of the hard or floppy type – the disks of a hard drive are usually called *platters*.

Double clicking The action used to launch a program by placing the pointer over the program name and clicking the mouse button twice in rapid succession. This action is used much less in Windows XP, *Me* or Windows 98 than in earlier versions because you can opt to use a single click to launch a program.

Dragging The action of moving an object on screen by selecting it with the pointer, then holding the mouse button down and moving the mouse so as to move the object over the screen. The object is released when the mouse button is released. Some important dragging actions make use of auxiliary keys such as Shift, Ctrl or Alt.

Drag and drop The action of dragging a file icon to another icon such as the printer icon or a disk drive or folder icon and releasing the mouse button. When a file is dragged and dropped to the printer icon it will be printed (if it is printable and if the printer is on-line); when the file is dragged to a disk drive icon it will be copied to that drive. Another form of the action is to select an item such as text or a graphic and drag this to another position in a document.

Duron The low-cost processor from AMD that uses the same design methods as the Athlon. The same Socket-A is used for both Athlon and Duron, making it easy to upgrade from Duron to Athlon simply by changing the processor.

ECP A development of the Centronics parallel port allowing two-way data transfers. This type of port is used to allow modern printers to be controlled by software. See also *EPP*. USB connection is now superseding the use of the parallel port.

Embedding The action of placing a drawing or an icon into a document, with the icon representing another document or a drawing. A document dealing with the topic of using the mouse, for example, might have a drawing between two paragraphs on the screen. Clicking on that drawing would allow you to edit it using the program that created the drawing. The embedded picture or document is part of the codes of the whole document. See also *Linking*.

Emulation The imitation of another device, such as an inkjet printer emulating the control codes of another type, such as a Hewlett-Packard Deskjet model.

EPP A development of the Centronics parallel port for two-way data transfer; used mainly for interfacing the PC computer with industrial control systems.

Ethernet A standard form of networking system that is now usually incorporated into motherboards along with firmware in ROM. This allows computers to be networked together or connected to broadband Internet through a router.

Expansion slot The socket (usually one of 4 to 8) within the computer which will accommodate a plug-in card that enhances the capabilities of the machine. Such slots are used for video cards, disk controller, network card and other add-on devices. The ISA slots run at a slow speed and can be used for comparatively slow devices such as sound cards. Faster cards must use the PCI slots, and fast graphics cards can use the AGP slot.

Extension The set of up to three letters following a full stop (period) in a file name. For example, in the name MYFILE.TXT, TXT is the extension. The extension letters of a file name are used to indicate the type of file. Windows 95 onwards allows longer file names to be used, but the facility for an extension is retained.

Firewire A system of fast data transfer using serial methods. This was developed by Apple Corp. and is now appearing in PC applications, particularly digital camcorder interfacing and the use of external drives. Most modern computers incorporate Firewire ports as standard.

Flash BIOS A form of BIOS whose contents can be changed by applying abnormal voltages and inputting data under the control of a program.

Flow control A method of ensuring that serial or parallel data sent from one computer to another is synchronized, often by sending handshaking signals to indicate ready to send and ready to receive.

Font or fount A design of alphabetic or numerical characters, available in different sizes and styles (roman, bold, italic). Note that a font called Euro Collection can be obtained if you need to use the Euro symbol € in text, or you can use the Insert – Symbol action of Word. The Euro symbol is included in the Character Map set for Windows 98 (Version 2) onwards.

Footer A piece of text that appears at the bottom of each printed page in a document. The footer often includes the page number.

Foreground 1. The colour of the lettering of a document or lines of a diagram. 2. The part of the screen which contains the current active window. 3. The program which is currently under keyboard control and taking most of the processor time (see also *Background*).

Graphics resolution The measure of detail in a picture, in terms of dots per inch or dots per screen width. The higher the resolution of a picture the better the appearance, the longer it takes to print and the more memory it needs. See also *colour depth*.

Handshake See Flow control.

Header A piece of text that appears at the top of each printed page in a document, often used to carry book and chapter titles.

Highlight A method of marking an icon or text, using a different shading or colour.

Icon A graphics image that represents a program or menu selection which can be used (made active) by clicking the mouse button over the icon.

Inactive window A window which contains visible text or graphics but which is not currently being used by the mouse or keyboard.

i-pod A portable player for MP3 files, developed by Apple.

Linking A form of insertion of text, graphics or other files in which the inserted material is not added to the document but retains links to its own file and to the program that created it. If you click on an icon for a linked picture, for example, you can edit the picture, and the new edited version will affect any other document linked to that icon – changing one copy changes all (in fact, there is only one copy, used by all the documents in which it is linked). Linking a graphic into a text document makes very little difference to the size of the document, unlike an embedded graphic. Once a link has been made, the file that is linked should not be moved nor renamed unless you also edit the link.

Local bus A set of connections between the processor chip and other components or cards that runs at a high clock rate and can be used for fast data transfer. The older ISA bus can be used for slower data interchange. The type of local bus used for Pentium machines is the PCI bus, but faster buses such as AGP are used for more specialized uses.

LPT An abbreviation of *line printer*, used to mean the parallel port (also indicated by PRN). When more than one parallel port is available, these will be numbered as LPT1, LPT2, etc.

Macro A recorded file of a set of actions, allowing the actions to be repeated by replaying the file (by pressing a key combination or selecting the file name). Many programs, such as Word for Windows or Lotus 1-2-3, contain their own macro system. It is possible, because a macro is a program, to make a macro run automatically when a document is opened, and this is a way of passing a virus to your computer.

Mark To select portions of text, graphics or complete documents or programs.

Maximize The action of making a window expand to fill the screen. This can be done from the *Control Bar* menu, or by clicking on the up arrow at the right of the title bar.

Memory resident (or TSR) A DOS program which is loaded and remains in the memory of the computer rather than being run and discarded as most DOS programs are. Such a program can be called into use by a key combination or it can permanently affect the machine until it is switched off. Windows uses its own version of this action, and the use of some DOS-TSR programs can cause Windows error messages to appear.

MIDI An acronym of *Musical Instrument Digital Interface*, a system for allowing a computer to control electronic musical instruments. Windows provides for such control by way of sound files, but only if a suitable sound card is added in an expansion slot of the computer, and the appropriate instruments are connected to the MIDI port.

Minimize The action of shrinking a window and the program in it to an icon.

Modem A device which converts computer signals into musical tones and vice versa, allowing such signals to be transmitted along telephone lines. A dial-up modem is used for low-speed Internet contacts at 56 Kb/s, and while active it prevents the use of a telephone on the same line. See also *Broadband*.

Motherboard The main board of a computer, into which expansion cards, the processor, and memory chips can be plugged. Most machines allow the whole motherboard to be swapped so that the machine can be considerably upgraded.

Mouse The small trolley whose movement on the desk controls the movement of a pointer or other indicator on the screen. The use of the mouse is central to Windows actions, though disabled users can opt for key alternatives. See also *trackball.*

MP3 A file type for compressed music files, allowing music to be downloaded over a fast Internet connection, or hundreds of music tracks to be placed on a CD-R disc or into an i-pod.

OLE Object linking and embedding, see *Linking*, *Embedding*, *Packaging*.

Opteron The first 64-bit processor, from AMD, to become available for PC machines. At the time of launch, there was no version of Windows available to utilize 64-bit capabilities fully.

Packaging The use of an icon to represent a piece of text or a drawing so that it can be embedded or linked in another document. When the document is printed, the icon is printed, but double clicking on the icon when the document is on screen will show the packaged material. Packaging also allows a program that cannot be used directly for embedding or linking to have its files represented as icons in this way.

Parallel port The connector used for printers which sends data signals along a set of cables, eight data signals at a time. Also called a Centronics port. Modern versions allow two-way communication through this port, see *ECP*, *EPP*, but the use of parallel ports is rapidly becoming obsolete in favour of USB connections.

Parameter A piece of information needed to complete a DOS command. For example, a COPY command would need as parameters the name of the file to be copied and the destination to which it had to be copied. Windows uses methods such as dragging and pointing in place of typing parameters.

Parity An old and crude system of checking memory by using an additional bit as a check on the contents of a byte. At a time when memory was unreliable, parity was used on all PC machines, so that each byte of data used nine bits rather than eight. This precaution is no longer needed, and modern computers dispense with parity, making memory cheaper. Parity is also used for serial data communications if more modern methods are not employed.

Paste To copy a piece of text or graphics from the Clipboard into a window – this does not clear the Clipboard, so that more than one Paste action can be used on the same material.

Pixel A unit of screen display, a dot, whose brightness and/or colour can be controlled. Nothing smaller than one pixel can be displayed on screen.

Platter A disk, usually made using aluminium, coated with magnetic material and used within a hard drive for storing digital information.

PnP Abbreviation of plug and play, a system of hardware card design that allows a card to be plugged into a modern computer and used without the need to set jumper switches.

Point size A printer's unit of type size, equal to 1/72 inch.

Pointer The shape on the screen that moves as you move the mouse. Windows uses several different shapes of pointers to indicate that the pointer will have a different action when it is over a different part of a window. Some programs that run under the control of Windows will use other pointer shapes in addition to these types.

Printer driver A program that determines how the printer makes use of the codes that are sent from the computer. Using the wrong printer driver will result in very strange printed output, because different printers use different methods. Many dot matrix printers, however, use Epson codes, and many laser printers use either Hewlett-Packard Laserjet codes or the universal PostScript system (from Adobe Corp.).

Proportional font A font in which the spacing between letters is varied according to the space needed by each letter. The alternative is a fixed-space font, as used in typewriters.

Reboot Restarting the computer either by using the Ctrl-Alt-Del keys (a soft reboot) or by pressing the RESET key (a hard reboot). Either will wipe all programs and data from the memory.

Restore button The button that is placed at the right-hand side of the title bar when a window has been maximized – clicking on this button will restore the former size.

Router A device that connects computers to each other (in a network) and to the Internet. The use of a router is the preferred way of connecting a computer to broadband.

Screen font A font that appears on the screen to indicate or simulate the font that has been selected for the printer. In this way, the text that is printed is an exact copy of the text seen on screen. Some screen fonts have no printer counterparts. Use of TrueType fonts ensures exact correspondence between screen appearance and printed copy.

Scroll bars The bars at the right-hand side and bottom of a window. Dragging the button in the scroll bar performs the action of moving the window over the text or picture, allowing a different portion to be viewed.

Select To choose an action by clicking its icon (another click needed to run it) or to mark text or graphics for cutting.

Serial port The connector used for sending or receiving data one bit at a time. This is used mainly for connecting computers to each other, either directly or by way of a modem through telephone lines. A few printers require a serial port connection; many others allow it as an option. The serial are referred to by the letters COM. See also *USB*.

Soft font A font which is not built in or in cartridge form, but sent as a file from the computer to a printer, and which needs to be loaded again after either the printer or the computer has been switched off. Such a font can be made to appear in identical forms both on screen and on paper. The TrueType fonts of Windows are soft fonts.

Sound card An add-on card that fits into an expansion slot allowing sound inputs to be digitized, and sound outputs to be taken to amplifiers and loudspeakers (some cards incorporate a small amount of amplification). Such a card, of which *SoundBlaster* is typical, allows sound effects to be incorporated into Windows actions, and it can also be used in sound recording on disk or on CD.

Spool To store printer information in memory so that it can be fed out to the printer while the computer gets on with other actions.

Swap file Part of the hard drive used in Windows to swap data with memory so that the memory is not overloaded.

Text file A file that contains only a limited selection of codes for the letters of the alphabet, digits and punctuation marks. Such a file will display as readable text on screen.

Tiling An arrangement of windows in which there is no overlapping, unlike Cascade.

Title bar The strip at the top of a window that contains the title of the application, and also the control box and minimize/maximize arrows.

Trackball A form of pointing and selecting device, like an inverted mouse. A trackball is preferred when there is no space to move a mouse.

TrueType font A form of soft font packaged with Windows and with Windows applications which presents the same appearance on the screen as on paper, allowing you to be much more certain that what you see is what you eventually get. The extension letters TTF are used for font files.

USB The Universal Serial Bus, a fast data connection intended for use by all peripherals such as monitor, keyboard, mouse, printer, scanner, etc. Versions of Windows prior to Windows 98 did not (except for a few late releases) cater for USB use. USB-2 is a much faster version suitable for digital video.

Vector font A font that consists of a set of instructions to draw lines, as distinct from a bit-map, which is a pattern of dots. A vector font can be easily scaled to any size.

Virtual machine Referring to the use of memory organized by Windows so that each application can be run in its own portion of memory, as if it were running in a separate PC.

Virtual memory The use of a hard disk by Windows as if it were part of the memory of the computer.

Windows application A program that has been designed to run within Windows, and which will not run unless Windows is being used. All such programs present the same pattern of controls (the *user interface*) making them easier to learn.

Appendix B

Abbreviations and acronyms

ADSL Asymmetrical Digital Subscriber Line, a method of using telephone lines for data in which the download speed is much greater than the upload speed (since you normally upload only a few keystrokes, but download a large amount of data).

AGP Accelerated Graphics Port, a very fast (66 MHz or more) slot for graphics cards of the AGP type.

ANSI American National Standards Institute, the title is used for a number code system that follows the ASCII set for numbers 32 to 127, and specifies characters for the set 128 to 255.

ASCII American Standard Code for Information Interchange, the number code for letters, numerals and punctuation marks that uses the numbers 32 to 127. Text files are normally ASCII or ANSI coded.

AT Advanced Technology, the designation used by IBM in 1982 for the computer that succeeded the older PC-XT.

ATA AT Attachment, a device intended to connect to the AT bus such as an IDE hard drive. Also called PATA, see SATA.

ATX AT Extended, a later design of casing, power supply and motherboard that simplifies connections and component positioning, improves cooling and provides more low voltage supplies, plus facilities like standby operation.

BIOS Basic Input Output System, the program in a ROM chip that allows the computer to make use of screen, disk and keyboard, and which can read in the operating system.

CAD Computer Aided Design, a program that allows the computer to produce technical drawings to scale.

CD-ROM A form of read-only memory, consisting of a compact disc whose digital information can be read as a set of files.

CGA Colour Graphics Adapter, the first IBM attempt to produce a video graphics card.

CISC Complex Instruction Set Chip, a microprocessor which can act on any of a very large number (typically more than 300) instructions. All of the Intel microprocessors to date are of this type. See also RISC.

CMOS Complementary Metal-Oxide Semiconductor, a form of chip construction that requires a very low current. As applied to memory, a chip that allows its contents to be retained by applying a low voltage at negligible current.

CP/M Control, Program, Monitor, one of the first standard operating systems for small computers.

CPU Central Processing Unit, the main microprocessor chip of a computer.

CRT Cathode Ray Tube, the display device for monitors used with desktop machines.

CTS Clear To Send, the companion handshake signal to RTS in the RS-232 system.

DCE Data Communications Equipment, a device such as a computer that sends out serial data along a line.

DECT Digitally enhanced cordless communications, a standard for the design of digital cordless telephones.

DDR Double Data Rate, a form of memory design that can operate at twice the clock rate of the input clock signal.

DIL Dual In Line, a pin arrangement for chips that uses two sets of parallel pins.

DIMM Dual In-line Memory Module, a memory expansion card for modern computers that can be used singly rather than in pairs (as was needed for the earlier SIMM units).

DIP Dual in Line Package, a set of miniature switches arranged in the same form of package as a DIL chip.

DOS Disk Operating System, the programs that provide the commands that make a computer usable.

DSR Data Set Ready, another form of handshaking signal for RS-232.

DTE Data Terminal Equipment, a receiver of serial data such as a modem.

DTR Data Terminal Ready, the RS-232 companion signals to DSR.

DTP Desktop Publishing, the use of a computer for composing type and graphics into book or newspaper pages.

ECP Extended Capability Port, a form of parallel port with two-way data flow, used for modern printers.

EGA Enhanced Graphics Adapter, the improved form of graphics card introduced by IBM to replace CGA.

EISA Enhanced Industry Standard Architecture, a system for connecting chips in a PC machine which allows faster signal interchange than the standard (ISA) method that has been used since the early PC/AT models.

EMS Expanded Memory System, the original standard for adding memory to the PC/XT machine, no longer used.

EPP Extended Parallel Port, a design of parallel port that allows two-way data flow and is intended for interfacing to devices other than printers.

ISDN Integrated Signals Digital Network, a system of cabling, using fibre optics, that is used for high-speed digital links for computing and for digital sound and video links.

LCD Liquid Crystal Display, a form of shadow display which is used on calculators and portable computers. It depends on the action of materials to polarize light when an electrical voltage is applied. Colour LCD displays are used for portable computers, and larger versions are becoming available at reasonable prices.

LCS Liquid Crystal Shutter, an array of LCD elements used to control light and so expose the light-sensitive drum in a laser printer. The LCD bar is used as an alternative to the use of a laser beam.

LED Light Emitting Diode, a device used for warning lights, and also as a form of light source in laser-style printers.

MCA Micro Channel Architecture, a system proposed and used at one time by IBM as a way of connecting chips within a computer, intended to replace the AT-bus (ISA).

MDA Monochrome Display Adapter, the first type of video card used in IBM PC machines.

MIDI Musical Instrument Digital Interface, a standard form of port and serial data code used to allow electronic instruments to be controlled by a computer, or to link them with each other.

MS-DOS Microsoft Disk Operating System, the standard operating system for the PC type of machine.

NLX A type of motherboard that connects into an add-on card ‘riser’ to make it easy to replace a motherboard without replacing parts that are common to all motherboards.

NTSC National Television Standards Committee, the body that drew up the specification for the colour TV system used in the USA and Japan since 1952. This system is not compatible with the European PAL or SECAM systems.

OCR Optical Character Recognition, software that can be used on a scanned image file to convert images of characters into ASCII codes.

OS/2 An operating system devised by IBM and intended to replace PC-DOS (the IBM version of MS-DOS).

PAL Phase Alternating Line, the colour TV system devised by Telefunken in Germany and used throughout Europe apart from France.

PCI PC Interconnection, a fast form of local bus used for speed-critical cards such as graphics and video cards. The PCI bus has now replaced the older ISA bus for expansion cards.

PBX Private Branch Exchange, sometimes a problem for using modems.

PSS Packet Switch Stream, a method of transmitting digital signals efficiently along telephone lines.

RAM Random Access Memory. All memory is random access, but this acronym is used to mean read-write as distinct from read-only memory.

RGB Red, Green, Blue, the three primary colour TV signals. A monitor described as RGB needs to be supplied with three separate colour signals, unlike a TV monitor that can use a composite signal.

RISC A microprocessor that can work with only a few simple instructions, each of which can be completed very rapidly.

RLL Run Length Limited; a form of high-density recording for hard drives.

ROM Read-Only Memory, the form of non-volatile memory that is not erased when the computer's power is switched off.

RS-232 The old standard for serial communications.

RTS Request to Send, a handshaking signal for RS-232.

SATA Serial ATA, a serial cable system for connecting drives to a computer with more flexible and less bulky cables. The older system is now known as PATA, parallel ATA.

SCART The standard form of connector for video equipment, used on TV receivers and video recorders.

SCSI Small Computer Systems Interface, a form of fast-acting disk drive interface which allows for almost unlimited expansion. Used mainly on Mac machines, but also found (in a less standardized form) for some PC devices.

SECAM Séquence Couleur et Memoire, the French colour TV system, also used in Eastern Europe and the countries of the former USSR. This is not compatible with PAL or NTSC.

SFF Small Form Factor, a type of PC that uses a smaller motherboard and casing, typified by the Shuttle design.

SIMM Single Inline Memory Module, a slim card carrying memory chips, used for inserting memory, now superseded by DIMM.

SMART Self-Monitoring and Reporting Technology, used on hard drives so that they can check and report on faults or potential faults.

TIFF Tagged Image File Format, one method of coding graphics images that is widely used by scanners. Graphics files using this system have the TIF extension to their filenames.

TSR Terminate and Stay Resident, a form of DOS program that runs and remains in the memory to influence the computer.

TTL Transistor–Transistor Logic, a family of digital chips. The name is often used to mean that a device will work on 0 and +5 V levels.

UPS Uninterruptible Power Supply, a unit using batteries that will provide power to the PC for a limited time when mains power fails. The UPS will keep the computer running long enough to shut down all files and switch off, and the UPS batteries will be recharged when mains power is restored.

VDU Visual Display Unit, another name for the monitor.

VEGA Video Extended Graphics Association, a group of US manufacturers who have agreed on a common standard for high-resolution graphics cards.

VGA Video Graphics Array, the video card introduced by IBM for their PS/2 range of computers.

Appendix C

Contacts

The following is a brief list of names, telephone numbers and web sites for manufacturers whose web site can be used to download upgraded drivers and other software items.

Company	Tel. No	Web Site
3Com	0800966197	www.3com.com
Agfa	02082315511	www.agfa.co.uk
Amacom	0208 9937373	www.amacom-tech.com
AMD	01276803299	www.amd.com
Canon	08705143723	www.canon.com
Creative Labs	01189344744	www.creative.com
D.Link	0208 2355555	www.dlink.com
Epson	01442261144	www.epson.com
Fujitsu	0990359752	www.fujitsu.com
HP	0207 5125202	www.hp.com

Company	Tel. No	Web Site
IBM	0800 893771	www.ibm.com
iiyama	01438314416	www.iiyama.co.uk
Intel	0870 6072439	www.intel.co.uk
Iomega	0800 897314	www.iomega.co.uk
Kingston	01932738800	www.kingston.com/uk
Lexmark	02082801701	www.lexmark.com
L.G.Electronics	01753500400	www.lge.com
Logitech	0208 3086581	www.logitech.co.uk
Maxtor	0035312041111	www.maxtor.com
Microsoft	0345 002000	www.microsoft.co.uk
Mitsumi	01276671029	www.mitsumi.co.uk
NEC	02089938111	www.nec.co.uk
Origin Storage	08701 688889	www.originstorage.com
Samsung	01525718444	www.samsungelectronics.co.uk
Sitecom	01252 551055	www.sitecom.com
Tally	0870 8731555	www.tally.co.uk
Teac	01923819699	www.teac.co.uk
Toshiba	0121 7884545	www.toshiba.co.uk
Visioneer	01483445480	www.visioneer-europe.com

Appendix D

BTX machines

During the second half of the year 2004, manufacturers will start to introduce a new standard for motherboards and cases, the **BTX** standard, which will eventually replace the existing ATX designs. The reasons for this change, prompted by the success of the Shuttle machines are:

- smaller size, with some case types typically only 4-inches high;
- much quieter running, some machines may not need fans;
- better heat dissipation;
- SATA connections to internal drives;
- PCI Express internal slots;
- USB, DVI, and Firewire connectors, no PS/2, parallel printer port, old-style serial port, or old graphics connectors.

At the time of writing, no motherboards or cases for BTX have appeared for sale to the public, so that the ATX type will continue for some years to come, but the trend to smaller machines is now well on its way. The following description of BTX is taken from the draft specifications.

The most noticeable change in the motherboards is that the expansion slots at the rear of the motherboard have changed sides, and are now on the right-hand side as you view the motherboard from the front (see Figure D1). The new grouping of components allows for a large slow fan (in a thermal unit casing) to cool the processor, chipset and memory with efficient heat removal along with low noise.

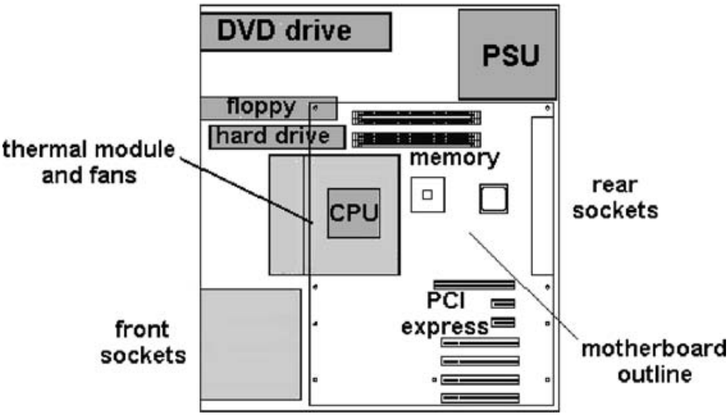

Figure D1 Outline of a typical BTX motherboard

The smallest proposed motherboard (all dimensions in inches) comes in at 8 × 10.5 (for comparison, the Shuttle **outer** casing dimensions are around 8 × 11), with larger versions of 10.4, 10.5 and 12.8 × 10.5. All will use SATA, and the PCI slots use the new PCI Express system, compatible (they claim) with existing cards, but the AGP slot will no longer exist, so you might feel that upgrading your existing ATX system to a £200 fast AGP card might not give you the lifetime advantage you hope for. The smallest BTX casing, PicoBTX, will permit one 3.5″ and one 5.25″ drive bays (like the Shuttle); the next size up (microBTX) allows one 3.5 bay and two 5.25 bays. A tower case, allowing three of each bay size, will probably be used for servers.

The PCI express system that is used along with BTX motherboards is a form of two-way serial connection using methods that were developed for networks. Though this is claimed to be hardware-compatible with recent PCI cards (emphasis on recent), I would not assume that any PCI cards you are using at the moment would work. In particular, the high speed of PCI Express (hence the name) means that graphics cards can be developed to take advantage of this, killing off the AGP type of card. Another benefit is that large slots are needed only for the fastest cards, so that smaller slots can cater for cards (such as a sound card) whose bandwidth demand is more modest.

I must emphasize that all of these changes, though well on the way, will not become normal run-of-the-mill items for some time, so that if you are building or upgrading you need not wait unless you particularly want all the benefits of speed, size and silence. If, as I have suggested earlier, you do not need to be at the cutting edge of technology, then you can continue with an ATX build at present, bearing in mind that your next computer might be of the BTX type.

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