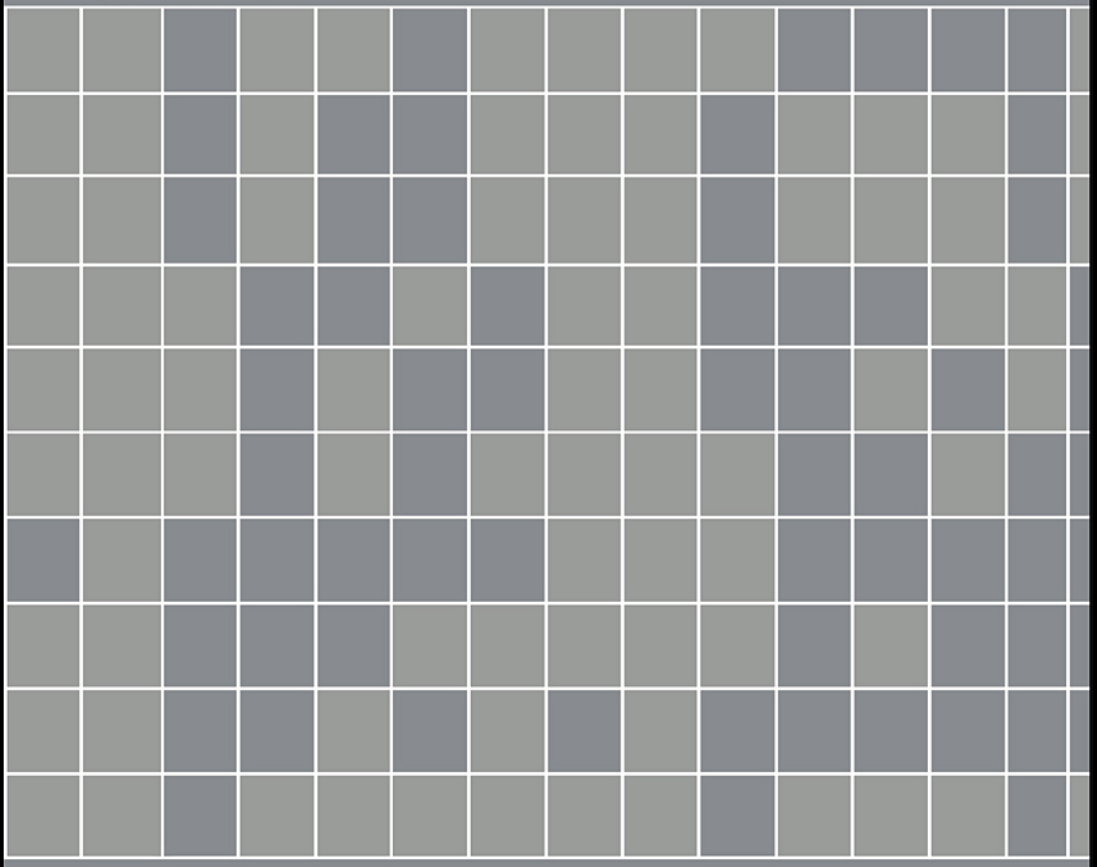
Christopher Woodward
Jaki Howes



Computing in Architectural Practice

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Preface

The authors were introduced to one another by the publisher: 'Mac Man meets PCWoman'. The result is an amalgam of facts, ideas and opinion, which is, we think, even-handed: the book is a joint effort. Both authors have made contributions to each chapter. Some of the material here originated in courses run at The Bartlett University College London and at Leeds Metropolitan University, and the authors would like to thank their colleagues at those institutions for invaluable help and advice.

Both authors think that ease of use, clarity and currency of computer applications is paramount and that every architect should now be using a computer, if not for drawing then at least for helping simplify and perhaps making more enjoyable some of the mind-numbing clerical and administrative tasks which even the smallest practice undertakes. Computers are probably changing the ways in which our society works, and will certainly change the way in which buildings are procured, increasing the speed of communication and modifying the roles of all specialists, including architects. But whatever form the changes take, computer applications are no substitute for skill and imagination.

Introduction

The RIBA IT Group, then based in Leeds, surveyed all UK practices in August 1994 to see what use they were making of computers: 10% of the 1675 practices who responded were not using computers at all; two-thirds of these were one or two person bands, the remainder had up to eleven employees; 487 (28%) practices were not using even a rudimentary drafting system—many saw no need; the responses from Eastern and South West Regions showed that here 40% of practices preferred a pencil for drawing.

The term CAD is used loosely, covering everything from *DiddiCad* drafting to tropospheric animation. There were 1028 CAD users. The highest percentage was in Scotland, then London; the lowest was in Ulster. Many practices had more than one system. The PC-based *AutoCad* had the lion's share of the market: 406 primary users. Its nearest rival was *MiniCad* (Macintosh-based) with 98, then MicroStation with 61 (24 PC, 37 Macintosh). PC-based systems outnumbered Macintosh-based, *except in London*. The famous names, in general, were using MicroStation.

An alarming number of primary CAD systems were identified: 26 PC-based, 15 Mac-based and 11 UNIX-based. By now many of these will be unsupported (some were obsolete when they were installed). Only 20% of practices had CD-ROM drives.

The three years since the report was produced is a long time in the computer world. New machines have CD-ROM drives as standard and frequently have built in fax/modems for communications. Machines used for business and commercial purposes are usually written off against tax and replaced every three to five years. Not so in academia.

Universities have difficulty meeting the demands of increasingly computer-literate students, to the extent that one school of architecture is using capital to upgrade networking and peripherals but stipulates that students should provide their own computers. In March 1996, the thirty-six or so schools were equally divided between those who use *AutoCad* and 3D *Studio* on PCs and those who used Macintosh-based CAD software. Apart from the students who want to learn to use CAD so that they can get a job, the majority want a powerful design tool that will allow them to visualize projects as realistically as possible. Students expect, and the vast majority have, e-mail addresses and access to the World Wide Web. Some secondary school

students now select universities by accessing Web pages rather than sending for a prospectus.

This book is organized into five chapters. The first is presented for those considering equipping themselves with a computer and software for the first time. Practices already using computers may wish to skip this chapter and proceed directly to the next three. The final chapter discusses possible future developments in this fast-moving field.

1
Getting started

1.1
What are computers?

Computers are machines which process information automatically and in accordance with given instructions. They do not 'think', but are being programmed to perform increasingly complex operations. They can carry out boring and repetitive tasks with speed and accuracy.

There are two generic types of computer, analogue and digital, and hybrids of these. Analogue computers operate with a 'model' of a problem where variables are represented by physical quantities such as voltage, which can be measured, and which can change smoothly and continuously. The analogue approach is unhelpful for all-purpose computing because an analogue computer is configured to solve specific problems, and is outside the scope of this book.

Digital computers are so called because they handle digital information (information expressed in binary form). Any information, image or sound that can be reduced to a digital signal can be handled. The first electronic computers were developed in the 1940s. These machines were large, slow, filled a whole room and were operated by valves. In the 1950s transistors replaced valves. Transistors used less power, generated less heat and took up less space, allowing smaller and more reliable computers to be manufactured.

Advance was accelerated in the 1960s with the development of the integrated circuit or 'chip'. A chip is a slice of silicon, or other appropriate material, onto which a circuit which can include transistors, is photographically copied and then processed. It can contain all the components of all the room-sized components of forty years ago. There are many differing types of processor chips, which determine a computer's architecture.

Microchips are everywhere, in washing machines, sound systems and motor cars, and these are generally taken for granted. (Consider how many things in an average house 'know' what day it is.) Computer systems that now handle most of the world

scientific, commercial, financial and defence information, tend to be feared. Like other tools, computers need not be feared, but only the people who operate them.

1.1.1 Digital computers

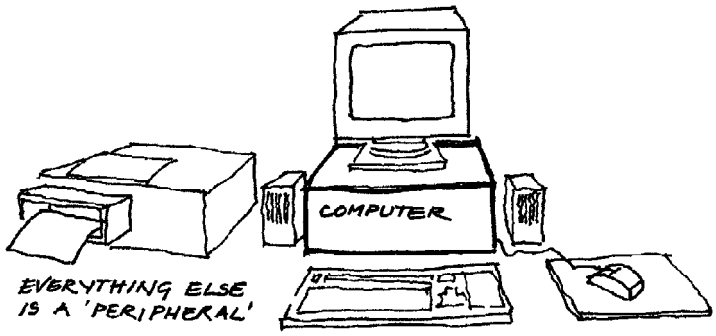
Digital computers require that all input is reduced to 'pulses', or one of two states. This is done using the binary system, which enables alphanumeric symbols, as well as visual and sound information, to be translated to a series of zeros and ones, corresponding electronically to 'off' and 'on'. Each zero or one is known as a bit (Binary digIT). A group of eight bits is called a byte. A group of 16 bits (up to 64 bits) which defines the 'lump' in which information is handled, is known as a 'word'.

As an example, there are 26 letters in the English alphabet, upper and lower case, 10 numeric symbols, at least fifteen punctuation marks, and many more special and mathematical symbols, so it can be seen that over one hundred unique identifiers are required. It takes at least seven bits to do this (2^7=128). When a key is pressed on a keyboard, a string of zeros and ones, eight bits long, will be sent to the processor. There is a standard code for doing this which should not vary between different types of machine: the ASCII code (American Standard Code for Information Interchange, pronounced 'Askey'). This consists of 256 unique codes. Further, extended codes are being developed to allow the characters from non-English alphabets to be manipulated and displayed.

The essential components of a computer system are:

- *a central processor* in which data is handled and calculation and manipulation of numbers takes place
- *memory* which stores data for use by the processor
- *input* devices which convert information into digital code to be handled by the processor
- *output devices* which convert the processed data back into an understandable form
- *storage,* places for storing information when the computer is switched off
- *system softwore* instructions which tell the processor and other devices how to read, handle and display data
- *application* software, sets of instructions which allow the computer to carry out specific tasks

The equipment is known as *hardware,* and the parts of it which do not occupy the computer 'box' are known as *peripherals*. The sets of instructions or programs which tell the computer how to operate are known as software.



1.1 Computer and peripherals

1.1.2
Types of digital computer

The distinction between categories of digital computer has become fuzzy. They are grouped by type of use, speed and physical size, but the most powerful microcomputers now have the same power as mainframes of the 1980s.

Mainframes

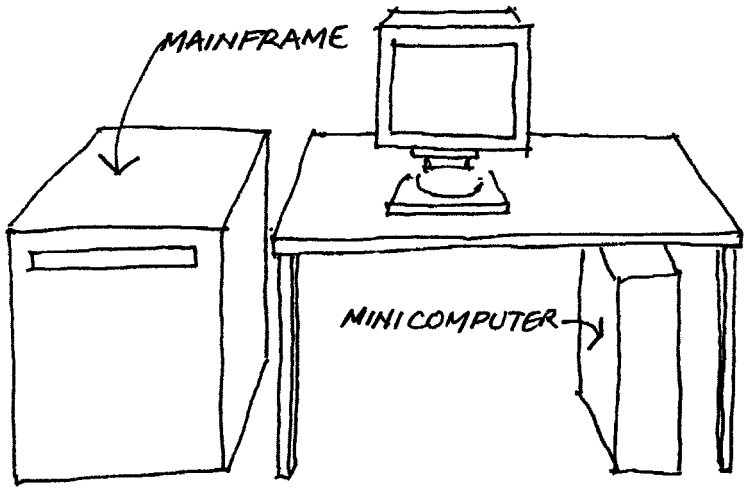
Supercomputers are large, fast, powerful machines which are used by institutions, government, industry and commerce for intensive numeric processing. *Mainframes* are used for mass storage and database management. They are physically 'big', at least the size of a refrigerator, and may be grouped to be even bigger. They can support a large number of terminals which can be connected directly, by telephone or by satellite link, and which allow many simultaneous users. Data is shared. The widespread use of computers of all kinds has increased the sensitivity of these systems to unauthorized access and malicious damage.

Minicomputers

The term *minicomputer* was used in the 1960s, when there were no microcomputers, by the Digital Equipment Corporation (DEC), to describe the PDP-8. These machines had 12-bit processors and were comparatively small, robust and were intended for a single user. The term is now used to describe 32-bit, or higher, machines which are capable of supporting multiple general purpose users and allow data to be shared, and run under operating systems such as UNIX.

Microcomputers (desktop computers)

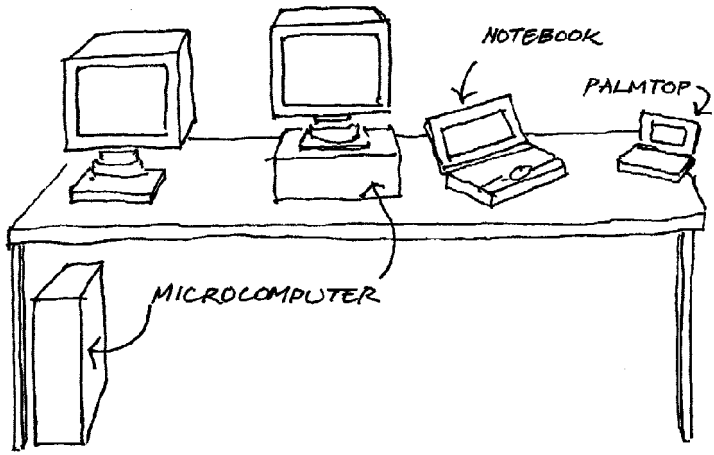
The first microcomputers appeared in the 1970s. They were the domain of enthusiasts and had to be assembled from kits. The first appliance computers appeared



1.2 Mainframe and minicomputer

in 1977, when the Apple II, the Tandy TRS-80 and the Commodore Pet were launched. Each of these had a different operating system. The IBM PC (Personal Computer) appeared in 1981, and was offered with a choice of three operating systems, of these, DOS (disk operating system) was the cheapest. By the end of 1983 the IBM PC running DOS had become a de facto standard. The Apple Corporation launched the Lisa in 1983. This was revolutionary as it had a *Graphical User Interface* (GUI). Lisa was not a commercial success because it was slow, expensive and had no network capacity. The Apple Macintosh was launched in 1984; it had a graphical user interface with *icons, windows, pull-down menus and a mouse pointing device*. In the 1980s and early 1990s most 'serious' software was developed for DOS-based systems, which had about 90% of the market. People who were interested in how computers work, rather than ease of application, considered Macintoshes to be expensive executive toys (probably because they were easier to use than PCs), useful only for graphics and publishing. In fact Macintoshes, together with the Apple Laser Writer, created the market for desktop publishing.

There have been many types of microcomputer, each with its own special characteristics and operating system; true compatibility between systems was rare. Market forces have led to some standardization leaving two generic types; machines that are compatible with the IBM PC and those that are compatible with the Apple Macintosh. Each of these systems has become progressively more powerful. Now software is being developed for both Macs and PCs, there is convergence in the style of computer interface and translation programs are available to allow transfer of data between them.



1.3 Microcomputers and portoble computers

Portable computers

Portable computers have built-in keyboards and screens, and can run on either mains power, via an AC adapter, or batteries. *Laptops* weigh about 5 kg and are becoming obsolete as smaller notebooks are becoming available, which weigh about 3 kg, and which support all the functions of a mid-range microcomputer. *Subnotebooks* are even lighter, but they have less power, less storage space and smaller screens. *Palmtops,* sometimes grandly called 'personal digital assistants' (PDAs), are generally used as personal organizers; their screens are small and the keyboards are not comfortable to use for more than notes. Notebooks and palmtops can be used in conjunction with fax facilities, or with a modem and mobile phone for e-mail. This is an area of rapid development.

1.2
Hardware

1.2.1
Processors

The intrinsic components of a 'computer', that is the bit that appears to do the 'thinking', are the *microprocessor* or *central processing unit* (CPU), which contains a control unit and an arithmetic and logic unit and probably internal cache memory, *read only memory* (ROM), *random access memory* (RAM), and a *clock* (a quartz crystal which controls the speed at which the central processor functions). All these

components are mounted on a *motherboard*. Processors are defined by two basic characteristics:

- *clockspeed* which determines how many instructions can be executed per second
- *bandwidth* which is the number of bits processed in a single instruction

The higher the value of either characteristic the more powerful is the processor. In addition microprocessors are based on either CISC (complex instruction set computer) or RISC (reduced instruction set computer) architecture.

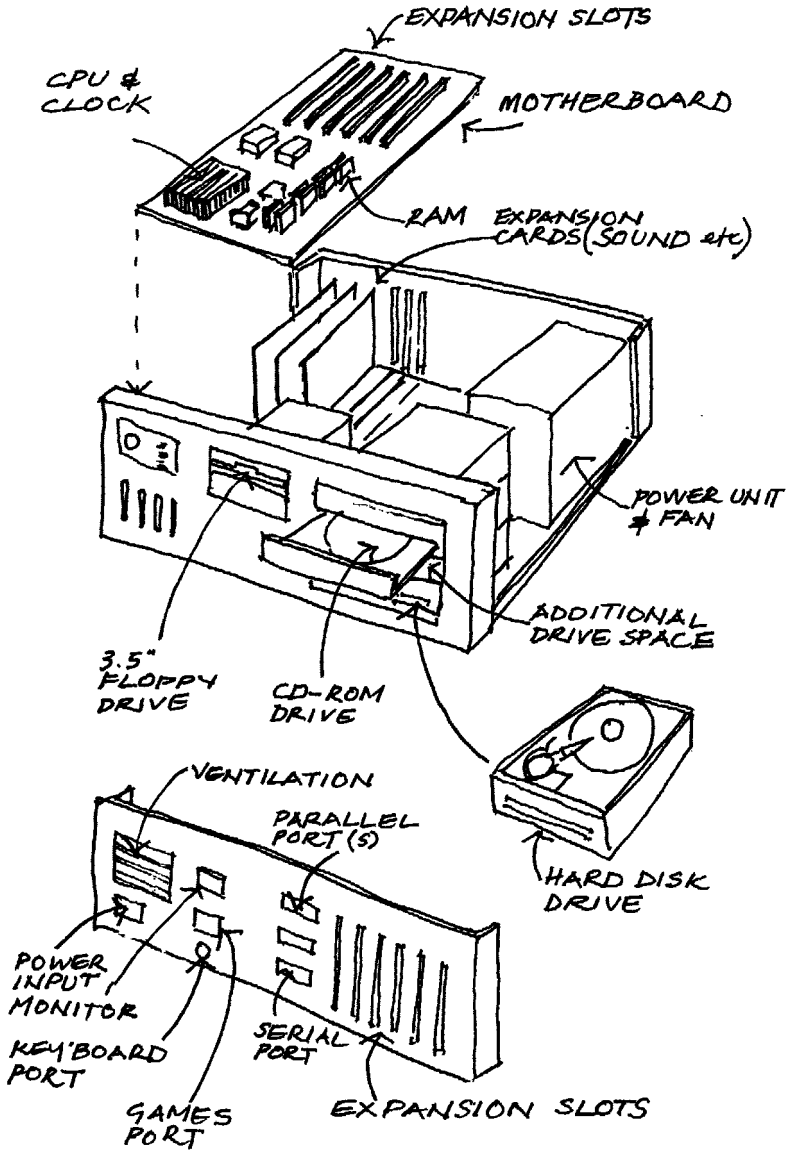
Most microcomputers, including PCs and clones, use CISC architecture. This means that the CPU recognizes up to two hundred coded instructions. Until the mid-1980s manufacturers tended to produce CPUs with increasingly complex and large instruction sets. Some manufacturers reversed the trend by developing chips which handle only a very limited set of instructions. This is known as RISC architecture. One benefit of RISC chips is that instructions can be handled very fast, another is that they are cheaper to design and produce. This architecture is used by many workstations and some microcomputers, including the latest Macintoshes.

There is controversy about the relative merits of the two architectures. RISC machines have speed and cost advantages and are seen by some to be the machines of the future. On the other hand simplification of hardware puts greater demands on the software; this results in larger programs. Argument is specious as implementations of both architectures are becoming increasingly similar. Many RISC chips support as many instructions as the CISC chips of a few years ago and CISC chips use many techniques formerly used by RISC; some hybrid chips are being developed.

Intel microprocessors (or clones) are used in PCs. Models after the 8086 are referred to by the last three digits of their code, 286, 386 and 486. Each supports different clock speeds. For example, the 80486 supports clock speeds from 33 MHz to 100 MHz. Intel has now moved to a naming scheme, so that the fifth generation chip is known as the Pentium, and the sixth, the Pentium Pro.

Until the early 1990s, Motorola chips were used in all Apple Macintosh computers and in many workstations. There are four main chips in the 680x0 family: the 68000, 68020, 68030 and 68040. Reference to these is made by the last three digits. For instance 'oh-thirty'. In 1993 Motorola co-operated with IBM and Apple in designing a RISC architecture which resulted in the introduction in 1994 of the PowerPC with numbers such as 601, 603 etc.

The CPU is the main chip in the computer which performs millions of calculations every second. Each CPU generation is available in several speeds and each new generation is faster and more powerful. For instance the Intel 386, which was considered to be the standard specification for most PCs in 1990, is now (1996) almost obsolete. The 486, which is available at speeds from 33 MHz to 100 MHz, processes one instruction at a time, and provides quite adequate performance for most tasks. The Pentium chip processes two instructions at a time and runs at speeds



1.4 Parts of a computer

up to 200 MHz. The P6 chip will process four instructions at a time and will run at speeds in excess of 200 MHz. There are similar high-speed developments in the Motorola chips used in Macintosh machines, currently available at speeds of up to 300 MHz.

The rate of development is such that there is almost built-in obsolescence every two or three years. Unfortunately, new software and sophisticated user interfaces require faster and faster processors, although many everyday tasks can be carried out quite adequately on older, slower, machines.

Processors which can handle software which was written for a lower specification chip are called 'downward-compatible'. It is possible to upgrade chips to a higher specification, but it is often advisable to buy a new machine and downgrade the old to a less demanding task.

The basic operation of the CPU is controlled by sets of instructions contained in read-only memory (ROM), a permanently encoded chip which cannot be altered.

1.2.2 Memory

The workspace in a computer is the random-access memory (RAM). It is the area into which programs for specific applications are loaded and then executed, and in which data being generated or manipulated by the user is stored temporarily. The capacity of RAM is measured in kilobytes (K), megabytes (MB) or gigabytes (GB). $K=2^{10}$, $MB=2^{20}$ and $GB=2^{30}$ or, for non-binary buffs, 1024 bytes, 1 048 576 bytes and 1.074×10^{9} bytes respectively.

The size of RAM determines the number of programs that can be run simultaneously, the speed at which they run and the size of data files that the user can create and manipulate. Dynamic RAM (DRAM) is used for the computer's main memory; it can be increased by adding *single in-line memory modules* (SIMMs), circuit boards that hold DRAM chips, and which are plugged into SIMM sockets on the motherboard. Some computers may use video RAM (VRAM), which holds the information required to show the contents of the video monitor or screen. It also enables a monitor to access VRAM for screen updates while a graphics processor provides new data. Static RAM (SRAM), which is six times faster than DRAM but more expensive, is so called because it needs to be refreshed less often than DRAM. Data held in RAM is temporary and disappears when the computer is switched off unless it is saved in back-up storage. It is good economy to buy as much RAM as possible. 32 MB is a sensible entry, at present, for general use in practice.

Most new computers now contain *cache memory* which lessens the time it takes for the CPU to retrieve information from RAM. *Internal cache* consists of fast chips which are built into the CPU. These store recently used data. If the CPU fails to find the required data in the internal cache, it searches the *external cache,* very fast SRAM chips on the motherboard, which store additional recently used data.

1.2.3 Storage

Storage is where programs (sets of instructions) and data are stored when the computer is switched off. Storage devices provide input to or accept output from the CPU. Most new personal computers have an internal hard disk, the capacity of which is increasing at a phenomenal rate. A glance through the trade literature shows that while five years ago average machines were equipped with a 10 to 70 megabyte hard disk, computers currently advertised can have hard disk capacities of one gigabyte or more.

Hard disks

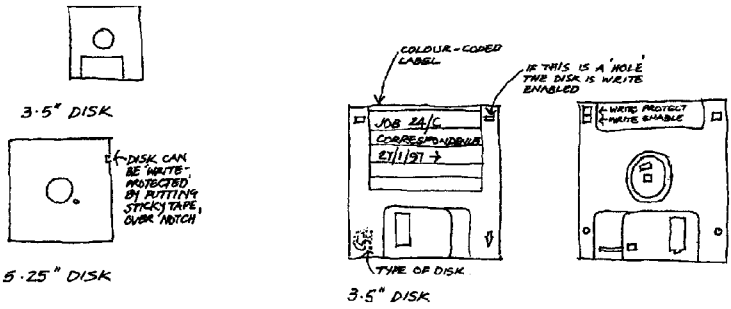
Hard disks may be built into the computer case, or may be used externally. Hard disks are essential for the storage and operation of frequently used programs. A hard drive stores data in the form of magnetic impulses by 'writing' these onto the plastic-covered surface (similar to that of a cassette or video tape) of a rotating metal disk. The data is 'read' by a read/write head. This disk is not visible from the outside of the computer case, but on PCs there is a warning light on the computer casing to indicate when this drive is working. The computer should not be moved when the light is on, because the read/write heads may slip out of alignment. If a PC has a single internal disk, the drive is usually called 'drive C'. Data on the hard disk can be lost or corrupted if the operator inadvertently mistakes drive C for one of the floppy drives, and attempts to reformat the disk.

Hard drives can also be connected to a computer externally. These are useful as back-up storage or to move data between computers. SCSI (Small Computer System Interface, pronounced 'Scuzzy') drives can provide a fast way of connecting a hard drive to a computer, as well as connection to other devices such as CD-ROM drives, scanners and printers.

Floppy disks

A floppy disk (diskette) is a removable storage device used for the storage and transfer of data from one machine to another. Floppy disks are commonly used to transfer new programs to the hard disk, but they are also one of the most common causes of the transfer of viruses. Floppy disks are susceptible to damage from magnetic fields, spilt drinks and to extremes of temperature, and should be treated with care.

Floppy disks are so called because the earliest disks were just that—flexible, magnetically sensitive plastic disks cased in square flexible cardboard. Eight-inch disks are now obsolete; 5.25-inch disks, which are becoming obsolete, and are still floppy, are double sided, and may be double density (with a capacity of 360 K) or high



1.5 Floppy disks

density (holding 1.2 MB). They can be *write-protected,* that is protected against accidental overwriting, by putting a small piece of sticky tape over the notch at the side.

A 3.5-inch floppy 'diskette' is a flexible, magnetically sensitive plastic disk encased in a rigid plastic cover. Diskettes come in two capacities, double density (720 K) which have one hole at the top of the disk, and high density (1.44 MB) which have two holes. These diskettes can be write-protected by moving the slide in one of the holes to the open or write-protected position. Before a new disk can be used in a computer, it must be formatted for that computer into tracks and sectors, that is organized in such a way that it can be read correctly by the read/write head.

Despite moves towards compatibility, it should not be assumed that disks formatted on one machine can be read by another. There are two problems, the first is physical, that is where the read/write head is not aligned to read both double density and high density disks; the second arises because different computer systems organize disks in different ways. PCs are unlikely to be able to read disks formatted on a Macintosh, unless the data has been stored in a PC format. Macintoshes can use conversion programs that allow them to read disks from PCs. Some PCs do not read disks that have been formatted on earlier PCs.

Current computers have slots on the front of the casing to support a number of disk drives, at least a 3.5-inch and a CD-ROM. If drives are to be added externally it is important to ensure that the computer has enough ports to support extra peripherals, or that the SCSI chain can support them.

It is essential to make sure that data held on back-up disks is transferred to the most up-to-date format before the disk drive hardware becomes obsolete, or to make sure that an appropriate mechanism is retained for reading archived disks when hardware is updated. Disks full of data soon mount up and have to be properly indexed and stored safely. It is as infuriating to search for data on a set of inadequately organized disks as it is to do a manual search through piles of paper. An increasing number of high-capacity disks, each of which require an appropriate drive, housed either within the computer case or externally, are available for the storage of archived data.

CD-ROM

Compact Disk—Read Only Memory. The disks are physically similar to those used for recording music. They have more than 600 MB capacity, that is enough space to store a multi-volume encyclopaedia. A program supplied on 200 floppy disks will fit onto one CD-ROM. Read Only Memory means that the information stored on a CD-ROM cannot be changed or overwritten.

CD-ROM drives are either integral to the computer or may be connected externally by a cable or may be incorporated in a SCSI chain. The speed of the drive determines how fast data can be transferred from the disk to the computer. This is called the data transfer rate which is measured in kilobytes per second (KB/s). Speeds are usually specified as ×2, ×4, ×8 (times two, etc.). Recommended speeds are specified on the package of the CD-ROM. The access time of a CD-ROM drive should be less than 280 ms; the lower the access time, the better the performance, especially for music or moving pictures.

CD-R

CD-Recordable systems are available which allow information to be written to and stored on a CD. This is a useful way of archiving information. These are expensive and it is thought that they may last only ten years.

PhotoCD

This is Kodak's name for its proprietary CD format for storing in digital form black-and-white or coloured photographic images. The disks which can be read by the CD drive in most current computers can hold up to about one hundred photgraphic images, each recorded in five different resolutions, from very coarse to very fine. Most high street photographic processors will take exposed undeveloped film and arrange to transfer the developed images onto PhotoCD.

Tape

Tapes are particularly useful for back-up and archiving information. Data may be 'compressed' by software to increase the capacity. Tape drives may be internal or external to the computer, although external drives are more useful as they can be used with more than one computer. Quarter-inch cartridges (QIC), which require the appropriate drive, have capacities up to 1.3 GB of compressed data. This is probably adequate to back up the hard disk of a PC. Digital audio tape (DAT), and the appropriate drive, can be used to back up information on a network file server. Up to 4 GB may be stored on a tape.

Removable cartridge drives

Various drives are available which use removable cartridges based on various technologies. These have the benefit that the data on either the cartridge or the drive and cartridge can be transferred somewhere else. Recent devices offer removable cartridges with capacities of up to 1 GB, and the cost of the drive is not much greater than that of a conventional hard drive.

1.2.4 Input and output devices

Input devices convert information to digital code that can be handled by the computer, and output devices convert code into a form that can be understood by the user. Devices are connected to the computer by electronic pathways known as buses. These are specified by width, which gives the number of bits that are transmitted simultaneously, and speed, measured in MHz.

1.2.5 Input devices

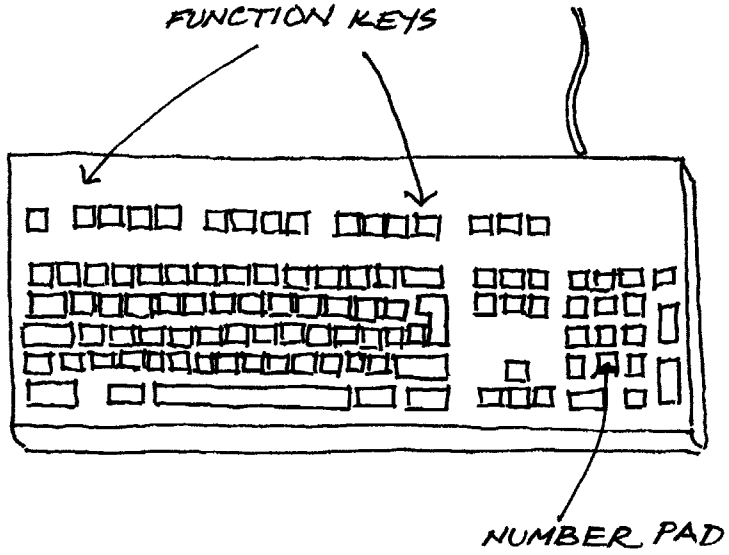
Keyboard

The most common input device for text-based applications is the keyboard. This resembles a (QWERTY) typewriter keyboard (if anyone can remember typewriters…) but has extra keys for specific purposes; these include a number pad and programmable function keys. The small keyboards of laptop and palmtop computers are often too small for comfortable prolonged use.

Mouse

A mouse is a hand-held device, with a ball on the underside, the movement of which on a surface causes the corresponding movement of a cursor or *pointer* to move about on the monitor. The cursor is used to locate points on the screen or, for example, to select items from a pull-down menu. Mice (mouses?) have one, two or three buttons, although few applications use more than one, and are connected by a wire to the computer. On PCs the function of the buttons varies depending on the mouse and the software being used. In general the left-hand button is used to *locate* if clicked once, and to *confirm* if double clicked. Items can be dragged around the screen if the button is held down.

Cordless mice are available which are battery operated and operate in a similar way to a television remote controller using infra-red transmission. *Tracker-balls* and *roller-balls* are 'upside-down' mice, where the cursor is controlled by movement of the ball.



1.6 Keyboard

Track pads, on some portable machines, use the movement of the user's finger across a sensitive pad to generate movement of the cursor on the screen.

Paddles and joysticks

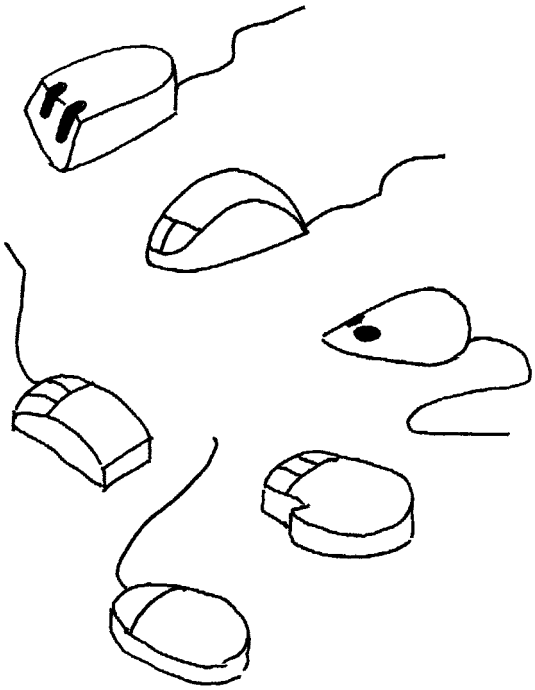
These are used in interactive computer games, allowing cursors and all manner of phantasmagoria to be moved, altered or splatted.

Tablets and digitizers

Graphics tablets and digitizers range in size from A4 to A0. Beneath the surface of the tablet there is a sensitive electronic grid, by means of which specific points on the surface can be determined, and their location digitized. They can be used to select options from a menu which is laid out on them, or for digitizing drawings. Exactly how they operate depends on the particular system. Menu options or points may be selected by a stylus, which is similar to an inkless ball-point pen, or by a cross-hair cursor (puck). They are often used in CAD systems, and many people prefer this method of input to using a mouse and pull-down menus.

Touch screens

Touch screens allow 'pointing' by touching the screen with either a light pen or a finger. The take up of technology has not developed as fast as might be

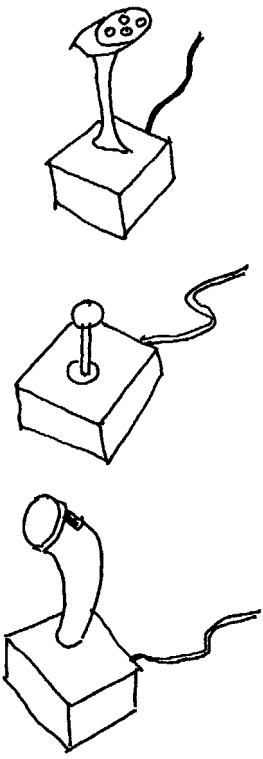


1.7 Mice

expected. If monitor screens remain in a vertical plane anything other than 'pointing' is physically difficult. (Touch screens were used by the Stock Exchange in the late 1980s.) Difficulties are caused by parallax errors, lack of accuracy, dust, static, damaged screens and physical fatigue of the arm of the user.

Scanners

Scanners, which may be flat-bed or hand-held, are devices for electronically digitizing printed, graphic or photographic material, so that it can be handled by a computer. The scanned material can the be used in a variety of applications, where it may be edited, scaled or enhanced. Scanned text may be processed by an optical character recognition program to turn it into a computer readable format. Scanners may operate in *line art,* black and white mode; in grey-scale mode, which gives black and white images with scales of grey; and in colour mode. Resolution is commonly 600 dpi (dots per inch) but can be specified; there may be no point in scanning to a higher resolution to that of the printer. Slide scanners are available for 35 mm transparencies at resolutions of up to 1800 dpi.



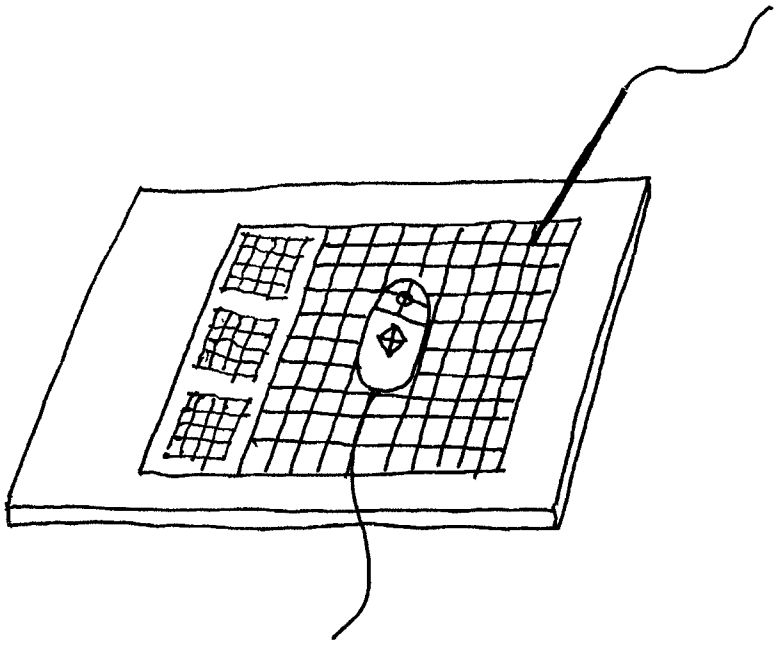
1.8 Joysticks

Digital cameras

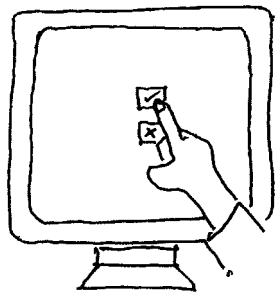
All the main photographic manufacturers are now producing digital cameras, whose optical mechanical parts are just like those of conventional film cameras, but which store images on built-in memory, hard disk or PC card. The images can then be transferred by cable to a computer for reading, editing or archiving. As yet, the quality of the images produced is nowhere near that of conventional film, but they are useful where quick results are needed, as film processing is eliminated. Likely applications are property surveys and records of site progress.

Voice recognition

Voice recognition devices are being developed, but it will be some time before the majority of users will be able to have a conversation with a computer, although Apple have produced a system that will recognize many discrete words in Standard American English. Limited voice recognition is used in security systems which can identify individuals. The wide variation in human vocal characteristics, syntax and grammar make it difficult to define speech unambiguously.



1.9 Digitizer



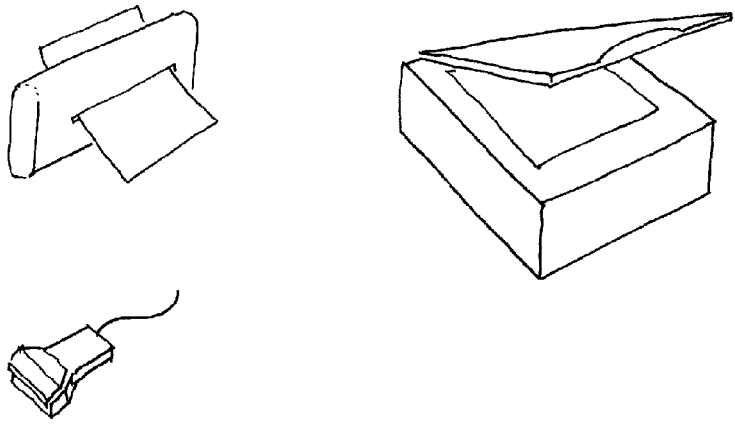
1.10 Touch screen

Character recognition

Devices are available that recognize individual handwriting and convert this to text that can be manipulated by the computer. Here again there are drawbacks of ambiguity and consistency.

Input from stored and transmitted data

Input to computers can come from audio, video or magnetic tape, from floppy, hard or video drive or from a network. Each of these requires the appropriate reading



1.11 Scanners

device, connection to the computer and internal card. Input from other computers can come via a *modem* (MOdulator/DEModulator) which allows digital signals to be transmitted on an analogue (wave form) telephone line. Modems are available with fax capabilities, which allow fax transmissions to fax machines and to other fax/modems.

An 'integrated systems digital network' (ISDN) is being established by BT and others. This network of optical fibre cables allows digital information to be transmitted directly, thus eliminating the need for a modem, and at much faster speeds than are possible with conventional copper cables. Computers are not able to communicate directly through the network without the addition of a currently expensive internal NTE (network terminating equipment) card. If the whole telephone network eventually becomes digital, handsets may need to be replaced or equipped with a coder/decoder (codec) which converts voice to digital code and vice versa.

Access to the Internet and the World Wide Web is available through service providers (Chapter 4).

Future developments

Research is progressing to develop input/output devices that can interpret eye and body movement and alterations in the physical and chemical brain manifestations of brain functions. These include the *data glove* which interprets hand movements and the data helmet which records and translates eye movement.

1.2.6 Output devices

Monitor (visual display unit)

The monitor displays text and images produced by the *video adapter,* which translates instructions from the CPU. The video adapter is an expansion card which PCs need and which plugs into the motherboard. It has memory chips which store information temporarily before it is sent to the monitor. There are several different types of monitor, but those associated with microcomputers are commonly raster, a type of screen display where the screen is scanned many times per second (like a TV screen). The size of a monitor is measured diagonally across the screen.

The picture on the screen is made up of a number of dots or 'picture elements', *pixels*. The greater the number of pixels the greater is the screen resolution. The lower the resolution, the larger the pictures appear on the screen. As the resolution increases, the amount of information that can be displayed on the screen increases, but individual parts of that display appear smaller.

The *dot pitch* of a monitor measures the clarity of the screen image, this should be less than 0.28 mm. *Colour depth,* that is the number of colours that a monitor can display, determines how realistically images appear on the screen.

For home and small business use, a 14- or 15-inch monitor is probably adequate, in combination with a video adapter that displays 256 colours with a 640×480 resolution and 512 K of memory. This known as a VGA (video graphics array) monitor. CAD applications require larger screens, more colours, memory and higher resolution. Macintoshes will drive most monitors without an additional card, but the number of colours displayed depends on the size of the screen and the amount of VRAM in the machine.

Projectors

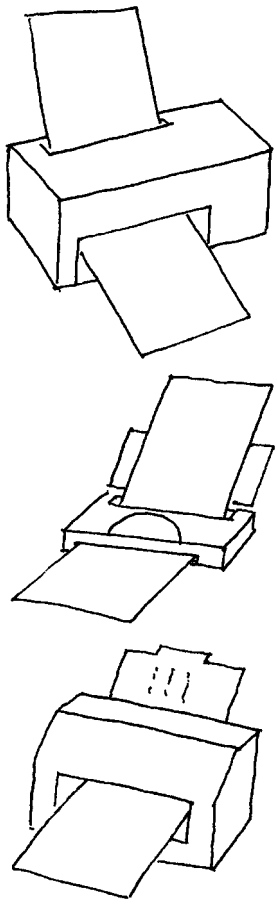
For presentations, projectors are available which receive the output from the computer to the monitor, and project the image onto a wall or screen. There are two types: the first uses a transparent LCD screen which is placed on a standard overhead projector; the image produced tends to be rather faint and colours may be distorted. The second, which is more expensive, projects three colours which mix to form a clear image.

Printers

Printers produce paper copies of what appears on a computer screen. The type of printer required depends on the desired quality of the output, the speed of the printer and the running costs. The speed is measured in either in characters per second (cps)

1.12 Data helmet and data glove

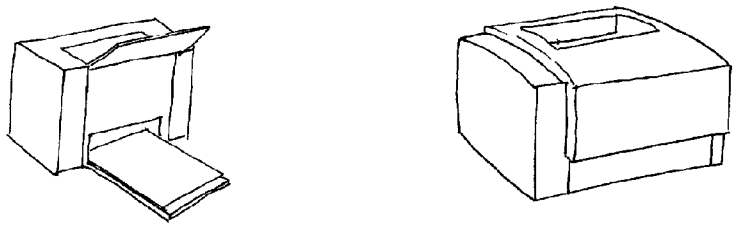
or in pages per minute (ppm). The quality of the output depends on the resolution which is measured in dots per inch (dpi). A printer may have its own chip to process data for printing and it may also have a 'buffer' memory which temporarily stores the information to be printed. When this memory is full, the computer has to wait before sending more data. As a computer sends data faster than a printer can handle it, a



1.13 Ink-jet printers

print spooler may be installed. This is a program in the computer which allows the data to be stored either in memory or on disk until it is required by the printer, and the computer to use another application before the printing is finished.

The cheapest printer is the *dot-matrix printer*. These form characters from a series of dots produced from a printing head from which different sets of blunt pins are pushed forward to strike an inked ribbon. Whilst such printers have largely been superseded, the physical impact of the pins allows the printing of multipart forms. Usually feed is continuous and uses fan-fold paper which has holes on a perforated strip down each side and is pushed through the printer by a tractor feed. Nine-pin printers produce draft quality documents and 24-pin produce similar quality print to a typewriter. Dot-matrix printers are usually sized for A4 paper, occasionally A3.



1.14 Laser Printer

Ink-jet or *bubble-jet* printers which produce images of up to 720 dpi at a speed of about three pages per minute are ideal for home use, general business correspondence and drawings up to A3 size. The print head sprays ink on to the page through small holes. Unless the printer cartridge contains smudge-resistant oil-based ink, care must be taken to allow the ink to dry before the paper is handled. Colour ink-jet printers operate by spraying cyan, magenta, yellow and, in the more expensive and higher quality models, black ink. It is possible to use ordinary paper in these colour printers, but better results are obtained if special, coated paper with a high clay content is used. A4 ink-jet printers are standard, A3 are available and A2 are rare.

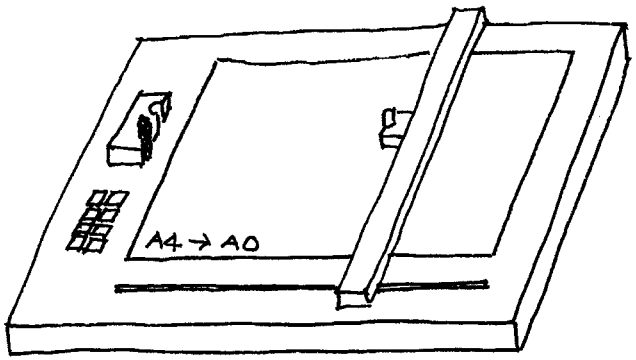
Laser printers work at a higher speed, typically 4, 8 or 12 pages per minute; they operate on the same principle as a photocopier and use toner to render the image. Most laser printers produce images at 300 dpi, but are available at 600 dpi and up to 1200 dpi. The printer should have a buffer memory of 1 MB if text only is being printed and at least 4 MB if graphics and scanned images are to be included. Colour laser printers are much more expensive, but produce superior quality output to ink-jet printers.

Thermal-wax colour printers operate using a heated print head, which melts wax from three or four full-page coloured wax-coated ribbons, or sticks of solid ink, and deposits it on specially coated heat-sensitive paper. Resolution is from 300 to 600 dpi. The sharp, rich images are suitable for prepress and for overhead transparencies.

Dye sublimation printers use heat to change the ink from coloured ribbons into a gas which hardens on the page. The resulting image looks like a photograph.

Plotters

Plotters are expensive and can cost as much as the total of the software and other hardware for a microcomputer based drafting system. Pen *plotters* may be either *flat-bed* or *drum*. On a flat-bed plotter the paper is laid flat, and from one to eight pens travel over it with freedom to move in any direction. With appropriate software, different line styles, colours and thicknesses can be produced. Sizes range from A4 to A0. On a drum plotter, the paper rolls backwards and forwards over a drum and a number of pens move from side to side. The paper may be fed sheet by sheet or may



1.15 Flat-bed pen plotter

be supplied from a continuous roll. Drum plotters take up less horizontal area than flat-bed plotters.

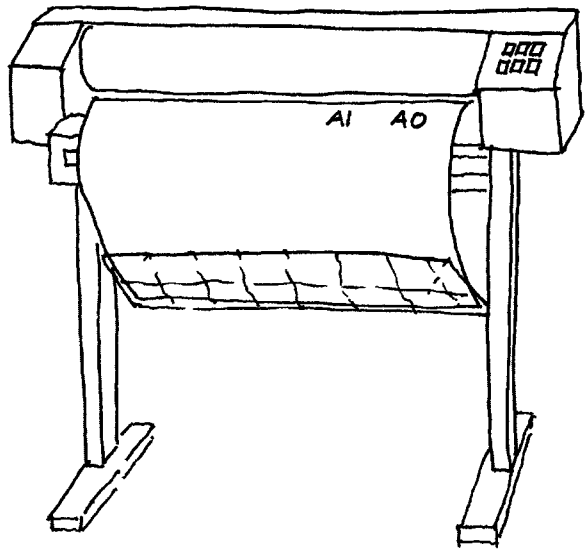
Plotting takes a long time, literally hours, but can be done overnight or at weekends. The quality of the output looks like an extremely accurate manual drawing. There are methods for producing wobbly lines and software that produces crossed corners to make drawings look hand done. This quality depends on the condition of the equipment rather than its capabilities. Paper-feeds jam, pens get worn, run out and misbehave in a similar way to drawing pens.

Ink-jet plotters are big ink-jet printers. They can be sheet-fed or roll-fed, are available either to produce monochrome or coloured drawings, and cost about the same as equivalent size pen plotters, which they are superseding rapidly. A cartridge travels on a rail across the paper and prints one strip of the drawing at a time. The paper is then advanced on a roller and the next strip printed and so on. They have the advantage of considerably increased speed; require less attention and are capable of producing colour rendered perspectives. Resolution is between 300 dpi and 600 dpi. An Al monochrome drawing can be plotted in a few minutes. Colour printing is no more expensive, except for consumables, than black.

The disadvantage is that the output looks less like a conventional line drawing than that produced by a pen, but only very small circles and oblique lines show the inherent jaggedness of the process.

Electrostatic (laser) plotters are expensive (at least four times the equivalent sized ink jet) and are necessary only for large volumes of large monochrome drawings. They work on the same principle as a photocopier, and can produce prints very quickly and on sizes up to A0, on single sheets or on a continuous roll. Top end of the range machines can double as photocopiers and scanners.

The appropriateness of large drawings must be questioned. Now that drawings are transmitted electronically it might be sensible to limit drawing size to A3, so that, provided the recipient has the correct file format and printer driver, the drawing can be produced on a printer on receipt.



1.16 Ink-jet plotter

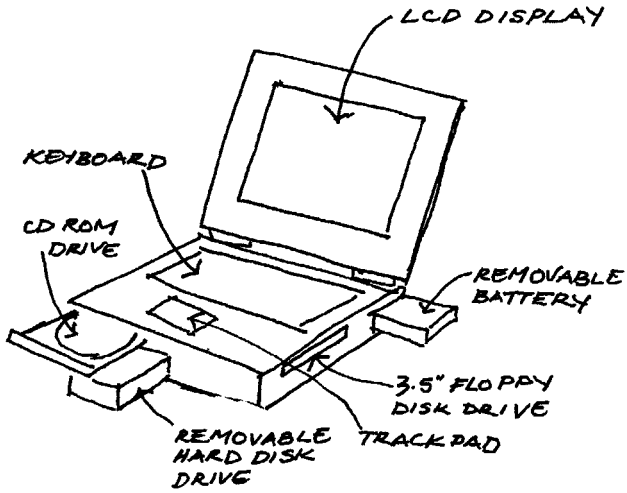
Sound

In order to obtain the audio output which is essential for the use of CD-ROMs and multimedia software, a sound card is necessary for PCs (all later Macintoshes have this facility built in). The edge of the sound card has several ports to which peripherals may be connected including a joystick for games, a CD or cassette player, speakers, microphone and MIDI (musical instrument digital interface).

1.2.7
Portable computers

A portable computer may be useful for carrying around documents in convenient form, making notes at meetings or for surveys. The more lavishly equipped can be used for presentations, and it is possible to connect a remote machine to the office via a modem and appropriate software to call up or send back information. Some machines offer a docking facility by which the portable can be connected on the desktop to a larger monitor, peripherals such as disk drives, and to network with desktop machines.

The hardware should be chosen carefully to achieve maximum efficiency. Portables can be run from mains electricity, using an AC adapter, or from batteries. Nickel cadmium (NiCad) batteries have a life of 1–2 hours but suffer from 'memory effects'. This means they must be drained completely before they can be recharged. Nickel metal hydride (NiMH) batteries are more expensive, last up to three hours and are



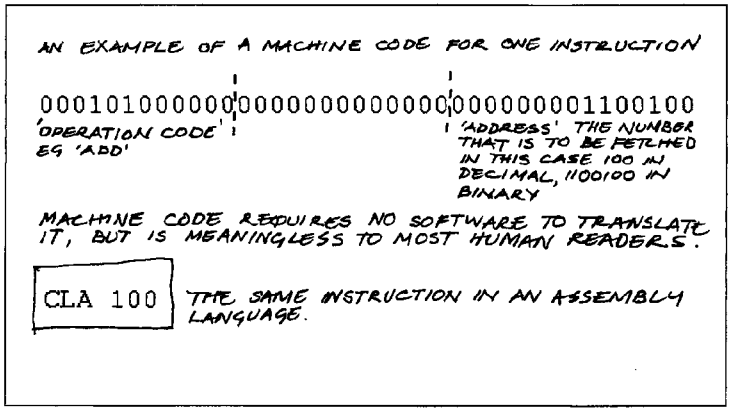
1.17 Portable computer

less prone to memory effects. Lithium-ion batteries are not prone to memory effects, last up to five hours, but take longer than others to recharge.

Screens on portable computers are flat and use liquid crystal display (LCD) or thin film transistor (TFT) technology. For serious use as a computer, rather than as a notebook, the screen should be at least 225mm measured diagonally, and should have a 640×480 resolution with a minimum of 256 colours. Screens may be monochrome (becoming obsolete), grey scale or colour. Colour passive matrix screens are difficult to view at an angle; active matrix (TFT) screens are more expensive but are bright and may be viewed from wide angles. The machine should have a socket on the portable to allow connection to an external monitor for presentation purposes. Extra facilities can be added to a portable computer by plugging them in to an appropriate port or by the use of a PC Card. Many portables have two slots to accept these. Cards are available which allow the addition of memory, modem and networking capabilities, as well as other devices.

Pointing devices for portables are usually contained within the case. Mice are unpractical for operation in limited spaces, such as trains. Pointing devices such as tracker balls, pointing sticks and touchpads should be checked for ease of use when choosing a portable. Ease of use is also a deciding factor when choosing a keyboard. The keys should not be too close together or too small.

Portables should have a hard drive of at least 200 MB, and 8 MB of memory. They are available with or without floppy and CD-ROM drives, but should be capable of supporting these facilities, externally, if necessary. At minimum, a portable should have one of each of parallel, serial, SCSI, mouse/keyboard, monitor and port



1.18 Machine language

replication ports. Many portables are now equipped with slots for PC cards which can contain, for example, further memory, a modem, or a miniature hard drive.

1.3
Software

1.3.1
System software

Control programs

Control programs control the hardware, are written in machine code (binary code), and are used by the operating system to control how the computer functions. These programs are generally built into the computer as ROM, and are sometimes known as *firmware*. The computer user will never need to be aware of what these programs are doing.

Operating systems

It is the operating system (OS) which gives particular machines their character and offers the user a particular way of working. Operating system software controls how the computer hardware and application software work together. They are manipulated internally by means of a control language which is processor specific. Operating systems are developed using assembly languages which are symbolic codes used to represent machine code instructions. Applications written for one operating system will not operate on another, nor can operating systems be easily transferred

between generically different types of machine. In an ideal world a user could expect all computers to behave the same way; sadly this is not so. Market forces have seen the demise of a number of operating systems, and PCs have become generically 'IBM compatible'.

The operating system used by PCs, until the advent of Windows, was MS-DOS (produced by the Microsoft Corporation) or PC-DOS, the IBM equivalent Unless menus have been written for a DOS-based machine, what appears on the screen, the user interface, is characterized by the 'C prompt' C:\ > -. The user must have some knowledge of relatively few of the hundred or so DOS commands to continue. DOS uses directories to organize the data, and single commands. The advantage of DOS is that, should anything go wrong, the experienced user can determine exactly what is going on inside the machine.

The Macintosh operating systems, Mac OS, on the other hand, was developed with a graphical user interface, a much more user-friendly interface, characterized by icons at which the user could point, using a cursor or mouse. Macintoshes also developed the use of windows, separate work areas on the screen. All programs written for the Macintosh operate in a consistent way.

Microsoft Windows provides a user-friendly interface for PCs, the earlier versions of which run using DOS. Windows 95 and Windows NT are true operating systems in that they do not need DOS to operate. Windows provides a graphic user interface which uses windows, group icons, progam icons and pull-down menus. Programs developed for Windows operate in the same way and information can be exchanged between them.

The UNIX operating system, a multi-user, multi-tasking system, was invented for use on minicomputers and workstations, especially in universities and other large organizations, and on many World Wide Web servers. UNIX, with its terse command-line interface, is notoriously difficult for naive users, and various 'shells' have been developed to provide some of the benefits of a graphic interface. Some very sophisticated drawing programs will run under UNIX, but there are few other generally useful available applications.

Programming languages

Applications software is written in a high-level language that corresponds more closely to English than do assembly languages or machine code. For example the English-like instructions GOTO and WRITELN, represent a complicated set of instructions in machine code. High-level languages are converted to machine code by either a *compiler* or an *interpreter*. A compiler translates the program all at once and produces an executable application; an interpreter translates line-by-line during operation (at 'run-time').

Some commonly used languages are BASIC (Beginners' All-purpose Symbolic Instruction Code), 'Visual Basic' (Microsoft's version of BASIC), Pascal (named after

Blaise Pascal), C and C++ (an object-oriented version of C) and HTML (hypertext mark-up language) used for the production of World Wide Web pages. Java and ActiveX are versatile languages used for multimedia applications particularly on the World Wide Web. Like hardware and operating systems, programming languages become obsolete.

Software development

It is not necessary to have any knowledge of a computer language, of logic or of programming in order to run a commercially available application successfully. While writing macros or small programs is fun, it can be very time-consuming and the average user will not have the expertise, time or inclination to try. Generally, it is now unrealistic and unnecessary to develop software in-house, although it may be desirable to do some customization of commercial software. This should be undertaken only by people who know exactly what they are doing, and is generally best left to the supplier.

1.3.2 Applications software

Applications software is developed to carry out specific tasks such as word-processing or drawing. It is written in programming or assembly languages, but this is of only passing interest to the user who should be able to use the program by following the instructions.

However clever and sophisticated software may seem, its value lies in ease of use. There is too much elegant software about which takes an age to learn to use, has capabilities that are rarely used and is not clearly documented. Help facilities are frequently provided on screen, but are not particularly useful if the user does not know what they are trying to do or what mistake they have made. It is important to check the usefulness of the manual, the screen help and the telephone help provided with software.

Packaged software is produced for a wide range of applications. A package would, typically, contain a word-processor, spreadsheet, database and graphics. The advantage of suites of software is that they share a common interface and that files or information can be transferred easily between the different functions. Again, documentation is important: the more complicated the program, the more easy it is to make a mistake.

1.4
Overview of a range of applications

This is grouped by the way in which it is most useful in an office, although software in one group may be used in another:

- *office management:* word-processing, desktop publishing, graphics, spread-sheets, accounts, filers, databases, personal organizers, presentations
- *design aids:* surveying, drafting, modelling, visualization, animation, virtual reality, costing and quantities, structural and environmental calculations
- *running a job:* job costing, project management
- *communications:* internal and external networks

1.4.1
Office management

Office management software is available which will handle the full range of management functions including all aspects of accounting, staff, client and project details, marketing, documentation, archiving and library information services. Many users, especially smaller practices, may, however, prefer to develop their own tools using generic programs such as spreadsheets or databases.

Word-processing (document production)

Most computers are supplied with word-processing software. At its simplest a word-processor is like an electronic typewriter, but mistakes can be corrected easily, blocks of text can be moved around, copied or inserted within a document and there is a range of print and page styles. Graphics may be incorporated or may be inserted from other sources. Word-processors can store standard documents that can be amended to suit a particular job and, if linked to a database containing names and addresses, can be used to produce mail shots. Additional features of many word-processors are spelling and grammar checkers. Word-processors which were designed for the Macintosh or for Windows on a PC are popular with one-finger typists, but less so with professional typists who have been disinclined to use a mouse.

Desktop publishing (presentation of reports and publicity)

DTP applications can be used for the production of brochures, reports and promotional material. The difference between the high end of word-processing and the low end of desktop publishing is minimal. DTP systems, which derive their terminology from typesetting, allow text, drawings and photographs to be 'pasted up' page by page in a variety of formats and using a wide range of typefaces (fonts) and sizes. Drawings and images that have been produced on drafting or graphics

systems, or that have been scanned, can be manipulated in a DTP program. Images can be changed in size, scale and location; they can be stretched, copied, rotated and cropped. Text imported from a word-processor may be respaced, changed in size and font, put into columns, rotated, made to flow around images and edited.

The output of a DTP program may be sent to a printer with a resolution of 300 or 600 dpi which will be adequate for general in-house purposes, but professionally produced documentation is more likely to be printed by a bureau at 2400 dpi.

Graphics (presentation of images)

Most word-processors, spreadsheets and DTP software include limited graphic facilities for making simple diagrams. If more sophisticated images are required for presentational or promotional material, images may be produced or edited using a graphics package.

Graphics packages include:

- drawing systems, which produce images from lines (vectors)
- charting and graphing, which produce graphs, histograms and pie charts from numeric data
- painting software, which allow 'free-hand' drawing and 'painting' by building up images as a pattern of pixels. Any image in digital form, produced by e.g. a scanner or digital camera, can be sized and cropped, and any of its properties (contrast, brightness, saturation) edited. This material can be combined with other digital images. A building can be added to a site. It is, of course, possible to produce entirely 'genuine' fake images.

Spreadsheets (prediction and calculations)

Spreadsheets have a wide range of uses in information storage and retrieval, presentation, forecasting, 'what-ifs' and calculations. They are particularly useful for accounts and financial forecasting.

Conceptually, a spreadsheet is a large sheet of electronic paper ruled out into rows and columns, where text, numbers and formulae can be entered. Calculations are almost instantaneous; this enables various scenarios to be tested. Graphics in the form of graphs, histograms and pie charts can be generated.

Accounting and financial prediction

Specialized accounting software is usually supplied as modules, which would include cash book, budgeting, fee details, expenses, disbursements, salaries, PAYE, job estimating, job analysis, financial forecasting, resource planning, nominal ledger, client (sales) ledger, purchase ledger and invoicing (see also section 1.4.3, Job costing).

Filers and databases (information storage and retrieval)

Filers or *flat-files* are the electronic equivalent of a card index, which can handle one set of individual records at a time. They are straightforward to use and may be adequate for most office applications. They can be searched by key words.

Databases can contain several sets of records. If relationships between them can be identified, these databases are known as relational. How databases are set up, how data is entered and the terminology used varies between packages. Setting up a relational database requires time and attention to detail, and consideration of what information will be required from it in the future. The database must be regularly updated and maintained; this is time-consuming but essential. An incomplete or inaccurate database is not worth the time or money spent in setting it up.

Personal organizers (electronic Filofax)

Personal organizers may be used on desktop and portable machines. They include diaries, lists of names, addresses and telephone numbers, notes, and can produce daily schedules or appointments and reminders.

Presentation software

These are programs which can be used to produce standard 'business presentations'. They consist of a series of 'screens' or 'slides' which can be displayed sequentially. Screens may be composed of text, graphics, coloured backgrounds, bulleted lists, sound and possibly animation. Clients may expect this type of presentation—or they may be repelled by it.

1.4.2 Design aids

Design aids are anything that will facilitate design activity or which allow the design team to foresee the effects of design decisions. In the near future it may be possible to construct full electronic building models which will be shared by all those involved in design and construction. The models will be composed of objects, not just representations of physical objects, but groups of data that know how to behave in particular circumstances.

Surveying

Software is available that will accept the output from an electronic theodolite (EDM) and allow it to be imported into drafting and modelling software.

Drafting (electronic technical drawing)

Drafting systems draw in two dimensions, and are used to make production drawings in much the same way as a traditional drawing board. They do not hold a model of a building or artefact, but a record of vectors: lines, curves and points. Input to a drafting system may be from the keyboard (slow), from a graphics tablet, pull-down menus or a mouse. While it may take roughly the same amount of time to input a computer drawing as it takes to draw it by hand, if the drawing contains a large number of repetitive elements the relative speed of input increases with the number of elements. The advantages of computer drafting over manual are similar to those of word-processing over script: computer-generated drawings are exact, clean and easy to modify. The disadvantage is a possible lack of individuality.

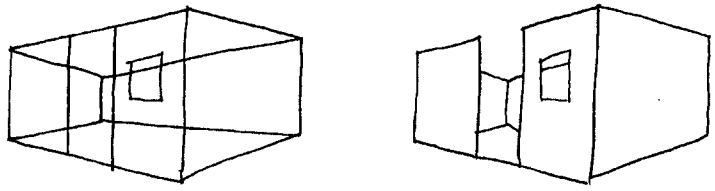
Drawing systems have a number of layers, known variously, depending on the system, as *views*, *levels*, or *overlays*. These can be imagined as layers of tracing paper, which are overlaid and each of which contains a separate set of information. The layers can be viewed in different combinations to show the relevant information for a specific purpose. There are standards relating to what information is put onto which layer. It is advisable, when the system will allow it, to conform to the layering standards dictated by the client or used by the rest of the design team.

Modelling and visualization

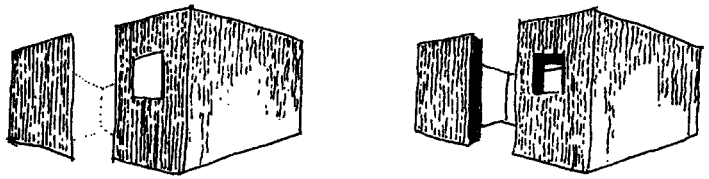
Modelling can be used to evaluate any characteristic of a building that can be represented digitally. In CAD, wire-line and surface modelling are visualization aids, whilst solid modelling, used in its true sense, is an application which allows objects to be created in three dimensions, and attributes assigned to them. Solid models have been developed in engineering applications where properties such as centre of gravity or of inertia can be derived. Buildings are hollow but composed of assemblies of solid components, each of which has visual and physical characteristics and attributes, such as cost. A fully integrated model would mimic all these and allow computer-generated prototypes to be evaluated. There are rapid developments in this area which are being driven by large client bodies and international contractors.

Wire-line (visualization)

These are created by locating points in three-dimensional space and joining them up with lines or curves that represent edges. The object or building can then be viewed from any angle or height and in perspective. Most systems that include wire-line representation allow for the removal of hidden lines, this makes the drawing easier to read. Wire-line representations are quick to produce and are useful in the early stages of design to investigate massing, and can be used as a basis for freehand drawings.



1.19 Wire-line



1.20 Surface and solid models

Surface modellers (visualization)

These model with infinitely thin planes. The planes can be generated by joining points on lines, curves or splines. Surface models are good at portraying surfaces curved in three dimensions and are most commonly used in engineering (for instance to visualize car bodies) and in product design and advertising. Their architectural application is limited to interior and exterior perspectives and terrain modelling. These models can be coloured and shaded, and shadows can be generated. Some systems allow several light sources to be introduced, and the effects of these to be produced by ray tracing. As these models have no 'substance', architectural drawings tend to look a bit cardboardy unless great care is taken with the definition of planes.

Solid modellers (modelling and visualization)

In solid modellers, geometric solids are created as 'lumps of stuff', which can be rotated, sectioned or viewed from any angle. Whereas in a surface model there is nothing in the middle of what appears to be a solid, in this case there is. What it is can be defined by the assignation of a series of attributes based on a series of mathematical models. Solid models can range from a simple assembly of geometric 'primitives' such as cubes, spheres, pyramids and cones, to integrated building models. The latter provide a series of linked modules which allow specific functions to be carried out, for instance ground modelling linked to building modelling, both linked to a drafting system and an interactive database. The advantage of solid modelling in architectural applications is that the building model can be cut through to give a true section. Some modellers allow quantities to be taken off and other information to be attributed to them.

Animation (visualization)

Successive 'frames' that have been produced on a visualization system can be linked together to form a screen sequence or video, a 'walk through' or a 'fly around'.

Virtual reality (visualization)

systems purport to recreate reality, usually solely visually, and by means of a device such as a data helmet, allow the observer to enter and move within that 'reality' and to interact with it. Desktop Virtual reality' allows the user to manipulate the screen image of three-dimensional images by moving the mouse. Properties can be attributed to surfaces and objects. These systems are, at present, rather cartoon-like and require beefy computer resources.

Structural and environmental calculations

There is some doubt about the advisability of architects doing their own calculations except as an indication, especially as indemnity premiums rise. On the other hand, for small practices who do not work with consultants, there are structural and environmental packages from which the output is acceptable to Building Control. Before buying any software for this purpose it is advisable to check with the local authority.

It is unwise for anyone to use software to carry out calculations which they could not do by hand, given enough time. It is essential to know what the underlying mathematical model is and when an answer is implausible or of the wrong order of magnitude. Calculations which are used frequently can be set up on a spreadsheet in-house.

There is an enormous range of technical software, the majority of which has been written for DOS-based systems rather than Macintosh or Windows. It is important to check whether software is available for an existing operating system and is compatible with other software which is in use.

The following list is not exhaustive but gives an indication of the available range:

- foundations, piling, hydraulics
- structural analysis, wind loads, steel, concrete, timber, masonry
- environmental analysis, space loads, condensation, lighting, noise, fire, ventilation
- energy consumption and monitoring
- mechanical services, plant, ductwork, lifts
- piped services
- electrical services

1.4.3
Running a job

Job costing

Job-costing software can be obtained either as an independent package or as modules of an office management system. Typically, job-costing software would include details of staff, resources, expenses, clients, fees, forecasting, performance targets, contracts, document issue and a report generator. Alternately, a small practice might develop its own using a standard application such as a spreadsheet.

Project management

Project management software is used by contractors and project managers, rather than architects, for programming operations on site. Software may be based on critical-path analysis, Pert charts or Gantt charts. The latest software relies on good graphic display and is a relatively easy to use for a wide range of operational planning purposes.

1.4.4
Communications

Computers may be *networked* to communicate within an organization. In order to communicate with the outside world, the computer will need to be equipped with a modem which may be internal or external. This device will allow files to be sent directly to other computers with a modem, provided they use an appropriate standard and speed of transmission. To gain access to e-mail, the Internet or the World Wide Web, a service provider must be selected. Service providers are fee-charging commercial companies who maintain an 'electronic mail box' for the user to and from which messages can be sent.

1.5
Acquisition

1.5.1
Single user

Buying a computer is not such a dodgy business as it was five years ago but it is important to make sure that it has enough memory and storage space to support the applications that are to be run. It is a good idea to look through computer magazines and the general press to see what is currently on offer. If a home machine is to be used for work brought home from the office it is essential to ensure that it can read the

disks, that the operating system is compatible and that the software can read files from similar software. The biggest incompatibility is between Macintoshes and PCs; but even some PCs of the same generic type will read high density but not double density disks. (This is because of minute variation of the setting of read/write heads on different machines.) A word of caution: vendors frequently try to off-load models which are about to be superseded. What looks like a good deal may not be. Having said that, if a machine is to be used for word-processing only, a superannuated model will do. New machines are frequently launched before they have been fully tested (this is left to the user), so it may be wise to avoid the impulse to buy the most up-to-date machine and settle for one which has gone through the first stages of testing.

For drafting, multimedia, Internet, e-mail and Windows applications, a minimum of 16 MB RAM is needed, with a minimum of 1.6 GB hard disk, a × 8 CD-ROM drive and a 166 MHz processor (200 MHz, say, for a Macintosh). Monitors should be at least Super VGA with a minimum of a 256-colour display; keyboards and mice should be comfortable to use. Most new machines now come with an internal modem; the top of the range models can handle voice, data and FAX calls. PC-based multimedia applications will require a sound card and speakers. There must be enough expansion slots to support all the foreseeable peripherals.

1.5.2
Computers in practice

Practitioners who are not yet using computers will approach the acquisition of a system with trepidation. This section is advice to the completely uninitiated. It may not be necessary to have a computer in a very small practice with established clients, consultants and contractors, but it will certainly be useful, and it is now impossible to undertake larger contracts without a computer system.

For practices larger than a single practitioner, the first step should be to evaluate existing office procedures. These will have become established over the years and may conceal areas of inefficiency. Practices considering quality assurance have to subject themselves to stringent self-analysis, and then may have to accept the possibility that administrative or technical procedures need revising. If computers are not used at present, the following check list, which is similar to that used for quality assurance, should be considered in conjunction with possible computer applications.

General office management

- number of people employed, full time, part time or contract; the possibility of increase or redundancy
- level of employment of current staff, workload and future prospects; consideration of how quickly a project could be taken on
- current financial situation and future prospects

- office organization, running of projects, client liaison, consultant liaison, production drawings, site inspection, contractual matters. Who does what? Who has an overview?
- how are records of decisions made during a project kept? Are telephone calls noted? Does anyone have an overview?
- who orders office equipment and stationery? What control is there? Who makes the decisions?
- who deals with trade reps and trade literature?
- in what condition is the existing office equipment?

Job running and costing

- is there a standard procedure when a job comes in?
- does the practice make fee bids? On what basis?
- how are jobs obtained, run, costed and archived?

Accounting

- how are accounts run and by whom? At what intervals are accounts updated?
- how many ledgers are kept?
- what accounting procedure is used (e.g. double entry)?
- are the accounts linked with job-costing, PAYE or forecasting systems?
- what happens to petty cash, equipment and stationery receipts?
- how is VAT handled?
- what happens about recoverable expenses?
- who administers fee accounts?
- are timesheets integrated into the accounting system?
- does anyone know the current financial position? If not, how long will it take them to find out?

Secretarial tasks and administration

- how much time do administrative staff spend on general office activities? Typing? Filing? Answering the telephone?
- is there a receptionist and/or telephonist?
- are letters written longhand for a copy typist? Dictated to a shorthand typist? Recorded on cassette for an audio typist? Are there numerous procedures according to individual preferences?
- could all the typing be done by one person? Would this be a full time occupation? What is the optimum arrangement for using existing personnel?
- are standard letters, invoices, accounts, memoranda and instructions used?
- how many copies of outgoing correspondence are used? How frequently and by what system are they filed?

- how are other records such as faxes, architects' instructions, memos, notes and telephone messages filed? Are they duplicated?
- what kind of typewriters are used? Are they due for replacement?
- can the photocopier reduce, enlarge and/or reproduce colour?
- who is responsible for the maintenance of office machinery? What contracts exist and which member of staff deals with them?
- what is the condition of all equipment and when is it due for replacement?

Library information and archives

- are case studies and job records used as feedback information?
- what happens to records of completed jobs and the associated drawings?
- how long does it take to retrieve this information?
- what happens to trade literature? How is it filed and how long is it kept?
- is technical and trade information updated regularly? Who does it?
- is there a microfiche?

Design and drawing procedures

- is a standard set of drawings used for every job? What is it?
- are standard details used? For what and when?
- are standard plans, generic forms or layouts used? For what use and when?
- is it usual to produce perspective drawings for clients? Is this work done by individuals, in-house specialists or is it contracted out?
- is the conceptual design done by one or a small group and then 'farmed out' to others; to project teams?
- how are amendments made? How are these logged other than on the drawings?
- how is the issue of drawings recorded?
- how is consistency between drawings checked and ensured? Who does this and how often? How long does it take to produce an average drawing?
- what media are used and for what? (ink, pencil, tracing paper, tracing film, colour, etc.)
- what size and scale are drawings? Why?
- are sketch designs and outline proposals incorporated into reports? How?
- how is production information issued to consultants? To site? How are amendments resulting from instructions handled and recorded?
- does the practice have a dyeline machine? When is it due for renewal? What size drawings can the photocopier handle?

Technical support

- how much work of a specialist nature is carried out?
- do the specialists work to the same mathematical models as regular consultants?

- are the specialists prepared to work to the same mathematical model or protocol as available software?
- is the practice prepared to accept liability for the results produced?

1.5.3 Definition of needs

Many of the tasks defined in the above lists could be carried out using a computer, but may be adequately done by existing methods, depending on the size of the practice. Investigation of the computer market takes time and, therefore, money. Large or busy practices may find it better, economically, to employ a consultant than use staff time.

Tasks that are being carried out inefficiently should be identified. Inefficiency in this case means using a person's time for a task which might be better carried out by someone else, with the help of a computer, or not at all. It is sensible to incorporate these findings in a written report, which can act as a vehicle for discussion and serve as a record. Change may not be necessary or may be limited to amendment of staff duties or office procedures. It may be necessary to replace office equipment.

The next step is to produce a specification for the jobs that might be carried out using a computer, the current and estimated size of these jobs in terms of volume of input, and the time within which each job has to be carried out. This specification need not be long, but it must be explicit and comprehensive, defining the functions expected of the computer system, the total budget available for software, hardware, maintenance and training, and the time for installation. This is another point at which the appointment of a consultant should be considered.

1.5.4 Sources of advice and consultancy

There is no such thing as an expert: it is impossible for anyone to be completely conversant with the enormous range of software which is available. There are some sources of independent advice, but these will be familiar only with software which they have used or tested. Some consultants, and all software houses, dealers and vendors, have a vested interest in selling a particular range of products. Software for every application varies in the way in which tasks are carried out. A CAD system, for example, that suits one practice will not, necessarily, be the best for another, and neither may be what the client requires. A package that will generate quick shaded perspectives may not be the most appropriate tool for the making of production drawings. For this reason it must be made quite clear what is required of a system when advice is sought. 'Which is the best CAD system?' is an impossible question to answer definitively.

RIBA IT groups

The RIBA IT Committee, based in London, considers policy. Members are practitioners, staff from the RIBA and RIBA Companies. The companies have set up a bulletin board, access to which is free for members, and World Wide Web pages are at http://www.riba.org. A network of consultants who are conversant with the needs of architects has been set up. Fees will be standard throughout the network. Further information may be obtained from the RIBA hotline.

Responsibility for help to small practices has been delegated to the RIBA Yorkshire Region IT group. This group will give free general advice on procedures, but is not prepared to recommend specific hardware or software. Its telephone number is 0113 245 6250 and callers will be referred to a group member who can give the most appropriate advice.

Schools of architecture

All schools of architecture use computers and some run short courses in computing for architects. Whilst staff are under pressure during term it is often possible to arrange a visit to inspect hardware and software and to get advice, but tuition will not be free.

User groups

There are user groups for various types of machine and for most major software packages. The groups exist for self-help and are usually prepared to help potential users. Details of these groups may be obtained from producers of hardware and software, and from the Construction Industry Computer Association (CICA).

Consultancy organizations

RIBA Companies produce a software selector which is intended for use by architectural and related practice.

The Construction Industry Computing Association is an independent body which has information about users, hardware and software. CICA consultants will give initial advice by telephone, but require payment for further services. Annual membership of CICA costs an amount which varies according to the size of organization. Members receive regular bulletins and a software directory in addition to preferential rates for conferences, publications and consultancy. Their address is: CICA, I Trust Court, Histon, Cambridge, CB4 4PW; their telephone number is: 01223 236336; and their fax number is: 01223 236337.

The National Computer Centre, which is based in Manchester, gives independent advice about a wide range of computer applications.

Consultants

A glance at the Yellow Pages will reveal a large number of purveyors of computer expertise, but as in all walks of life there are cowboys. The best advertisement for a consultant is a personal recommendation from a satisfied client. Consultants can be asked to provide a list of former clients. A specification of practice requirements should be sent to potentially suitable consultants, with a description of the services expected, timescale and budget. If a consultant is not to be appointed, the best advice can be obtained from a practice that is about the same size, has a successful computer system, is not in direct competition and has learnt from its mistakes.

Exhibitions

There are numerous exhibitions of hardware and software which are advertised in the national and professional press. These are of use to visitors who know exactly what they need. The inexperienced or first-time buyer should be warned that the salespeople and demonstrators may have learnt a presentation exclusively for the event and may have no in-depth knowledge of architectural practice. As the purpose of exhibitions is to sell, it is advisable to get an idea of a range of products at an exhibition and then arrange to have a private demonstration.

Magazines

Specialist computer magazines are excellent reading for computer buffs, but may be unintelligible to the inexperienced. Architectural periodicals run features that often give a good background but limited specific advice (see the Further reading list at the end of the book).

Dealers

Some dealers will provide hardware and software together, but cannot always be relied upon to have any knowledge of specialist software which they do not supply. It is advisable to define the range of software before consideration of what hardware is required. If service is slow or off-hand before a sale has been made, it is likely to be even more slack when it comes to after-sales service.

1.6 Implementation

1.6.1 Choosing hardware and software

Several decisions have to be made before buying a computer system; the available budget, the range of applications to be run and where the computers are going to be located. It is not always practical to run all applications for all machines in an office, although compatibility between machines is essential. Word-processing, spreadsheet and database applications can be run on lower specification hardware than CAD systems. If a single machine is to be installed it will need to be of the highest available specification. The budget should include the cost of software and manuals, the computer(s) with screen, mouse and keyboard, printers, plotters and any other peripherals, training and maintenance.

Software should be chosen before hardware. If data is to be transferred to or from clients, consultants or contractors, it is essential to take compatibility into consideration at the outset. When a list of possible applications has been prepared, it is advisable to shortlist several pieces of software for each, and to get demonstrations. These can be arranged by finding the nearest dealer from the software supplier. It is important to ensure that the software is capable of carrying out the range of tasks for which it is intended and whether it can be extended or upgraded. For straightforward applications such as word-processing and to some extent, drafting, it is easy to see whether the software fulfils internal requirements. The merits of more complex software often does not become apparent until a user has become familiar with it; this is not easy at a demonstration. It is useful to talk to existing users.

For each item of software the following information should be obtained:

- will it perform the required range of tasks?
- its cost
- cost of hardware on which it is recommended to run
- is training necessary and is its cost included in that of the software? If not, what is the cost?
- what are the terms of the maintenance contract, if any?
- are the manuals intelligible? (Many manuals explain commands but do not give details of procedure.)

It is advisable to get all software and hardware through the same dealer, to arrange for the dealer to install all the software, and to require that the system is up and running before paying.

1.6.2
Macintosh or PC?

There is too much rather foolish argument about the relative merits of Macintoshes and PCs. The facts are that Macintoshes have always had a consistent user interface, a standard way of handling software, have many built-in facilities, are considered easy to use, and have been used for serious applications, predominantly by designers. Now that Windows is becoming the accepted user interface for PCs, the distinction is becoming fuzzier. PCs often require extra cards to add facilities such as graphics, communications and sound, but if these facilities are not required the computer may operate faster without them. Very much more software has been written for DOS based machines than for either the Macintosh operating system or for Windows, but as development is so rapid, this will not be so for much longer. The more widespread use of operating systems that run with RISC chips may necessitate rapid updating of software.

It is impossible to predict the exact nature of developments, but the tendency is towards convergence and common standards. Who knows where the MMX technology for PCs and NeXT technology for Macintoshes will lead.

Provided that the hardware will run the desired range of software, and that output can be generated in a format that can be read by the requisite machines, it really does not matter what 'breed' it is. What is important is that the motherboard has enough expansion slots for additional cards to support future needs, and that there are enough existing external ports to support immediate peripheral requirements.

1.21 Ease of use: PCs vs Macintosh (from Iomega's Zip Drive Installation Guide)

Start the setup or Install program

Windows95 users: Open *My Computer* and double click on the floppy drive icon. Double click on the **Guest95** icon (illustrated at right) to set up your system to use the Zip Drive. After Guest 95 completes your hardware setup, double click on the Zip drive icon in *My Computer* and open the **W95stuff** folder. Double click on **Setup95** to install Tools 95.

DOS Users (Windows not installed): At the DOS prompt, type **a:guest** (or **b:guest** if the Install floppy is in drive **b**), and press Enter. Note the drive letter Guest assigns to your Zip drive, then type **d:\scsi\install** (where **d:** is the Zip drive letter), and press Enter. After the software installation is complete, type **d:\dosstuff\reclaim** (again use the Zip drive letter in place of **d:**), and press Enter. You will not be able to save files to your Zip tools disk until you run the reclaim program.

Mac users: double click on the **Zip Install** icon.

A standard PC should have two serial ports, one parallel port, a video port (to connect to the monitor), a mouse port and a games port. Serial ports have either 9 or 25 pins and are 'male connectors'. They are used to connect a mouse, digitizer,

modem, scanner, serial printer, or *dongle* (security device). The connection to them is a plug with the same number of sockets and a cable which may be over six metres long. A parallel port has 25 holes and is a 'female connector'. Parallel ports transmit data eight bits at a time and consequently are eight times as fast as serial ports. They are required for parallel printers and plotters, tape drives, and some dongles. Parallel cables are not reliable for distances over six metres.

The message is simple: get the best hardware that the budget will allow. Try to obtain hardware and software from the same source. Take advice. Try not to pay for anything until all the software is up and running satisfactorily. In any case the system is likely to be obsolete within three years of purchase. Individuals and small practices should consider paying with a credit card to take advantage of the card company's insurance and buyer protection schemes.

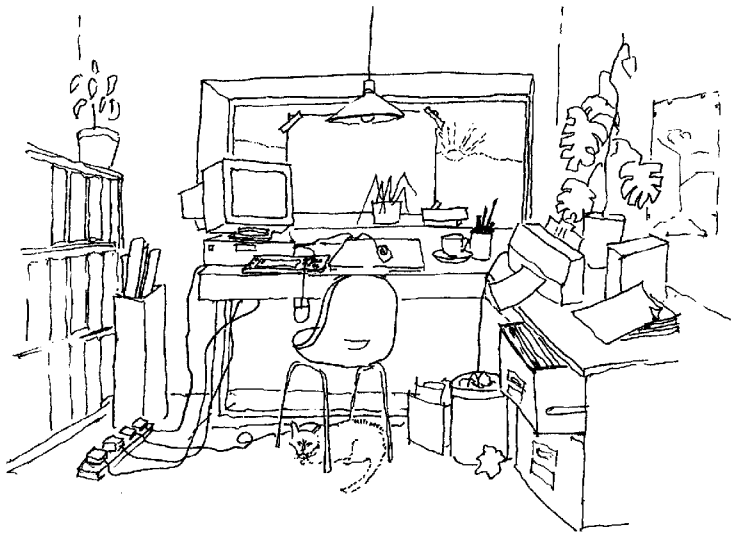
1.6.3
Space and environmental requirements

Computers no longer require special environmental conditions, but people have much the same needs as ever. Heat and noise generated by hardware is now reduced considerably and should not be a problem.

Lighting is crucial. It is difficult to work at a monitor if there is disabling glare either from windows or from ceiling-mounted luminaires. While a lower level of general illuminance is necessary for work at a computer, too great a contrast should be avoided and it should be possible to alter the illuminance incident on the plane of any reference material to suit the user. Task lighting is recommended. Blinds should be fitted to windows, and monitors located where it is not necessary to keep ceiling-mounted luminaires switched on. It is a good idea to experiment with possible locations using a portable television. Computer use is now covered by European Union Health and Safety at Work regulations and employers must be conversant with these.

Computers require space, much more than is implied by glossy sales literature and talk of the 'paperless' office. Any microcomputer needs plenty of space around it for access, the connection of peripheral devices and for ventilation. The peripherals, which may or may not be on the same surface, need space around them. The monitor may sit on top of the computer case, or directly on the desk top; whichever is the case, it is a European Union requirement for the screen to be able to swivel both vertically and horizontally. The centre of the screen should be between about five and twenty degrees below the horizontal eyeline of the user. Reference material should be at the same distance from the user as the screen, and, ideally, on an adjustable sloping plane.

The keyboard will normally be attached to the back of the computer case by a spring cable. Some people like to work with the keyboard on a horizontal surface in front of the monitor, others prefer to use it to one side, or on their knee. Mice and



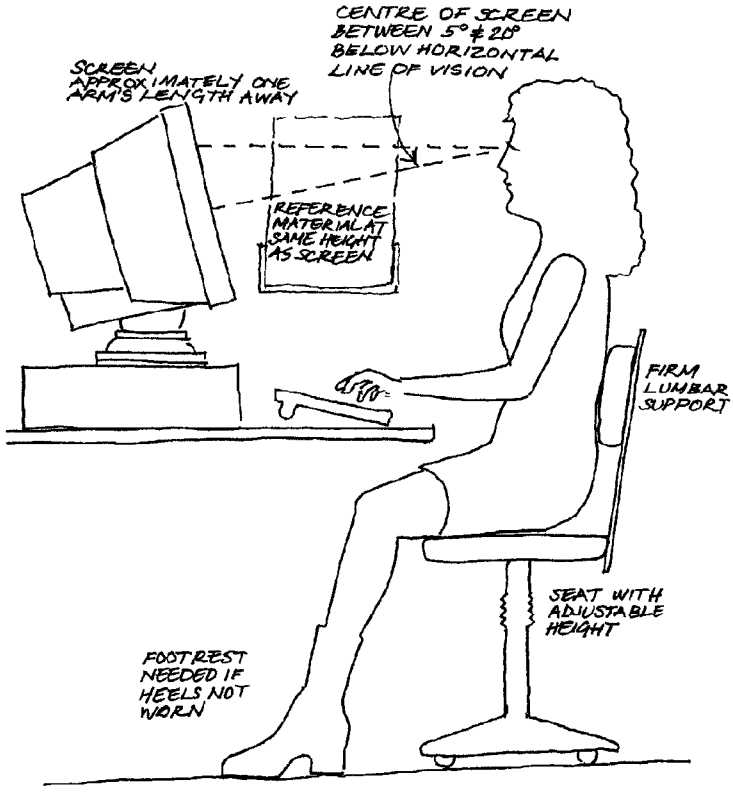
1.22 'How not to do it'

graphics tablets are located on the desk surface to the left or right of the screen, depending on the handedness of the user.

The layout of hardware should be planned in advance, making allowance for layout space and the accommodation of the manuals provided with the hardware and software. Where applications are to be used which require the computer operator to work at a word-processor or drafting system all day, the environmental conditions and the furniture layout should be considered for every individual and be in accordance with regulations.

1.6.4
Furniture layout

- the desk and chair should be arranged so that the centre of the screen is between five and twenty degrees below the horizontal eyeline as should any reference material that needs to be consulted; it should be possible for the operator to keep their feet flat on the floor
- the working plane should be large enough to enable the user to reposition 'electronic tools' to suit the nature of the work
- the layout should respond to the user's reach; an L-shaped or curved desk may allow equipment or reference material to be reached more easily
- the underside of the desk should be high enough to give plenty of knee clearance; adjustable desks which can be altered to suit individuals are advantageous



1.23 Furniture

- large digitizers must be positioned carefully; it is difficult to use them from a seated position; to avoid 'draftsman's back', the digitizer may need to be raised or tilted
- chairs should give firm lumbar support; this can be provided by an adjustable back rest; they should be stable (five point base with self-locking castors), have a swivel action and an adjustable seat height
- where keyboards are in constant use it is more comfortable for the operator if the chair slopes slightly downward towards the back support (less than 14 degrees); elbows should be level with the keyboard and wrists should be higher than fingers

1.6.5 Electricity

The computer casing contains a power supply unit which produces heat, about 200 watts, which is dissipated by an internal fan. Ventilation inlets to the computer case should not be obstructed as overheating can cause damage.

Trailing cables are dangerous, unsightly and bad for the image. Wire-managed furniture is commonplace in large commercial offices, but is not necessary if desks where computers are used are placed back-to-back or against a wall.

Computers require 'clean' electricity. Surges or power drops can cause damage both to hardware and software and consequential loss or corruption of data. Networked computers should be on a separate protected circuit to avoid interference from other office machinery. For individual microcomputers it is sufficient to feed the computer and peripherals from a multi-socket block with a built-in filter, which protects against surges. The block can be fitted to the back of a desk and the single cable from it to the power source can be made safe and unobtrusive. Where computers are used all the time, and data is sensitive, protection is needed against power failure. In a power failure all the contents of the active memory are lost. To avoid this, an uninterruptible power supply (UPS) is necessary. This is a box with a number of outlet sockets, and that contains a battery which, if the mains power fails, runs the computer for long enough for data to be stored, and the system to be shut down. Computers can be damaged during electrical storms. All cables connecting the computer to a power outlet, network or modem should be disconnected. All equipment should be earthed properly.

Computers can suffer from electrical interference from inside or outside the building. If the cause is not identifiable the electricity or telephone company can be asked to investigate. Computers should not, but can, cause interference to other equipment, particularly radios.

1.6.6
Installation and maintenance

Someone in the office should be designated to oversee the installation and then manage the system. For larger installations this may require the nomination of a System Manager. The hardware should be set up and tested by the supplier, who should install and, if necessary, test the operating system and make sure the peripherals work properly. Whilst the installation of software is relatively simple, it is advisable to ask the hardware supplier to install all the software to ensure there are no clashes and that there is enough memory. When software has been installed, decisions must be made about how it is to be used to suit the needs of the practice.

Setting up databases and complicated spreadsheets is time-consuming and exacting. It is not simply a case of loading the software and running it, but of pre-planning to get the system into a condition which will allow it to be used in the desired way.

Password protection (each user has an individual access code) and levels of access may need to be set up, and there may be a need for a customized 'front end' (what the user sees and what choices are offered when the computer is switched on). If there is no one available who knows precisely what they are doing, it is a good idea to employ an expert to do this.

1.6.7
Maintenance

Maintenance for hardware will cost about 15% of the capital outlay, per annum. It is essential to take out a maintenance contract and to read the small print. Most suppliers and dealers undertake to trouble-shoot on the same working day or, at least, within twenty-four hours. This service may be slightly better if the hardware is leased, as faulty equipment is generally replaced immediately.

For software other than bespoke systems, 'maintenance' is likely to consist of updates as they occur and access to a twenty-four hour telephone helpline. Help does not appear on the doorstep because a user is unable to operate the software. Even if the software is faulty it is unlikely that help will be available other than from a telephone helpline. It is therefore essential that the software is installed correctly at the outset and that initial training is provided by someone who is able to demonstrate that it works properly.

1.6.8
Training

If training is necessary, it may be included in the cost of the software. How much training is available and its cost should be determined when choosing software. Some software houses run courses that last for several days and take place on their own premises. It may be possible to arrange for in-house training. It is prudent to get at least one person trained properly who can then train others. It takes about three hours to get to grips with a piece of software and a further seven to become reasonably proficient, although these figures of course vary with the software and the skill of the operator. For small installations and 'off the peg' software, a limited amount of training may be provided by the supplier, but this should not be taken for granted.

1.6.9
Health and safety

Employees are covered by the Health and Safety at Work Act (1974) and the subsequent European Union Directive (1994). Computers do not normally create a health hazard. Suggestions of danger from excessive radiation are unproven, but there are much more straightforward dangers. Electric shocks can occur from a build up of static, from faulty wiring and connections, and from overloaded power sockets; people can trip over trailing cables. Other detrimental effects are caused by inadequate consideration of ergonomics in relation to the furniture and to the environment. A comfortable temperature, adequate humidity to avoid static, adequate ventilation, careful positioning of anything that generates noise and lighting that does not give rise to glare or screen reflections are all essential.

People who work continuously at computers should be encouraged to take regular breaks, at least once an hour, to give their muscles and tendons time to relax. Repetitive strain injury (RSI) is an increasingly common and recognized complaint, particularly among keyboard operators. It is tiring to stare at a screen for long periods, and here again eye muscles need to relax by looking at a distant view (greater than 12 m). Failure to do this will result in loss of visual acuity. Operators should not be discouraged from looking out of the window.

Headaches can be caused by a combination of unsuitable lighting, poor ventilation, screen flicker, boredom, eye strain, stress or the general dislike of computers. If people think that they are getting headaches because of continuous computer use, they may be better employed doing something else unless the specific cause can be identified and removed or mitigated.

There is no reason why working with a keyboard should be any more likely to cause RSI than working with a typewriter, except that people tend to work faster and in a more static position. Similarly, using a digitizer should be no worse for the back and neck muscles than working at a drawing board. An ill-positioned mouse pad is likely to cause wrist and shoulder pain. If the technology is new to a practice and problems occur, the new set-up will be blamed. If people are able to move around at regular intervals and avoid working in one position, problems should not occur. It is important to note early symptoms such as tiredness, pins and needles, weakness, swelling joints, and nagging pains in the wrists, arms, shoulders, neck or back. Appropriate medical advice should be sought.

1.6.10 Security

The scope for disasters when using computers is much greater than in a paper-based office. The potential number of risks are greater and damage is not always immediately visible.

Accident and theft

In the event of flood, fire or burglary, data held on computers and disks may be corrupted or lost. Back-ups or, preferably, double back-ups should be made at least once a day, and one copy kept in another place (another office, a partner's house, a safe deposit box). Hardware should be insured under a business machines all risks policy. If the equipment has been delivered but not invoiced, is on loan or is on trial, it should be insured to cover its own value as 'goods held in trust'. Insurance arrangements for leased equipment should be discussed with the lessor. Computers are affected by excessive heat or cold, sudden impact, liquids or smoke. Keyboards are usually disabled, if only temporarily, if liquids are poured over them. (They may

be rescued by being inverted, shaken, and a hair dryer gently applied.) Smoking, eating and drinking are not compatible with computer use.

It is not usually worth insuring software unless it has been developed in-house or is bespoke as copies should be kept in a safe place. However, some software originators will not supply a new copy of the program if the original is damaged. Where software may be copied but can only run with a dongle (a mechanical device or disk that allows a program to run), the dongle should be insured for its full replacement value. Software companies are unlikely to replace lost dongles unless there is absolute proof of destruction.

Data insurance is expensive and can be difficult to assess. Back-up copies are better insurance than taking out a policy against physical damage. Insurance against theft should be considered if the data would be valuable to another party.

Access to computers and data

The simplest way to reduce risk of theft and unauthorized access to computer equipment is to lock it up. Clearly this is unpractical during working hours and in large open offices. It is possible to fix the cases of computers and peripherals to adjacent surfaces, but even this is not completely safe. Access to the computer boxes is needed for maintenance and expansion purposes and there is a market for stolen computer chips. Alarms can be installed. All areas containing computers should be fitted with smoke detectors and security alarms and should be securely lockable. Unauthorized visitors should be discouraged. It is much easier to slip a 3.5-inch disk into a pocket than to conceal a manila folder.

Unauthorized access within an organization can be reduced by password protection on each machine; passwords may be hardware or software resident. People are notoriously careless about passwords and often keep them on a handy piece of paper. Passwords should be confidential, should be changed frequently and certainly should not be written on a yellow sticky slip and put in the top right-hand drawer. If the installation is large enough, there will be someone who manages it and who will have the knowledge and skill to access anything on it; this person must be trusted and enjoy the total confidence of the most senior people in the practice. Widespread use of the Internet has increased the risks of unauthorized access. Confidential information should not be kept on a hard disk or on a networked machine; it should be saved onto tape or disk and locked in a safe with a back-up copy elsewhere.

Hackers may be inside or outside an organization. These are people with varying amounts of skill who delight in breaking into systems and who may do accidental or malicious damage. Nothing is really safe from a dedicated and competent hacker who is given enough time.

Viruses

Software and data are at risk from malicious and accidental damage caused by people, electrical failure, disk failure and viruses. Viruses are destructive programs which attach themselves to files that are frequently used by the operating system, to the hard disk, or which overwrite other programs. They often transfer themselves from the active memory to the hard disk when the computer is turned off, and back again when it is turned on. They can cause immediate destruction of the disk data structure, or attach themselves to the clock and 'lurk' until a specific date. Some are capable of self-replication and transformation, and will infect diskettes, thus transferring themselves to other machines. They are not always apparent and may be disguised as harmless files. Regular checks should be made of directories to see if anything has inexplicably increased, and particularly if a program or the screen appears to be behaving oddly. Viruses range from those which cause some executable files to be damaged, through those which cause undetectable gradual damage. to those which allow a third party access to an internal network.

Viruses are contracted from diskettes of dubious origin, free software of uncertain provenance, from e-mail and from the Internet. Software and diskettes should not be used unless they arrive in pristine shrink-wrapped packages. Diskettes which are used in several locations should be virus checked at each use. One of the most common sources of viruses is on home machines that support games software. The illicit copying of games is responsible for the transfer of many common viruses. Protection against network viruses is harder; it is not advisable to download software from remote sites. The best advice is to be vigilant. Memory-resident virus checks are available which will filter out viruses (*trojans, droppers, packagers* and *variants*) but these should be updated frequently.

Back-up

The importance of regular back-up cannot be emphasized enough. This should be carried out routinely and probably daily, either onto tape, diskette or removable cartridge. Back-up copies should be systematically dated, labelled and indexed, and kept in dust-free, dry, fireproof cabinets. Disks and tape can be damaged by heat, moisture, magnetic fields (generated by telephones and electronic equipment) friction, airport security scanners, shop security barriers, and general mishandling. Disks can damage the magnetic strip on credit cards and should not be kept in the same pocket or bag.

1.6.11
The Data Protection Act

The Data Protection Act 1984 legislates against unauthorized disclosure of information about individuals that is stored on a computer. It is permissible to keep

personal details of employees for salary purposes. When other information is kept about clients, contractors etc., most organizations that hold personal data are required to register this use with the Data Protection Registrar. Failure to comply with the Act constitutes a criminal offence, and may lead to prosecution and substantial fines.

Registration has to be renewed every three years. The registration document DPRI is long and time-consuming to complete. Individuals have a right of access to information held about them and must be supplied with a copy, on request, within forty days. Details of registration, of the fee, and the necessary forms can be obtained from the Office of the Data Protection Registrar, Wycliffe House, Water Lane, Wilmslow, Cheshire, SK9 5AF (telephone 01625 535711).

2
Office and job management

2.1
Documentation

2.1.1
Word-processing

Research has shown that at present architectural practices use computers mainly for word-processing: the production of text based documents such as letters, reports and specifications. This has come about because architectural practices traditionally produce increasingly large quantities of written documents and because the first small business computers introduced in the early 1980s were machines exclusively designed for word-processing and were used mainly by administrative and secretarial staff.

Word-processing programs can be used to create, edit, format, print and save text documents. While modern programs, graphical interfaces and sophisticated printing methods have encouraged the blurring of the distinction between the first three of these activities, they are probably still better regarded as separate. They can each be performed by different people on the same piece of text and, except in small or one person offices, probably should be. In an office, these programs may increase productivity by encouraging the use of standard documents and by allowing frequently used text to be incorporated into different documents. The protocols of computer filing may make for the more systematic storage and archiving of written documents.

Word-processing programs fall into two main groups: at one extreme are the handful of very large programs designed for the production of anything from a single letter to a very long report or a book. There is little middle ground, but even the largest of these programs do not require very large or fast machines to run them. At the other extreme are lean, fast programs designed for making small documents: these programs are often designed for use on portable machines which may not have a large amount of memory, or they may form part of an integrated 'suite' or 'package'

of programs such as Microsoft's Works, Claris' Works etc. A selected list of programs is included in Appendix B.

All Word-processing programs will provide facilities for:

- entering text: getting the words on the screen
- editing text: rearranging the text, correcting errors, considering alternatives
- search for some or all instances of a particular word and, if required, change it
- simple formatting of the text: setting the size and style of typeface ('font')
- formatting the document: setting the margins, paragraph styles
- printing the document on a variety of printers
- saving (storing) the document on a single machine or on an office's server The larger programs will additionally provide for:
- more elaborate formatting of text: automatic hyphenation, coloured text
- more elaborate formatting of paragraphs: bulletting, numbering, indenting, borders and boxes
- setting up templates for standard parts of documents or for standard formats
- semi-automatically correcting or altering text by 'searching and replacing'
- checking spelling, providing a thesaurus, grammar checking
- providing a count of the words in a part or the whole of a document
- elaborate document formatting including multiple columns, headers and footers, footnotes
- making an 'outline' of a structured document
- including tables, a series of boxes or cells like those of a spreadsheet; some may include limited facilities for calculations
- automatic page numbering
- producing indexes, tables of contents and cross references
- incorporating graphics, sound files or 'movies'
- 'merging' information from a database, e.g. names and addresses, to produce form letters or mailing labels; if the information from the other program is automatically updated in the word-processing program, they are said to be 'hot-linked'
- incorporating information from other programs such as spreadsheets; when this is done automatically the programs or documents are said to be 'linked'
- 'auto-correcting' common typing mistakes ('teh' for 'the' etc.) which can be specified in a list
- saving commonly used words, phrases or paragraphs in a 'glossary' from which they can be inserted into the text using keystroke shortcuts or selecting from the list
- allowing the writing of 'macros': lists of instructions which on a single command can implement frequently performed tasks such as rudimentary proofing
- providing automatic page numbering, often placed in a 'header' or 'footer'

2.1.2
Explanation of terms, requirements of professional typists

For the one hundred years before computers became common, general business documents were produced with the typewriter; more important ones might be sent to a printer for typesetting. The conventions of typewriting established over a century were well understood and accepted: a document on a standard sized sheet of paper would be set out with one inch side margins between which would run regularly spaced lines of monospaced type in Courier or Pica letters sized ten or twelve to the inch.

The use of word-processing programs and current printers in principle allows any document to look as if it had been professionally printed. Problems arise because the conventions of typography, the discipline of the professional printer, are more demanding, more extensive and less well understood than those of typing. It is all too easy to produce bad typography using a computer. Either the people producing the text must learn the typographical conventions, or their text must be formatted and edited by someone who knows them. Mistakes of spelling or grammar which might be forgiven in typing are more noticeable and give a very poor impression when produced in something resembling type.

2.1.3
Originating and editing text

The standard way of entering new text remains the keyboard. 'Not being able to type' is one of the main obstacles people feel they face in approaching computers for the first time, but at present there is no practical alternative. There are self-teaching programs to learn touch typing, but most people untrained in secretarial skills successfully rely on the 'hunt and peck' method.

Dictation systems are available which via a microphone and card will recognize continuous speech and turn it into computer-editable text, but these combinations of hardware and software are expensive (about £1000–2000) and they need heavy duty hardware to run them. They require 'training' to recognize their user's voice and may be susceptible to background noises. Suppliers are listed in Appendix B.

Existing text on paper can be turned into text editable by computer by scanning the paper document and using an optical character recognition ('OCR') program to convert it. This process can be quite accurate, but its success depends on the quality of the original and the size and clarity of its text. While what OCR programs can achieve is remarkable, their action is far from completely automatic and most text produced by this method will need checking and editing.

Computers can be set up to receive faxes and a fax may, if of sufficiently high quality, be read by an OCR program without having been printed to paper.

2.1.4
Templates, styles and standard documents

Word-processing programs can aid productivity and efficiency by allowing the creation of 'templates': empty documents which contain formatting information, or standard items such as a letter heading and logo. They can further help by allowing the creation of standard documents and forms in which most of the text is already entered and only certain names or numbers need to be filled in. The larger programs help in the creation of 'forms' which create 'fields' in which to place the variable information.

2.1.5
Illustrations, sound, 'movies'

The larger programs allow the user to incorporate files created in other programs either by 'embedding' them in the text document or by 'linking' the incorporated file to the original file. At its simplest, this allows for the inclusion within the text of any graphic element, line drawing, spot colour or tone, grey scale or coloured photograph. This may be useful for the creation of simple documents, but none of the word-processing programs provide the flexibility and fine control of page layout programs, (section 2.2.4) and for more complicated documents these programs are more appropriate.

Files of recorded sounds can also be included: an icon showing that a sound is available is then presented in the document and it can be replayed by selecting it. A document might consist of only a sound file made perhaps by dictation, but a written note of the same information might be more useful and versatile, and dictation requires a computer equipped with a microphone and recording software. Sound files tend to be very large and will make storage and transfer of the whole document cumbersome.

Similarly, files of moving pictures recorded in for example Apple's *QuickTime* format can be included, but the usability of this facility is dubious: the pictures are of low quality and the files tend, like those encapsulating sounds, to be very large.

2.1.6
Spelling and grammar checkers, thesaurus

Most programs now provide an automatic spelling checker which compares each word in a document against the words in its built-in dictionary. This will find the most obvious errors, but will not remark on wrongly used homonyms ('their', 'there'; 'its', 'it's'). Some programs additionally offer 'custom' dictionaries in which frequently used technical words or proper names can be recorded. A spelling checker cannot stand in for a well-trained secretary, editor or proofreader.

Grammar checkers are available, but none are ever well-reviewed and all seem to raise more questions than they answer. Most originate in the United States and may not be appropriate for European use.

Available in larger programs, a thesaurus will, given a word, supply a list of related words of similar or opposite meanings. This may help supply a missing word or offer a means of 'elegant variation': avoiding using the same word in the same or nearby sentence. While thesauruses do not supply definitions, they may help refine the sense in which a particular word is being used.

2.1.7
Mail merge

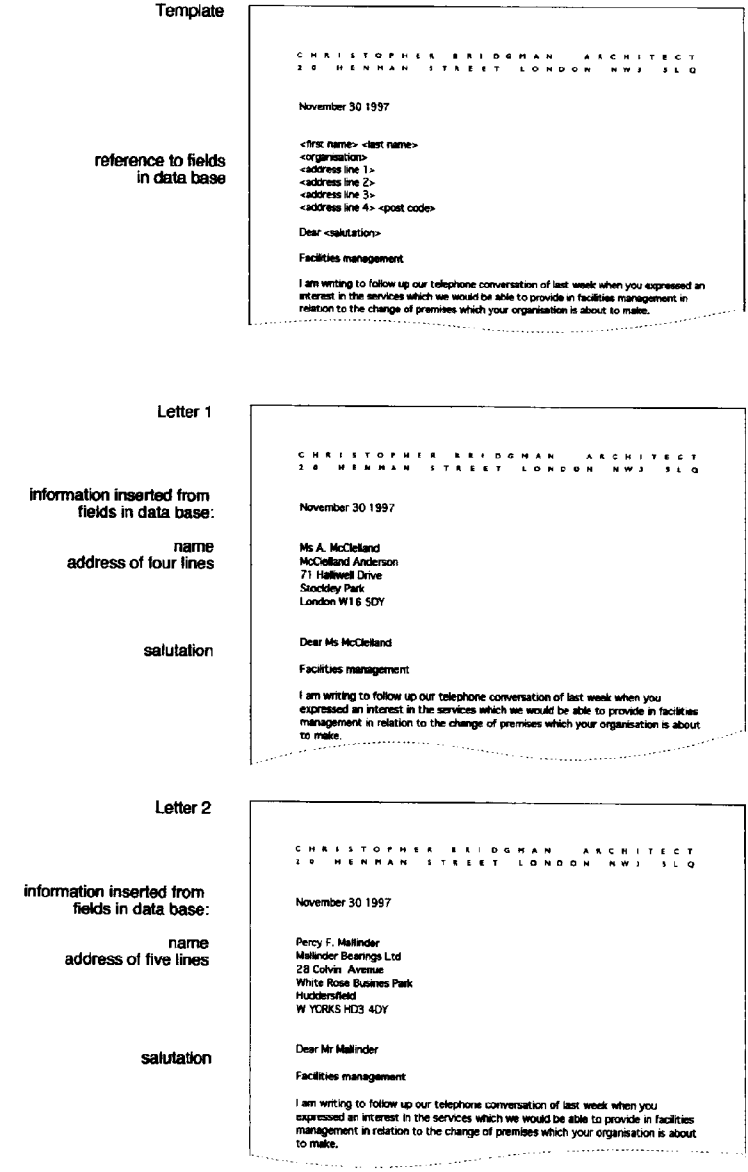
This term describes the method of combining information from a database or another text file into a series of new documents. The commonest uses are for preparing 'form letters', a number of letters each containing the same text but which are addressed to different people; and for preparing address labels for circulating these or other documents.

The file containing for example the names and addresses may be produced using a database, or it may have been set up in a word-processing program using a simple list, the entries separated by tabs; or in a table of the sort that Word provides.

When mail merge works, it can save huge amounts of clerical time, but it presents the same difficulties as all automatic processes. The original data must be consistent: the mail merge facility may have an elegant way of dealing with addresses which may have different numbers of lines from each other; it may be able elegantly to combine first and last names and titles; or it may not easily be able to do either of these. Transferring the information from one program to another may not be easy. Formatting the output so that it fits onto standard sheets of labels may require a lot of experimentation. Recording and remembering how the process works may be impossible.

2.1.8
The 'paperless office'

There are two opposing forces at work in the production of business documents: the first is that more and more of the processes of origination, production and transmission can be carried out electronically both within the office and with the world outside. The second is that devices for printing are constantly becoming cheaper, their products more sophisticated and approaching more closely those of a professional printer. The ubiquitous laser printer encourages the production of, for example, reports which would previously have been considered satisfactory if presented as stapled copies of typewritten sheets now being produced in near-typeset



2.1 Mail merge. The template and first two of a series of form letters produced in a word processing program by merging names and addresses from a database

quality following the consideration of many printed drafts and formats. The only general rule is to attempt to keep the document in electronic form until the very latest time before it is used or reaches its destination.

2.1.9
Managing the production of documents

If most people working in an office have access to a computer, it might be thought that every member of the office should be responsible for producing their own documents, for example that the architect should write and despatch his or her own letters. The advantage of this scheme is that correspondence is easily consulted by the person who originates it, and that secretarial services might be dispensed with. The disadvantage is that the products of those secretarial skills, the correction of errors and mistakes of spelling, ensuring that business etiquette is observed, ensuring that what emerges from the office is consistently presented, will be lost. Automatic spelling checkers are no substitute.

There are two solutions: the first is for the originators of documents to acquire secretarial skills; the second is for a hybrid process whereby the originator produces a first draft which is passed to an editor/formatter (or a secretary with these skills) for checking and putting into a consistent format before being copied, recorded, filed and sent out. Some or all of these processes may be carried out electronically rather than by using paper copies of the document. Avoid keeping multiple copies of the same document: there is no obvious means of finding out which is the most up-to-date or authoritative copy.

2.1.10
Storage, back-up and archiving

Current graphical interfaces and operating systems simplify the storage of documents by presenting a metaphor of 'folders' (formerly 'directories') in which documents can be placed, and this might prove adequate for storing and retrieving collections of related documents. This basic utility can, however, easily be subverted, and every office should establish its protocols of organizing and naming documents. If this is not done, it may be impossible to locate a particular document or to distinguish one from another: no computer yet offers an equivalent of flicking through or 'browsing' a sheaf of papers to find the right one.

Whatever system of storage or filing is adopted its contents should be systematically copied or 'backed up' so that if the first is damaged, the second is available as substitute. No computer-based system of storage is completely reliable or proof against physical damage such as flood or fire. The simplest way to back up a set of documents stored on for example an office's main hard disk is to 'mirror' or copy its entire contents onto a second hard disk. More cumbersome methods would

include those used for archiving, below. One person should be responsible for making back-ups. If the storage system is dispersed, for example, and all the documents relating to one project are stored on one machine, then the same system must be applied.

Similar protocols to those which would be maintained for the archiving of paper documents must be applied to their computer-produced counter-parts. Various methods are available for storage of documents to which day-to-day access is no longer required. A small office might use standard floppy disks with their modest capacity of the equivalent of about 200 A4 single-sided documents. Drives using removable cartridges holding between 100 MB and 1 GB are available from several manufacturers. At the upper end of the storage market are tape drives which will typically hold 7 GB of information. Whichever is chosen, it should be noted that the period of obsolescence of a 'standard' back-up or storage device is probably shorter than the period set in the Statute of Limitations, and it may be necessary at intervals to adopt a new 'standard'.

2.2
Promotion and marketing

2.2.1
Documentation as an aid in marketing

Architectural practices are increasingly required to produce marketing material: brochures of examples of work, commissioned or speculative reports for bids. The quality of this printed material and its graphic appeal, as well as its contents, may affect the outcome of the bid. Such material now competes both with that produced by other practices and with similar material produced by other professions and firms, and with media other than print: see section 4.3.8 on using the Internet for marketing.

Before small computers and laser printers became available, marketing material might have been simply presented in either photocopied typewritten form, or more elaborately by having a printer typeset and lay it out. Cheap and available 'desktop publishing' using small computers has made it possible for the smallest practice to produce material which at its best gets close to the quality of a professional print job but at a much lower cost.

Colour printing is thought to be more persuasive than monochrome, though none but the largest practices with the most time and money to spend should attempt the design and printing of colour in house. If colour is required, be aware of its expense, and at least employ a professional printer and probably have the work prepared by a graphic designer.

2.2.2
Page layout

For laying out text and graphic images, while many of their facilities may overlap, page layout programs generally take over where word-processing programs stop. They can be used for the production of reports, brochures and presentation material which combine text and graphics. Such programs offer facilities beyond those of word-processing programs such as:

- the ability to 'import' text, drawings and pictures produced in other programs and to incorporate them into the new layout
- more precise typographical control of the height of letters (point size), the spacing of letters (kerning and tracking), words (tracking) and lines ('leading') and paragraphs
- 'style sheets' or 'tags' which record the full specification of a character or paragraph by 'tagging' it; some programs can import others' style sheets
- 'master pages' on which items common to each page can be placed and which will appear on every page when the document is printed; programs may be limited to one master page per document, or they may allow multiple master pages
- 'guides' to set out pages and enable the precise placing of blocks of text or graphics
- non-text typographical features such as rules, boxes and borders
- the ability to make quite complex graphics such as diagrams using the program's built-in graphic tools
- the option for automatic and dynamic hyphenation
- irregular page layouts with any number of columns each of any width
- the ability to link blocks of text so that they run across pages and through a document
- the ability to rotate blocks of text and graphic elements by an arbitrary angle (probably a bad idea)
- the ability to make text 'flow' past or around an illustration or arbitrary shape
- the ability to handle colour, either text or graphics, and to make colour separations for colour printing
- the ability to work in several systems of dimensions: points, picas, millimetres, inches; architects may be particularly irritated by this feature since the point used in computing is based on the inch (1 point=1/72 inch) and there is no way of rationally combining its use with metric measurements

2.2.3
Fundamentals of page layout and typography

Just as the combination of word-processing programs and cheap laser printers has promoted the widespread circulation of documents which at their best look as if they might have been produced by a professional printer, page layout programs offer the possibility of reproducing the most sophisticated modern techniques of the layout of print and graphics. The production of such layouts is, however, full of pitfalls for those oblivious to the rules and conventions which have been established over the five

centuries of printing with movable type. The more sophisticated the page layout program and printing method, the more the effect of mistakes of spelling, grammar, punctuation and typography will be amplified. Some layout programs do not help by offering easy ways of producing typographically unsatisfactory results: just because it is possible to achieve a particular result with a program does not mean that it is a good idea or that it follows typographical conventions, or that a client will be persuaded by it.

Common examples of poor typographical style

- using too many typefaces (fonts) in the same document; try to use only one
- underlining text: avoid this: it rarely occurs in type; instead, for emphasis in body text use italics, or in headings use bold or a (slightly) larger point size
- using any of the special type styles such as 'outline' and 'shadow'; these belong to the early days of desktop publishing and are as dated as flared trousers; just because they are available doesn't mean that they are a good idea: stick to the typographical plain ('roman'), italic, bold and bold italic
- leaving the first line of a paragraph on the last line of a page; the stranded line is called an 'orphan'; if instructed, page layout programs will prevent this happening
- leaving the last line of a paragraph on the first line of a page; the stranded line is called a 'widow'; page layout programs will, if instructed, prevent this happening
- the last line of a paragraph should contain more than one word; this is usually quite difficult to avoid systematically by typographic means, although it can be done by altering the tracking of the affected text, or the text may have to be edited to omit the offending line or to add more words to it

Formatting punctuation

The rules for punctuation in type are different from those in typing. In print:

- all punctuation marks (.,;: ' " !? / etc.) immediately follow the previous letter with no intervening space
- all punctuation marks are followed by a space, and only one space (in typing it is conventional to leave two spaces after a full stop)
- use 'real' quotes and apostrophes: "hello", it's (but only use double quotes when these enclose speech; use single quotes for quotations from other writing); *Word* will produce these automatically if you have the 'Smart quotes' option checked under Preferences in the Edit menu (Full menus); this function must be used with

care; real quotes can probably be got from the keyboard using special key combinations; when importing a file, *PageMaker* will convert unformatted quotes to real ones if instructed to do so

- there are varieties of hyphen; use the plain one between words and to indicate continuation of a split word on the following line; use the 'n-dash' between numbers, e.g. 1992–93 (on Macintoshes the n-dash is option-hyphen); the 'm-dash', '—', — rather rare now, and more used in literature — is sometimes used instead of parentheses (on Macintoshes the m-dash is option-shift-hyphen)

Fonts

In the terminology of small computers, a *font* is a collection of all the letters needed to reproduce on screen and to print a particular typeface.

A *screen font* will show characters at the monitor's resolution of about 72 dots per inch, too coarse both to see the smaller sizes and from which to make good quality printing. Screen fonts are produced from the pattern of dots or raster which is exactly what the monitor displays.

PostScript or *'Type 1' fonts* developed by Adobe will, when used with a utility such as Adobe's *Type Manager* ('ATM'), produce the best image of a character on the monitor and on a printer equipped to interpret PostScript print at the highest possible resolution or quality that the printer can provide. PostScript fonts are specified by outlines constructed of straight and curved segments, and these can be scaled to suit the immediate purpose and resolution of the printer when finally they are rasterized. All the famous classic typefaces are available as Type 1 fonts. The Type 1 font is incorporated in ISO standard 9541.

TrueType fonts, developed jointly by Apple and Microsoft, work in a similar way to PostScript fonts, but do not require a PostScript interpreter to print them. There are fewer typefaces available in the TrueType format than in Type 1.

Microsoft, Adobe and others are uniting PostScript and TrueType fonts into a single standard, *'OpenType'* with the aim of standardizing the presentation of formatted type on the Internet. It is not clear what effect, if any, this new format will have on printing on paper.

2.2.4
Page layout programs

A number of small page layout programs characteristically costing about £100 are available, but they are designed for 'home office' use and are unlikely to be capable of the full range of publications which a practice is likely to originate.

The two most widely used large programs are PageMaker and Quark XPress, and both are available for PC and Macintosh machines. They cost between £500 and £1000. Each has their advocates, and each is involved in a long standing 'features war' with the other in which new features are added to successive versions of the program. XPress is the more widely used for magazine production in the UK. Both will perform all the functions described in section 2.2.1; they differ in the details of their interface and method of working. Either would be adequate for the complete preparation of any publicity material inside the practice, and both produce files which can be handed

to a printing bureau for, for example, colour printing. For the small office or for beginners, *PageMaker* has a reputation for having a well designed interface and being the easier to learn. If the practice intends to use a bureau to print some or all of its material, it is worth talking to them to find out which they prefer and what they recommend.

If the practice has a printer and is considering buying a page layout program, it should check that the output from the program can be printed on that particular printer. *Quark XPress,* for example, can only print to printers equipped to interpret the 'PostScript' page description language, and a software converter would be required for output to non-PostScript printers.

2.2.5
Printing and production

The output from a page layout program must take account of the method of printing. If it is intended to print on the office laser printer, then the design should take account of the printer's capabilities. The humblest laser printer will now produce serviceable text, although even at 1200 dpi (dots per inch) still nowhere near the quality of that produced by a professional imagesetter (typically 2500 dpi). But the best laser printer and software will still only reproduce grey-scale or half tone photographs or drawings to sub-newspaper standard. If high-quality photographic reproduction is required, use a print bureau. A hybrid method of production is possible in which the practice places and formats the text in the layout into which the bureau then puts, or 'strips in' the professionally scanned images, and these can then include colour.

2.2.6
Originating and managing a house style

There is no point in using a program to produce beautifully and persuasively arranged text if that text is riddled with errors: any text leaving the office should be finally edited before being formatted or laid out. Making corrections to text already placed in a page layout program is enormously inefficient and unproductive: however great the temptation to see a document in its final form, this should be resisted. The individual or practice should also be aware of questions of editing style: for example how numbers are written ('24' or 'twenty-four', how abbreviations are used ('Mr J Smith', 'Mr. J.Smith'). The collection of such editing rules and conventions is known as the practice's or publisher's 'style'. Help can be got from the very small *Hart's Rules for Compositors and Readers at the Oxford University Press* (37th edn, OUP, 1967) or the very large *Chicago Manual of Style* (13th edn, The University of Chicago Press, 1982). The latter will cover every stylistic eventuality.

Individuals or smaller practices wishing to produce their own publicity material themselves should gain expertise in page layout by training the person responsible for its production. The few reference books helpful in this field are listed in the further reading section at the end of the book. Many institutions such as colleges of art and design offer courses in using page layout programs, but many of these concentrate on exploiting a particular program's features rather than explaining the basics of designing with type. If a small practice cannot afford to employ a designer or chooses not to, then they should observe the rule 'keep it simple' by selecting one or two classic typefaces and placing the text thoughtfully on the page. Energy is better directed towards editing the text and correcting simple errors than towards gratuitous typographical complication.

Alternatively, larger practices might obtain such expertise from outside by commissioning a graphic designer or better a typographer to design a particular document or, best, to establish a house style for all the practice's printed output. The designer might be asked to produce templates for each type of document, brochure, report, etc. in the practice's preferred layout program together with specifications for all the paragraph styles, and to make printed dummy examples of each document. The designer cannot be expected to structure such documents: it is the practice's responsibility to have set up a clear organizational format for any material it wishes to publish.

At the same time, the designer might be asked to consider the practice's entire printed output including correspondence, letter heading or logo, and to produce specifications and samples of each: to establish a 'house style'. Large practices may find it worthwhile to commission a design manual for its publications. One large and successful London practice even commissioned its own typeface which it now uses consistently for all its printed material and for any graphics incorporated in the buildings it designs.

Once the practice's style is established, a system for managing its implementation must be established: a person or department must be made responsible for receiving and producing material for publication, and they must ensure that any individual initiatives are subject to the practice's standards and that these are observed. The standards or manual must be revised to suit new circumstances and developments and any changes publicized.

2.2.7
A page layout glossary

Align	to make the edge of a column of type straight; see also Justify, Ragged
Alley	the vertical space between two adjacent columns of text
Ascender	the strokes of letters e.g. 't' and 'I' which ascend above the general height or 'x-height' of lowercase characters; see x-height

ATM	*Adobe Type Manager:* a small program which when used with printer fonts produces the best possible appearance of type on a computer's screen and all printers
Baseline	the line joining the bases of characters e.g. 'x' or 'm' (but below which 'j' and 'y' descend)
Bleed (vb or noun)	to run an illustration up to or off the edge of a page
Character	the smart name for 'letter'
Counter	the part enclosed in, for example, the centre of the letter 'O'
Descender	the strokes of letters e.g. 'y' and 'j' which descend below the baseline
Drop(ped) cap	the first character of a paragraph made larger than the other characters and projecting down through more than one line of normal text; difficult to achieve with many DTP programs
Em-dash	the character'—', sometimes used as a parenthesis especially in fiction (option-shift-hyphen from the Mac keyboard)
En-dash	the character'–', longer than a hyphen but shorter than an em-dash. Used, for example, to separate numbers: '1995–96' (option-hyphen from the Mac keyboard)
Filter	a program which translates a file from one format to another to allow it to be imported from or exported to another program
Font	the name in computing circles for 'fount' or typeface: the family of sizes, styles and weights of a particular typeface
Gutter	the junction between the two pages of a spread where they are joined or bound
Half-tone	a method of rendering and printing images with an apparently continuous range of tones between black and white: achieved by using a raster of dots of different sizes; see *also* Line art
Justify (vb)	to line up the vertical edge of a column of type (the opposite of ragged); see *also* Align
Kern (vb)	to alter the space between a pair of characters to improve or equalize the spacing of all the letters in a word. Used particularly for titles and large uppercase letters where automatic spacing would exaggerate uneven spaces e.g. between 'A' and 'W'
Leading	pronounced 'ledding': either the size of the gap between two lines of type, or the distance between the baselines of two adjacent lines
Ligature	a pair of letters which are conventionally joined together e.g. 'fi' becomes 'fi' 'fl' becomes 'fl'
Line art	a picture or illustration which uses only lines or solid black or colour and no intermediate tones; see also Half-tone
Margin	the space between a column of type and the edge of the page
Orphan	the first line of a paragraph isolated at the bottom of a page: to be avoided; see also Widow
Pantone	the trademark name of a range of colours for printing
Pica	a unit of typographical measure, 12 points, 1 1/6th of an inch
Point	the smallest unit of typographical measure: on the Mac, 1/72nd of an inch

PostScript	Adobe's trademark name for their page description language: a format for storing, transferring and printing type and layouts generated on a computer
Printer fonts	the fonts used by a laser printer or Linotronic printer to produce near-typeset or typeset quality type; see also Screen fonts, ATM
Ragged	the opposite of 'justified': the right or left column of text is left as the words fall, not lined up
River	an irregular but noticeable band of white space running vertically across adjacent lines of type: caused by coincidental alignment of the spaces between words
Sans serif	a typeface without serifs: the ends of letters' strokes are plain
Screen fonts	the fonts used by the computer to picture characters on the computer's screen; see also Printer fonts, ATM
Serif	the bar or extension at the end of a character's stroke
Small caps	uppercase letters which are the same height as the lowercase letter 'x', often used for academic qualifications, e.g. 'Professor Peter Cook FRIBA'
Spread	the two pages visible when a book is opened flat: may be considered as one for the purposes of design
Stroke	the element of a character: the letter 'T' has two strokes
Style	a complete description of all the typographical attributes of a piece of text or of one character
Tint	shading made of a pattern of dots, usually specified as a percentage, for example 0% is white, 10% is a light grey, 100% is black
Tracking	the average measure of how closely or far apart a string of letters is spaced
Widow	the last line of a paragraph isolated at the top of a page: to be avoided; see also orphan
x-height	the general height, in points, of the lowercase letters of a particular font: the height of the lowercase letter 'x'

2.3 Spreadsheets

A spreadsheet is a set of electronic worksheets which enables the user to enter data and carry out calculations and to examine 'what-if questions. Spreadsheets were first used on mainframes for accountancy and related applications. In 1979 *VisiCalc* was developed for microcomputers and became the basis for other spreadsheets which were rapidly accepted for general use because of the ease with which arithmetic can be carried out and the ease with which they can be adapted for specific tasks. They are particularly useful for keeping records where data changes frequently. Anything which can be expressed in mathematical terms is suitable for a spreadsheet application.

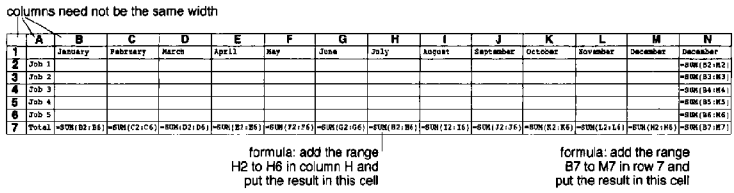
A worksheet can be imagined as a sheet of paper ruled out into rows and columns to form a matrix composed of an array of 'pigeonholes'. Each of these is known as a *cell*. The columns are identified by letters (A-Z, AA-AZ, BA-BZ etc.) and the rows by numerals, therefore each cell can be referred to uniquely: A1, AG45, GK56 and so

on. One of only three types of data may be entered into a cell: text, a number or a formula. The text may be a label, instruction, commentary or comment; numeric data may be integer, fixed point, or floating point (scientific notation); and formulae may be mathematical or show the relationship between cells. In addition there are special formats which include date, time and currency. To give a very simple example, suppose a number were to be entered into cell A1, and a second number into cell B1, if the formula (A1+B1) were entered into C1, the result would be shown in that cell. If either of A1 or B1 were to be changed, the result in C1 would change accordingly.

Spreadsheet software ranges from the simple 'workpad' to sophisticated systems which allow for interactive calculations between thousands of cells and the inclusion of, or interaction with, word-processing, graphics and/or database software; the latter form the basis for many office management systems. Today's spreadsheets have, typically, 256 columns and over 16000 rows, giving in the region of 4 million cells or spaces for entries. Multi-dimensional spreadsheets can be imagined as layers of individual worksheets, between which data can be exchanged.

2.3.1
Example

The figures are simplified examples of how a spreadsheet could be used to record and monitor expenses.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		January	February	March	April	May	June	July	August	September	October	November	December	Decamber
2	Job 1													=SUM(B2:M2)
3	Job 2													=SUM(B3:M3)
4	Job 3													=SUM(B4:M4)
5	Job 4													=SUM(B5:M5)
6	Job 5													=SUM(B6:M6)
7	Total	=SUM(B2:B6)	=SUM(C2:C6)	=SUM(D2:D6)	=SUM(E2:E6)	=SUM(F2:F6)	=SUM(G2:G6)	=SUM(H2:H6)	=SUM(I2:I6)	=SUM(J2:J6)	=SUM(K2:K6)	=SUM(L2:L6)	=SUM(M2:M6)	=SUM(B7:M7)

2.2 Spreadsheet showing set up

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		January	February	March	April	May	June	July	August	September	October	November	December	Total
2	Job 1		300	300			1000			200	200	200		2200
3	Job 2	700				300	100	100					100	1100
4	Job 3	2000	700	300	200	300	200	200	300	200	200	400	1000	5200
5	Job 4	500	300	100						100		100	100	1200
6	Job 5								1000			1000	500	2500
7	Total	3200	800	400	200	600	1300	300	1200	500	400	1700	1700	12200

2.4 Spreadsheet with data

Column A contains the titles of current jobs, say Job 1 to Job 5, in cells A2, A3 A4, A5 and A6. Row 1 from B1 to M1 contains titles, in this case, the months of the year. Cells B2 to M2 contain projected monthly expenses for Job 1; cells B3 to M3 for Job 2 and so on, to B6 to M6. N2 to N6 contain a formula which gives the total annual expenses for each job; B7 to M7 one which gives the monthly expenses for all jobs. N7 contains the annual total.

2.3.2
Characteristics of spreadsheets

It takes time and experience to determine the best way to set up a spreadsheet. Whether this operation is carried out in-house or undertaken by a paid specialist, it is essential that a clear description of the task, the way it is to be solved and the amount of variable data is provided in advance. The more complex the problem the more likely it is that special facilities will be required in the spreadsheet. It must be someone's responsibility to record how a particular spreadsheet is set up and what it does. Failure to do this will render the data unintelligible or inaccessible.

Spreadsheets may be menu- or command-driven or, in software that runs with a graphic user interface, by pointer, menu and command. Whichever is used, it should be easy to move the cursor from cell to cell, or to go to a specific location. 'Ranges' of cells are rectangular (a range may be a single cell) and are usually defined by the address of the upper left hand cell, a delimiter (..) or (:), and the address of the lower right hand cell. On Windows applications ranges may be selected by highlighting a range. It may be possible to identify ranges by name.

Some spreadsheets offer a selection of templates which set up sheets to a predefined format, and some allow for the creation of new templates. The spreadsheet will have default settings, for example columns will be the same width, text will be left justified in a cell and numbers will be right justified. The default settings may be changed by formatting either the whole sheet or specific ranges of cells. During formatting, the column widths and row heights can be changed for all or part of the sheet The alignment (left, right or centre justification) of entries in cells can be specified, as can the format and precision of numbers, character attributes and data types (text or value).

Labels, titles and headings can be added for columns and rows. It should be possible to 'fix' these when the sheet is being scrolled.

Cells on worksheets can contain either fixed or variable data. Data is entered by highlighting a cell, which becomes the active cell. This may be done by command, arrow keys or cursor. Fixed data are text, titles, labels and headings, dates and other fixed descriptions. Numbers may be integers, fixed point, floating point (scientific notation) or in a special format such as currency or percentage. Numbers may be data input by the user or the result of manipulation by a formula.

Most spreadsheets have a range of built-in formulae such as 'SUM' or 'MAX'. Formulae may be determined by the user and entered into specific cells. In order to identify an alphanumeric string as a formula it must be preceded by a special sign such as (+) or (=). The basic mathematical symbols used in spreadsheets are:

*	multiplication
/	division
+	addition
•	subtraction

Spreadsheets usually carry out calculations in the following order:

1 terms in brackets (parentheses)
2 exponentials
3 division
4 multiplication
5 addition
6 subtraction

For example the expression 3×11+17÷2 would give a result of 41.5. Some spreadsheets calculate from left to right. The result of the above expression, as it stands, would be 25. Care must be taken about the order in which expressions and formulae are entered. In order to avoid confusion, it is prudent to use brackets to clarify a calculation; to make the intention clear, the example above might be written (3×11)+(17÷2). Some worksheets automatically recalculate results when new figures are entered in cells involved in formulae; others have to be provoked into doing so ('manual recalculation').

Spreadsheets may be edited in various ways. Columns and rows can be added, deleted, moved or hidden. The contents of cells, or ranges of cells can be moved or copied. Formulae may be copied either using exactly the same cell references in both locations (absolute cell reference), or by relative cell reference; here the same calculation is carried out using different cell references.

When using a large sheet it will not be possible to view the whole of it on the screen. Some packages provide windows so that the screen can be split horizontally, vertically or both, so that widely separated portions of the sheet may be viewed at the same time. Where windows are not provided, it should be possible to 'fix' labels on the screen when the rest of the spreadsheet is scrolled.

When software has been checked for appropriate size and ease of use, it should be ascertained that it supports the range of mathematical, statistical, financial and logical functions that will be needed for the calculations that are required. A procedural language may be included for the creation of macros, shortcut commands that represent a series of instructions, which can be written to carry out commonly used functions, helping to improve speed and efficiency.

Most spreadsheets allow sorting of information, by rows or columns, numerically or alphabetically and in ascending or descending order. Graphics software may be included in the system, which will allow graphs, pie-charts and histograms to be produced, often in colour. Other graphics may be included, from a library of objects,

imported from other programs or originated by the user. Most spreadsheet software contains a range of built-in functions; the terminology used varies between systems. It is important to check the manual to find out what the words mean and exactly what the built-in functions do.

Data on a worksheet may be arranged in the form of a database. Database functions may be included such as counting cells, finding averages, maxima and minima, and calculation of standard deviation.

Printing needs special consideration. Spreadsheets tend to be wider than they are long, and very large. Printing either has to be done in sections that are then pasted together; carried out on a wide carriage printer; or the system may contain a utility that allows for sideways printing. All software that is used on a Macintosh or with Windows allows landscape as well as portrait printing.

2.3.3 Choosing a spreadsheet

Compatibility

If a spreadsheet is to be installed on an existing computer it is important to ensure that there is enough memory and disk space to support it and that it will not interfere with other applications. It is unlikely that a new user would buy a computer solely to support a spreadsheet application, so that memory, disk space and compatibility should be considered in conjunction with other applications.

Size and speed

- is the spreadsheet large enough to accommodate the proposed application?
- how fast are access, retrieval and calculation?
- is there adequate file storage?

Ease of use

- does the software run over a graphic interface? Is it command- or menu-driven?
- how easy is it to set up a new spreadsheet?
- how easy is it to set up labels and titles?
- how easy is to move the cursor between cells or to a specific cell?
- how are ranges of cells identified?
- how are formulae entered?
- is there adequate on-screen help?

Format

- what provision is there for templates and user-designed templates?
- is it possible to set column widths and row heights?
- what are the maximum and minimum cell dimensions? Is it possible to format a single cell, a single column or row, or a range of cells?
- what fonts and point sizes are available?
- what are the possible formats for numerals: integer, fixed point, floating point, etc.?
- are there special formats for date, time and currency?
- can the contents of cells be left, right and centre justified?

Editing

- what sort of editing can be carried out and how?
- can columns and rows be modified easily? Can they be inserted, deleted, moved, copied, blanked and hidden?
- how easy is it to modify the contents of single cells?
- how easy is it modify, copy and move formulae? Viewing windows
- can several areas of the sheet be viewed at the same time? If so, how many?
- is it possible to retain labels on screen when scrolling?

Functions and facilities

- how many automatic mathematical, logical and statistical functions are there?
- can columns and rows be organized in user-specified ascending or descending order?
- is there a procedural language or facility for creating macros?
- what graphic functions are available? Automatic graphs, pie-charts and histograms? An image library? Drawing or paint facilities?
- are database functions available?
- what other add-ins are available?

Printing

- what range of printers can produce hard copy?
- can a print file be created and stored?
- is there a landscape or sideways facility?

Data interchange

- are files created by the system compatible with other software?
- can files be exported to and imported from other software? If so, in what format?

Product support

- are the help facilities adequate?
- does the manual describe procedures for setting up a worksheet and why things are done or does it only describe functions and commands?
- does the vendor or supplier give telephone support?

2.4
Accounting, job costing and off ice management

2.4.1
Accounting and job costing

The *CICA SoftwareDirectory* lists some sixty programs for helping office resource control and management. Of these forty or so run with DOS, eleven with Windows and four on the Macintosh. Software is usually supplied in modules so that extra facilities can be added as necessary. It varies in complexity and may be suitable for single or multiple users. This software has some of the characteristics of both spreadsheets and databases and may be a preferable alternative to both.

Accounting systems generally contain standard accounting procedures and give adequate provision for security protection. They should provide nominal, sales and purchase ledgers, include cash book information, cheque and remittance advices and invoicing and payment routines.

Job costing software systems handle records of projects, and may include features similar to those required for project management. The systems allow for cost and charge out rates for members of staff related to projects. Time, expense, disbursement, fee and profit details can be included. Most systems allow for 'what-ifs' and estimates.

Management systems may include some or all of the above. In addition software is available that facilitates quality management to BS5750, and enables standard procedures for documentation, drawing records, staff, client and contract records to be established and maintained.

The choice of system will depend on how well the existing office procedures adapt to the system. Some customization, at least in terms of passwords and levels of access, will need to be done. Customization is costly; it may be advisable to change procedures to suit a system. It is essential that the user has a clear view of what is required, otherwise customization can be difficult, time consuming, acrimonious and expensive.

Choosing an office management system

For new installations the system should be installed and set up by the software supplier on the recommended hardware. It is important to make sure that plans for future expansion are taken into account If the software is to be installed on existing machines, storage memory and processor requirements should be checked. Ideally, management software should be installed on machines which are used for administration only, and to which there is limited access.

Size

Will the system store the requisite amount of information?

Ease of use

- How easy is it to move around the system, to add new records and to extract specific information?
- Are the on-screen instructions and help facilities adequate?
- How easy is it to spot mistakes?
- Does the documentation give clear procedural instructions?

Features

Which of the following modules does the software contain (or are they available for future use)?

- administration: staff records, addresses, checklists, diary, drawing records, document records.
- job running: project/job files, work in progress, contracts, certificates, instruction, job monitoring
- fees and accounts: cash book, fee details, expenses, salaries, PAYE, job estimating, job analysis, financial forecasting, resource planning, nominal ledger, client (sales) ledger, purchase ledger, invoicing.

Customization

How much customization is needed?
In what timescale and at what cost?
How many passwords and levels of password can be set up?

Data interchange

Can data be imported from or exported to other software? In what format?

Training

How much, if any, free training is given? How much does training cost? On whose premises?

How easy is it to get follow-up help? Is there a help-line? How much does further training and sorting out cost?

2.4.2
File management systems and databases

Data (a plural term which is used, commonly, as a single term) is anything which has a meaning on a digital system. Information is data organized in such a way that people can use it. A database is a collection of data organized in such a way that it can be stored, analysed and retrieved as information. So-called 'databases' range from flat-filers which are the electronic equivalent of card indexes to huge systems, like computerized libraries and flight reservation systems, which run on mainframes. If a database were to be used for full office management, the amount of time and effort involved in the determination of a conceptual model, let alone choosing and setting up the database, would not be worthwhile unless a specialist were employed, either from within the practice or as an outside consultant. Another option would be to use an off-the-peg office management system. These are based on database and/or spreadsheet programs and can usually be partially customized. Some procedures may have to be changed to suit the system. The benefit of these programs is that the structures and relationships are predetermined so that the user is concerned only with data entry and maintenance.

Databases are useful for applications like drawing records, archives and facilities management. They are also a good method of keeping current records of personnel, projects and clients, and names and addresses for mail-shots and mail-merge operations. No matter how small the database, someone will be needed to manage it, and to take responsibility for the implementation of the database, access to and security of data, monitoring and standards, and regular and consistent back-up of data.

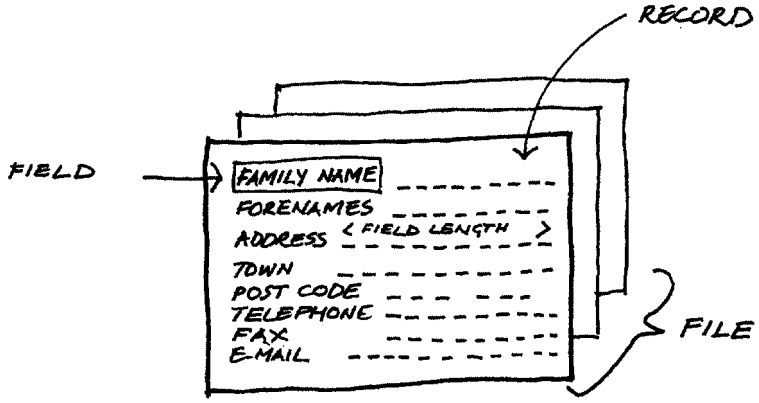
Traditional databases are organized by files, records and fields. A *file* is an organized collection of records; a record is a collection of related items of data which together can be treated as a unit. Within a record there are fields: a *field* is a single piece of information. The database can be searched by identifying *key* fields. For example police crime statistics constitute a database, stolen cars a file, and details of each theft, a record. The record contains fields, time of theft, location of theft, make of car, registration number, owner and so on. The database might be searched by key field 'make of car'.

Large databases may be *distributed:* either the database may reside on one computer but may be accessed from remote locations, or that part or all of the database may be duplicated and housed at several remote locations.

For applications that reside on microcomputers, there are some problems with definitions: some filing systems are called databases, and the terminology used varies between both types of system. The user, of course, has not the slightest interest in the terminology, provided that the system will store and access information quickly and accurately. A file may be known as a table, a record as an entity record, and a field as an attribute. The first-time buyer may be confused by the variations and find it difficult to compare like with like.

2.4.3
Flat-filers (card files)

A flat-filer is a programme that allows records to be kept in a single file and does not share information with other files. These card index type applications are easy to set up and learn and are ideal for single purpose use, such as an address book or client details. They are relatively cheap and easy to use. The disadvantages are that files cannot be cross-referenced with others and data is often duplicated.



2.4 Flat file

Filers differ in the way in which they are organized. In *serial files* records are stored in the order in which they are entered, rather like keeping addresses in a notebook in the order in which they are received. This means that the file has to be searched from beginning to end to find a particular record. This type of file organization is inefficient and rarely used. *Sequential files* are arranged in ascending or descending *key* order (a key is an identifier, such as a family name); the file is searched sequentially until the desired key is found. The addresses can now be kept, say, in the alphabetical order of the family names. In *indexed sequential files* the computer address of a record is

written to an index as it is stored. The file can either be searched sequentially or, if only a few records are required, records can be accessed directly by searching the index. The addresses in the example are now kept in alphabetical order in a book with indexed pages for each letter of the alphabet. *Direct file* systems are used when information is processed in a random pattern. A record can be accessed without the system having to go through other records first. There is a direct link between the key and its storage address. If an address book were to be organized like this it would be possible to turn straight to an individual family name.

2.4.4
Structure of databases

A database is a collection of related and cross-referenced data. Data may be stored in:

- files, with records and fields
- tables, with rows (records or tuples) and columns (fields or domains)
- objects: an object is data with associated procedures; that is a 'lump' of data that knows how to behave in specific circumstances

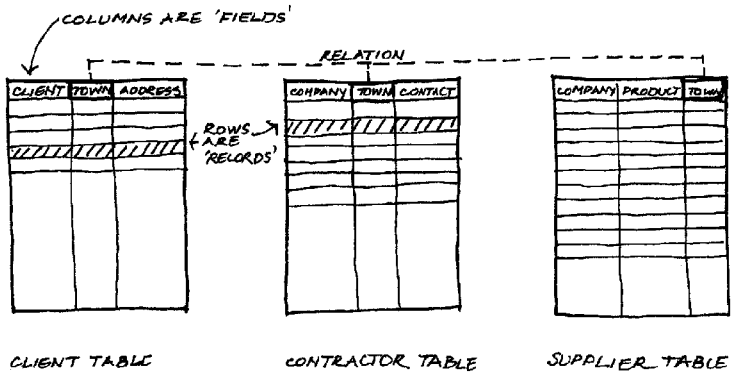
A database can be viewed in three ways: conceptually, logically and physically. The conceptual model is the overall view of the information that needs to be stored and how it is to be used and by whom. This is similar to consideration of the organization of a manual filing system.

The logical view concerns the way the data can be organized to form a database. It is important to identify all the record types that need to be used, the necessary relationships between them and the fields within them. The size and data type for each field should be considered, and key fields and fields with multiple occurrences of data identified.

The physical view concerns the way in which data are stored, that is the actual structure of the database. There should be a technical description of the content and structure of the database.

The conversion of a logical to a physical database is carried out by a database management system (DBMS). This is the software that manages the creation, storage, updating and deletion of data, and the mechanism which allows files, tables or objects to be cross-referenced or integrated.

There are four logical models which are used commonly: *hierarchical, network, relational* and *object-oriented* , all of which refer to the way the DBMS organizes the information internally. The internal organization affects how quickly and flexibly information can be extracted. In the hierarchical model, records and fields are related by a parent-child relationship. One parent can have several children, but not vice versa; the network model allows a child to have a number of parents. These 'traditional' models are used for large databases on mainframes. Access to these is fast



2.5 Diagram of relational database

and reliable. The disadvantage is that relationships between records have to be determined when the database is set up, making modification difficult. These databases may be highly complicated and are expensive in terms of maintenance and personnel.

The relational model, which is usually used on microcomputers, is entirely different, as there is no predefined logical structure. The database is built from tables where the user defines the relationships between records and fields. Data can be combined from different tables, and if data is changed in one table, all the related tables will change.

Requests for information from a database are made in the form of a *query*. Different DBMSs support different query languages, although there is a semi-standardized method, Structured Query Language (SQL). Databases can be interrogated in various ways, and most will allow output of data in the form of a report, and some allow graphics output in the form of graphs and charts.

Object-oriented databases are used in applications such as computer-aided drafting (CAD) and computer-aided software engineering (CASE), where the data to be stored are of a complex nature that cannot be expressed easily by other models. These systems include large amounts of archived data that cannot be altered, and require large amounts of memory.

2.4.5 Hypertext

Hypertext, usually thought of as an *authoring system*, is the basis of an unstructured, free-form, database system which was invented in the 1960s. It was developed for the Macintosh, for which it has been available as the *Hypercard* and *Supercard* programs since 1986; similar systems are available for PCs. 'Hypertext' is graphic oriented software where data are stored as objects which can be arbitrarily linked. *Hypercard* is

made up of 'cards' each of which is equivalent to one card or stack of cards. Each card may contain text, graphics and links to other cards or media. Associated objects are selected by icons which are known as *hypertext links, hot spots* or *buttons*. Objects, that is data related to text, pictures, music, programs and so on, can be creatively linked to each other. When an object is selected all the buttons for objects that are linked to it can then be seen. For example, a document about Beethoven might contain links to a photograph of Beethoven, a recording of the Moonlight Sonata, the score and to contemporaneous composers. Clicking on a Moonlight Sonata button could invoke a sound recording on a media player.

Users can browse from stack to stack, can add text and new cards and can create graphics from paint functions or copy from another card or source. No programming knowledge is needed for authoring purposes, where text and graphic fields can be defined and buttons can be moved or redefined, but built-in programming languages (HyperScript) allow for very sophisticated mini-applications to be built.

These systems are easy to use and ideal for presentations or archives which involve *multimedia,* that is combinations of text, graphics, animation and audio or video material. The disadvantages are that the memory requirements and hardware specifications are high. Storage is usually on CD-ROM or WORM (optical disk, Write Once, Read Many times). Additionally, it is perhaps too easy to produce ill-considered material.

Hypertext systems are useful for browsing through large databases that consist of disparate types of information, and, in particular the World Wide Web (WWW). The documents on WWW are formatted in *HyperText Markup Language* (HTML) that supports links to other documents as well as graphics, video and audio files. Hypertext links are known as *hot spots,* which are used to jump from one document to another.

2.4.6
When to use a database

Setting up a database requires time, not only to organize the data and to determine relationships, but for the tedious and necessarily meticulous task of inputting it. The completeness and accuracy of existing manual records should be considered. Transferring them to a computer may not make life easier. The more complicated the database the more essential it is to keep it complete and up to date. An inaccurate or incomplete database is useless; after all, computers are expected to be more accurate and reliable than people, paper and filing cabinets. A useful and used database will require a person whose job it is to manage it.

Databases may be an asset provided the organization can sustain the time and expense involved in setting them up and maintaining them. In general, small practices will have neither the need nor the resources. On the other hand, simple filers can be extremely useful, are cheap and easy to set up. They can be used for sets of records which

are used and updated frequently such as addresses or contacts, in the same way as card indexes.

It is important to realize that the primary function of a database is to collect and store data, and to allow retrieval in a number of different formats and combinations. A database is not the most efficient type of software for prediction and calculations. Although most databases allow for financial and statistical calculations, these do not operate as quickly as the equivalent functions on a spreadsheet.

2.4.7
Setting up a database

Microcomputer databases are usually 'relational'. This means that data is entered into tables and that relationships may be defined by the user when necessary, rather than at the outset. Relational databases may be manipulated by selecting records from tables, or combining tables to form new tables. Instructions may be entered by command or by menu; the terminology and command names vary between products. Whatever the system, the overall structure of the database, the tables and the fields within them should be considered carefully. Fields should be organized into data types, which may include text, numeric, date, time, currency and yes/no, and may include graphics or other objects. The database should be set up to avoid redundancy, give reliable and flexible access, provide straightforward maintenance, incorporate provision for growth and change of needs, and ensure data integrity and security.

2.4.8
Maintaining a database

In order to maintain a database, the following operations should be reasonably simple:

- updating: adding to, deleting from or changing the contents of a record
- adding: additional records (may be called inserting)
- deleting: the deletion of a record may be in response to a single command; it is preferable to have a two-step process where records are identified and then there is a prompt to verify deletion

Retrieval and manipulation of data

It is important to be able to ascertain what the contents of a database are. Information may be retrieved by:

- sorting: records maybe presented in a particular order (e.g. alphabetical)
- indexing: selected records may be saved to a separate file
- searching (finding, retrieving): by key

- query: queries may be by form, query language, query by example, logic or by wildcard (a single word or phrase)

Reports

It should be possible to generate *reports* (the results of a structured search that may be printed out) according to criteria determined by the user. In addition the user should have control over the design of the report, including layout, headers and footers, formatting and statistics.

Printing

It should be possible to print all or part of a database as defined by the user.

Graphics

Some databases allow for the inclusion of scanned images or other graphics as data types, for example for employee records or pictures of jobs or properties.

2.4.9
Security

Security is of the utmost importance if a database is to be used by more than one person. It must be decided who has access to what information and who is entitled to make alterations to the system or to records. The simplest way to prevent access to a computer is by mechanical locking. This is feasible if the database is on one machine, but not if it is networked. Password systems can be used to give individuals access to certain parts of the database and further passwords can be introduced to allow changes to be made to data. Data encryption can be used so that information is scrambled if accessed by an unauthorized user. The system administrator should be able to carry out audit trails to see whether alterations have been made to records. On multi-user systems there should be provision for file locking so that only one user can have access to a file at a time.

2.4.10
Choosing a database

It is important to ascertain that the database software is appropriate for the purpose for which it is intended, and that people are available to set it up and maintain it.

Purpose

The nature, amount and relationships of data should be determined, together with a specification of how it should be organized. It may be necessary to employ a specialist to do this.

Hardware compatibility

If the database is to be installed on existing hardware it is important to ensure that there is sufficient memory speed and storage to run the software, and that it will not interfere with other applications.

Size and speed

The size is determined by the software, the speed by a combination of the DBMS and the hardware.

- what are the program limits? How many files or tables? How many records per table? Fields per record? Characters per field?
- how long does it take to create a record?
- how long does it take to access a record?

Operation and ease of use

- is the system driven by commands or menus? Are these easy to understand?
- is it necessary to have a knowledge of the underlying structure of the system to be able to use it?
- is the procedure for setting up the system absolutely clear?
- what methods are used to create/select records? Is it possible to create a form for records?
- is the method of entry of records dictated by the system?
- are there enough prompts or on-screen instructions to make the above operations easy?
- is there an on-screen help facility?
- does the system give warnings or prompts of potential error or misuse? Are there instructions for recovery from error?

Data access and retrieval

- how is data accessed?
- how are records accessed? By index? By key field? By a combination of fields?
- how are queries carried out? Form? Query language? Example? Logic? Wildcard?
- can more than one table (file) be searched? How many can be joined or linked?

Editing

- is it possible to correct data during input?
- how easy is it to amend a record? Can this be done accidentally?
- how easy is it to create a new record? Is it possible to add new fields?
- how easy is it to delete a record? Can this be done accidentally?

Security

- is the security provision provided by the software adequate?
- are passwords and encryption included?

Functions and facilities

- what 'goodies' are provided?
- is there a procedural language?
- is it possible to create macros?
- is it possible to design, create and print reports?
- can mathematical operations be carried out?
- are graphics included?

Data interchange

- can the database/filer accept input from other software? Can the output be accepted by other software?

Product support

- are the instructions within the software adequate? Is there a demonstration or tutorial?
- is the manual lucid, straightforward and helpful?
- what vendor support is there? Is the telephone always engaged?

2.4.11 Archives

Any collection of information, recorded on any medium, can be considered as a database, and as such needs to be managed. Only those people of sufficient seniority in a practice to have access to all records, and who have an overview of all procedures, are competent to judge what should be archived. Archiving, in whatever medium, should be carried out by authorized and trained personnel.

Some practice information should be kept securely either permanently, or for varying periods of up to twelve years. It is advisable to keep project records for longer than the legal minimum. These are needed for feed-back, if not litigation, purposes. The Chartered Secretaries' and Administrators' 'Short guide to Retention of Documents' states that corporate records, such as partnership agreements, tax returns, investment records, insurance records, employee records and PR material should be kept permanently.

Project records should include design intent, design development, tender, contract and as-built records. Documentation should include correspondence with clients, consultants, contractors and subcontractors. There are standard recommendations for procedures and structures for the storage of paper-based systems, but there is some doubt about electronic storage of archives.

Notwithstanding the doubts, there are clearly two major questions: the first is whether it is expedient to attempt to store paper-generated material electronically, and the second is how to archive computer-generated material. Both are influenced by time, cost, security, durability and legal admissibility. In the first case paper documents have to be stored in fire, flood and theft proof conditions. Microfilming is a relatively inexpensive and accepted method for keeping records. Courts accept microfilmed copy provided it is supported by evidence of adequate records management procedures (procedures are laid down in BS6498). Like paper, microfilm must be stored in secure conditions.

Documents held on magnetic media are unstable, prone to a wide range of hazards, and deteriorate over time. In addition, many storage media are designed to be altered and thus are prone to accidental or malicious alteration or corruption. In order to store them digitally, paper documents and drawings have to be scanned into a computer and stored on a medium that does not degrade and cannot be over-written. It would appear that the most suitable medium, at present, is the WORM (Write Once, Read Many times) optical disk.

Until the legal admissibility of data retained on optical disk is clarified, however arcane this may seem, it is expedient to keep hard copy of computer-originated material. In the future, it is likely that records on optical disks will become legally acceptable, provided audit trails and appropriate authentication procedures are maintained.

2.4.12
Private and public databases

The amount of information available on CD-ROM and over networks is burgeoning. The contents of an average office library, including Codes of Practice, standards, regulations and product data are available in digital format—somewhere. Much information, including technical books and product information, is available on disks and CD-ROM. The Internet and World Wide Web give access to an abundance of

really useful information and to garbage. Because the networks are uncontrolled, all information has the same status, whether it is state-of-the-art technical material or the egocentric and confused output of a computer nerd in suburbia. Surfing the net is a myth, it is more like waiting at a bus stop, where there is no timetable, for transport of which the speed and destination is unclear. On the positive side, if the user knows where information is, they will get access to it, eventually. When the bus does arrive it will get to California as quickly as to Cleethorpes.

Private databases are accessible to subscribers. Product information systems, such as Barbour Index, are available for Windows 3.1 on diskettes and on CD-ROM. RIBADisc, which costs £80 plus VAT to RIBA members, and is free to registered practices, is updated twice a year. It includes the full text of the practice pages of the RIBA Journal for the last ten years, indexed abstracts of 14 000 articles from five leading architectural periodicals going back five years, and the Product Selector Plus. Currently, RIBADisc is produced for PCs only.

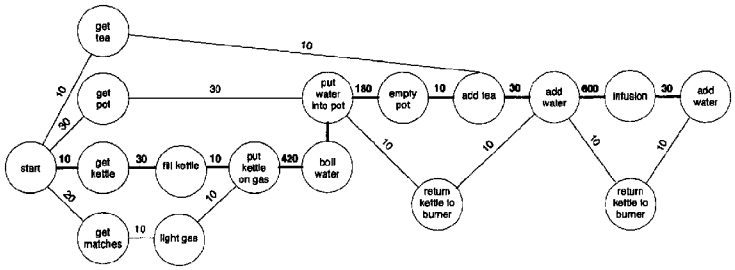
Other public databases, which are accessed via the Internet, are covered in Chapter 4.

2.5 Project management

Project management software is used extensively in the construction industry for the planning, monitoring and control of operations. It is based on the principle that any project can be split into a number of tasks, the duration of which can be forecast, and that some tasks must be completed before others can start. Operations management and research techniques have been incorporated into software, so that formerly complex, repetitive, exacting and tedious analysis of the relationships between the timing and sequence of tasks can be carried out quickly and semi-automatically using a computer. Project management software may be used for a wide range of resource planning activities and ranges in scale from the simple desktop diary and scheduling, to systems that can handle enormous construction schemes. Some features of these systems may be incorporated in office management and job control software for use by architects.

2.5.1 Project manager

The project manager is the person who is responsible for the planning and co-ordination of tasks to be accomplished by a team. This person (or people) has to split a project into tasks, and determine the duration of each and the sequence in which they should be carried out. When this has been done, the manager then has to put the information into a format and present it in a way which is useful.

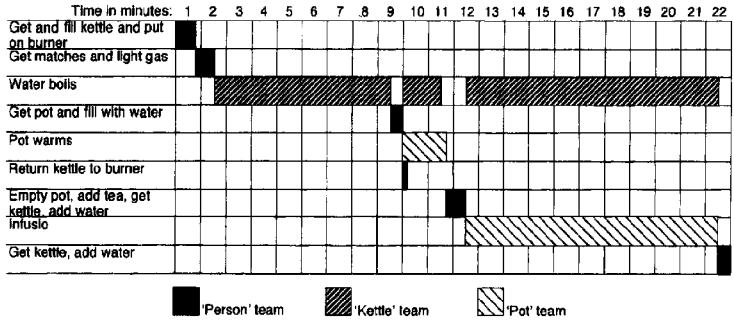


2.6 PERT chart

2.5.2
PERT chart

One of the techniques that is used to accomplish this, whether manually or with the aid of a computer is by Project Evaluation and Review Technique (PERT), originally developed for the 'Polaris' missile project. A PERT chart is a diagram which shows the timing of, and relationships between, a series of tasks. As a simple example, a PERT chart for making a pot of tea is shown below. The method is rather more elaborate than using a teabag, and is based on the nineteenth-century recommendations of Mrs Beeton. The teapot must be warmed with boiling water and left to stand for three minutes, then the water is poured away. A teaspoonful of fresh leaves per person is added to the pot, and freshly boiling water must be added, immediately, to fill half the pot. The tea should be left to infuse for ten minutes before the pot is filled with freshly boiling water. In this instance the chart appears to complicate what is an essentially simple process, but the organization of thousands of such simple processes is a complicated task.

In the tea-making project, the water must be boiled before the pot can be warmed, and the pot must be warmed before the tea is made. The longest route through the network is known as the critical path. It can be seen that the process takes 22 minutes. Whilst the whole operation might be considered to be carried out by one person, the heating of the water, the warming of the pot and the infusion of the tea can be considered to be carried out by separate 'teams'. It is obvious that the person making the tea is involved in the process for less than 4.5 minutes and could be doing something else for the rest of the time. A useful way of displaying this information is the Gantt chart.



2.7 Gantt chart

2.5.3
Gantt chart

A Gantt chart (not an acronym but named after Henry Gantt) is a chart of horizontal bars which show the start and finish time or date of a series of tasks. The tea-making chart is shown below.

Project management software will automatically produce appropriate charts from the data provided. Accurate logical planning is important before such software is used. Details of task lists, the timing and sequence of operations and responsibilities for tasks must be established before data are entered. Some programs are similar to spreadsheets, in that changing times and dates of operations in one area will automatically change dates and times in related areas. When the software has been set up for a project it is not only a powerful planning tool, but may be used for monitoring progress, time spent and costs, and for resource control and observation of actual or planned progress.

An extensive check list is unnecessary as it is more than likely that people doing this kind of analysis are using computers already. Suffice it to say that it is essential to have clear graphics, that an adequate number of resource groups can be accommodated within charts and that the system can cope with the required amount of complexity.

2.6
Information management

Architects produce several types of documents:

- correspondence
- reports, feasibility studies, bids
- brochures
- accounts and personnel records

- contract documents: drawings, schedules and specifications, certificates

The last involves the iterative circulation of information within the office and the issue of this information in the form of documents to consultants, contractors and subcontractors. The first process is often managed implicitly, or is managed reactively in response to consultants' programmes. The second requires the keeping of records about who has been sent what and when, and possibly for legal purposes.

Various computer-based applications exist to help record circulation of Information more systematically, and to store (archive) the results. Many of these programs are generic: their model is the general, possibly north American, 'business' involved in the supply of goods; some are addressed to the specific needs of architectural practice. Some merely offer a record of the circulation of paper documents and amount to no more than electronic equivalents of correspondence logs or drawing issue books. The most ambitious systems, and the one suppliers of hardware and software are most anxious to provide, offer the possibility both of circulating and recording the circulation of electronically originated material, produced either directly on the computer or rendered into digital form through scanning or scanning and optical character recognition. Most of these systems are written as special versions of a database application, and some are provided in modular form, each module devoted to a specific task. They may require that the user already possesses the underlying database application, or they may use a 'runtime' version of the application.

Whatever system is chosen or developed, the rule which applies to recording *all* information applies; do not have the same information recorded in different forms or in diferent places: have only one unique record of the information and one location.

2.6.1 Document management

Operating systems

Modern computer operating systems offer simple flexible methods of organizing documents comparable to the physical filing system or drawing storage chest. The hierarchical filing system of 'folders' in which can be stored individual documents or further folders may be sufficient for the needs of a small practice. Folders could be organized and named by job or type. The disadvantage of such a system is that a single document can only reside in one place, although the MacOS facility for 'aliases' can partly overcome this. (An alias has an icon like in the original document; this can be placed anywhere in another folder; this icon is a 'pointer' to the original document. One document can have many aliases in different locations.) Operating systems have means of searching for and finding particular files or documents based on properties the files might have or be given e.g. 'find all files later

than a particular date', 'find all files whose title contains a particular word'. Operating systems usually record the date on which a document was originated. No operating system will yet allow the user to 'find all files which contain a particular word'.

Indexing documents

Applications are available which will semi-automatically index all the documents, whether text or drawn, which an office has stored on its network of computers. When such an index has been prepared, it is possible to find any single document, or any text contained in a document. Such searches may use Structured Query Language (SQL) for their interrogations.

Document distribution

Single applications or modules are available to enable the user to set up distribution lists of sets of documents together with their recipients, and to simplify the recording of the issue of such sets. Smaller offices might consider setting up a simple spreadsheet template on which to record this information. A particular difficulty arises in the case of recording the issue of drawings with many layers which may be printed in different forms with only a subset of layers showing. This may only be overcome by ruthlessly restricting the number of ways in which a drawing can be printed, perhaps by restricting the number of ways to the number of recipients, and by giving each a single code comparable to a revision letter.

2.6.2
Archive and retrieval

All computer-based information should be copied and saved: 'backed up'. When the job is finished, the back-up may form the archive for that job, or the files may be saved on another medium. Drawings created on a computer can be saved in the format of the application with which they were made. Or, if their paper equivalents contain written annotations, they can be scanned and stored as bit maps, but this process will lose information and will produce very large files.

3
Drawing, modelling and visualization

3.1
Introduction

3.1.1
Definitions

Drawing or computer-aided drafting (CAD) programs help in the production of many of the various types of drawing made for the several stages of architectural activity without using paper, drawing board and T-square, triangle, scale, pencil and pen. The results may be printed to paper to provide scheme design or production drawings; or they may not: for the purposes of presentation, for example, the drawings may never leave the computer but be displayed on a monitor or projected like slides; and computer files of drawings can be transmitted down telephone lines to another computer anywhere in the world before being printed. Some clients may be impressed by drawings made using a computer, others may require production information to be prepared using computers or a particular drawing program.

No currently commercially available program provides a substitute for or supersedes the use of paper and pencil for sketching architectural ideas and diagrams (Stage B, RIBA *Plan of Work*), or for the technique of designing in which a plan, for example, is encouraged to emerge from a skein of lines by progressively firmer drawing, erasing and redrawing.

Modelling programs provide the means of making three-dimensional 'models' without using the modelmaker's traditional materials of wood, plastic and paint. Such programs have two main uses: the first in developing outline proposals to make quick sketch models to help examine alternatives of form or layout (Stage B); the second to make presentation drawings or illustrations, 'visualizations', perhaps replacing both the traditional physical model and the illustrations prepared by a perspective artist (Stage D). A third use, the preparation of short 'animated' sequences of views seen when moving through or past the model, has no counterpart

in current architectural practice but is extremely costly in time, labour and the use of equipment.

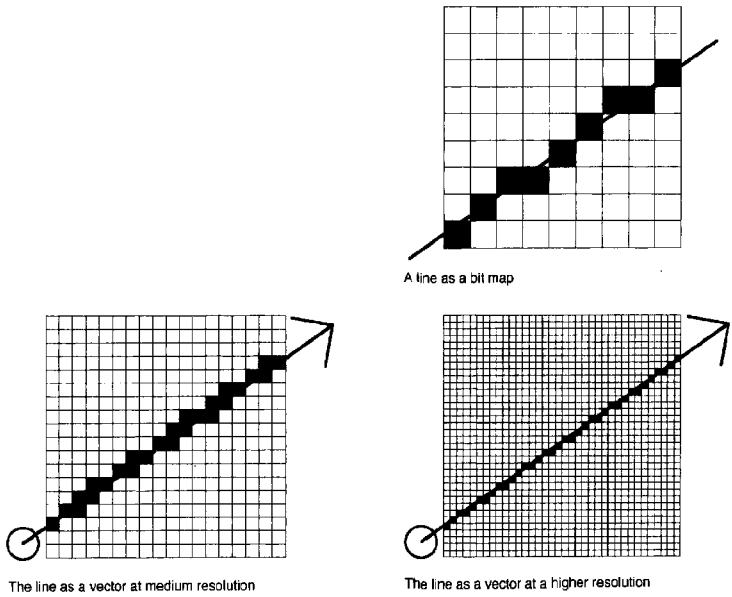
While the smaller programs for drawing and modelling can be run on modestly equipped computers, using them most productively, especially for modelling and rendering, requires the fastest computer with the most memory and the largest display that the architect or practice can afford. All current Macintosh machines can drive two monitors side by side and these need not be of the same size. This may be found particularly useful for drafting: one monitor can display the drawing, the other menus, palettes and tool bars.

Vector and bit-mapped graphics

A computer can be used to generate and manipulate two distinct kinds of graphics: vector and bit-mapped. Vector graphics, sometimes incorrectly called 'object-oriented' graphics, use geometrical formulae to represent shapes. Programs which create and manipulate vector graphics are known as 'draw' programs and all CAD programs are of this type. Vector images are more flexible than bit-mapped images because they can be edited and resized without affecting the resolution at which they are viewed or printed. They require less memory to store them than bit-mapped images.

Bit-mapped images are images whose information is saved as a description of the individual pixels which can be seen on the screen or printed as the individual dots of a printer. Such images are most useful for capturing continuously varying information such as that of a black-and-white or coloured photograph. The amount of information they contain depends on the resolution of the device with which they were created. 'Painting' programs allow 'freehand' drawings to be produced on the screen, using a mouse. A variety of line widths and painting tools are available, including 'brush', 'fill' and 'spray can'. Colours are selected from a screen palette or can be 'mixed' by the user. Scanned images may be introduced and manipulated. The screen image can be enlarged to allow alterations to be made pixel by pixel. A pixel, or picture element, is a single dot which makes up a raster screen image.

With the exception of plotters, most output devices, including display screens, dot-matrix printers and laser printers, are raster devices. This means that all vector objects of the sort produced by drawing programs need to be translated into bit-maps before they are output, but this only happens when all sizes and resolutions have been determined. The translation may take place within the computer or in the printer. PostScript printers, for instance, contain a raster image processor (RIP), or a combination of a CPU and software which converts vector objects.



3.1 Vectors and bit maps

3.1.2
Benefits of computer drawing programs

These may include:

- the first draft of a drawing can be prepared very quickly
- editing or altering a drawing is straightforward: drawings can be continuously edited without the need for scratching, abrasives or solvents
- those preparing the drawings are more productive
- the protocols which must be devised and followed require that the production of a suite of drawings may be more systematic than is necessary or possible with physical drawings
- a single drawing can contain more information than a hand drawn one could
- colour can be used illustratively or to code information, if only on the screen
- depending on the quality of the printing process, the paper print of a drawing produced with a computer may be more elegant, unambiguous and detailed than any drawing produced by hand could be
- the files of drawings can more easily and quickly be sent to consultants or contractor by phone line than its paper counterpart could be by post or fax

3.1.3
Disadvantages of computer drawing programs

These can include:

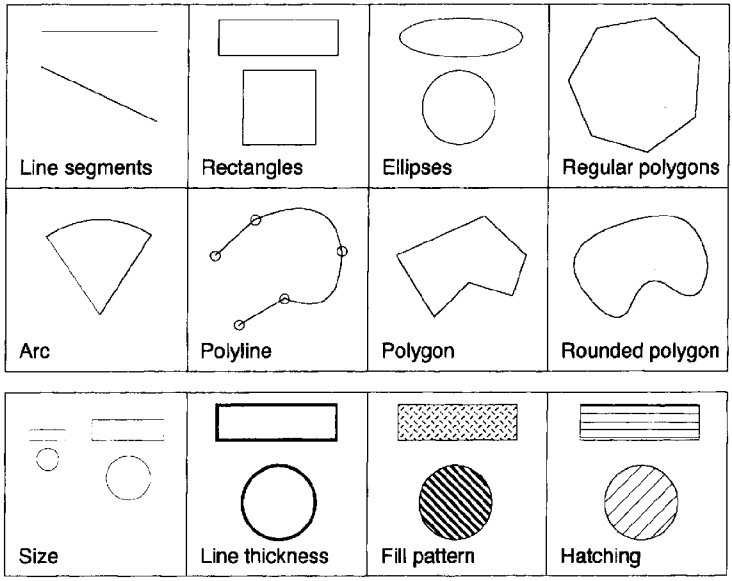
- the expense of training to use them
- the possibly long period of learning required to get the benefits
- the lack of industry- or profession-based standards for the organization of computer-generated information
- the difficulty of working out how someone else has constructed a drawing
- the irritation caused by the protocols to those temperamentally disinclined to follow them
- the temptation never to stop editing: the difficulty of deciding when a drawing is finished
- the necessity of keeping a parallel paper record of the electronically stored drawing
- particular programs may have a particular and unacceptable view of how to draw, what a drawing is or, worse, of how a building should be conceptualized
- a particular program may have been designed mainly for the needs of an engineer in the United States: it may not easily be adaptable to the needs of a British or European architect

3.2
Two-dimensional drawing

3.2.1
Programs for the smaller job or office

Smaller drawing programs cost between, say, £100 and £500. A list of programs and suppliers is included in Appendix B. These smaller programs allow the user to:

- work to scale on a 'drawing' represented on the computer display as a sheet of 'paper'
- assemble a drawing out of primitive elements or 'objects' e.g. lines, rectangles, ellipses, polygons, arcs, arbitrary curves, etc.; each object has a set of attributes, e.g. type, position or centre, size, line thickness, pattern and colour of fill, etc.
- use the familar Cartesian co-ordinate system with X and Y axes and points (x, y) to set out a drawing and to position and move objects; alternatively or additionally to use polar co-ordinates (angle, length)
- navigate a drawing larger than will fit on the screen by scrolling and panning across it, and by zooming in on or out from particular parts of it
- draw circles, arcs and curves accurately and without anxiety
- copy and paste repeated chunks of a drawing
- group:combine these primitive elements to make more complex objects
- trim lines to each other or to other objects
- hatch or enclose shapes and fill them with a pattern

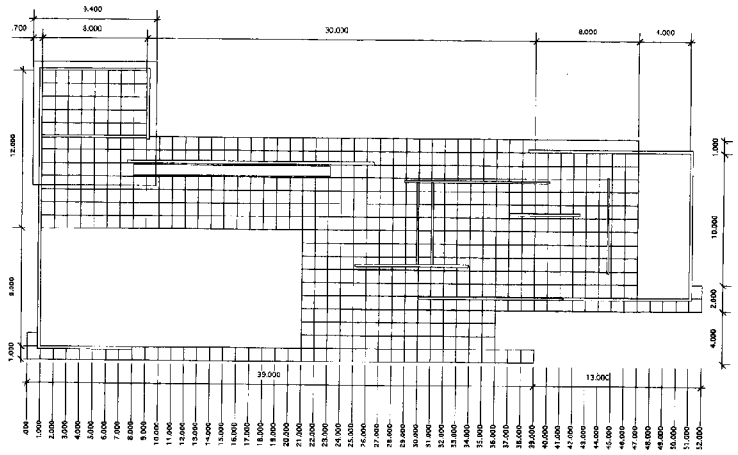


3.2 Some primitives and their attributes

- create a complex object, e.g. a door or window assembly, which can repeatedly be re-used in the same or another drawing; different programs call these entities 'symbols', 'library objects', 'cells' or 'blocks'
- 'constrain' the action of the drawing tools in various ways, e.g. to constrain lines to angles of 90° and 180°, or 45°, etc.; to constrain a rectangle drawing to produce squares or an ellipse to a circle
- use 'libraries' of ready-drawn parts or components supplied by, for example, manufacturers or professional associations
- use a grid or grids of sizes you determine to position objects
- 'snap' objects to end- or mid-points or other subdivision of a line or other object, or to a grid or grids which you determine
- use 'layers' or 'levels' to categorize the drawn information and to view and print these selectively and in different combinations
- provide facilities for adding neat and systematic dimensions
- provide elegant and editable notes, captions and titles
- set up 'views' of any part of a drawing and to name and save these
- alter or edit any aspect of the drawing at any time

3.2.2
Drawing programs for the larger job or office

Large drawing programs cost between £2000 and £3000 for a licence for a single user, perhaps less for a group of users. Examples include the widely used *MicroStation* (Windows NT, Macintosh OS) and *AutoCad* (Windows). The providers of these large programs and other firms may offer supplementary programs (sometimes called



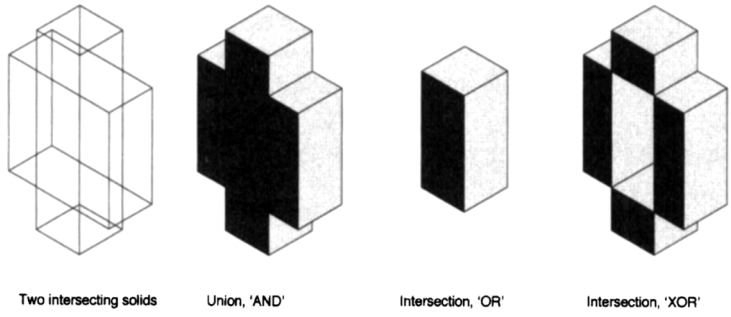
3.3 Dimensions

'plug-ins') for further particular uses such as modelling and rendering, the construction of databases, or for programming. These may be included in the basic price or may have to be bought separately.

The programs will require ample computer hardware: more, bigger, faster. Some will run on smaller operating systems like Windows 95 or Macintosh OS; others, including those allowing group work across a network, will require a network OS such as Windows NT or UNIX. A list of programs and suppliers is included in Appendix B.

These programs allow the user to:

- work with 'real' dimensions without first requiring the user to set a scale or drawing size
- construct and draw an object in many alternate ways, e.g. a line as a tangent to a circle; a line at the mid-point and perpendicular or parallel to another line; a circle set out from its centre or in relation to another object
- quickly draw one- or two-dimensional arrays of regularly repeating objects, e.g. setting out lines, a grid of columns, using rectangular or polar coordinates
- set up 'associative' dimensions, that is dimensions which refer to particular objects and which change automatically when the size of the object is changed
- combine elements together to make a whole, e.g. to 'chain' together line segments of various kinds to make a single complex entity
- draw walls or multiple parallel lines in a single operation, to be able to puncture these to provide, for example, doors and windows, and to provide simple ways of making various types of joints
- automatically add straight or curved chamfers to the corners of objects

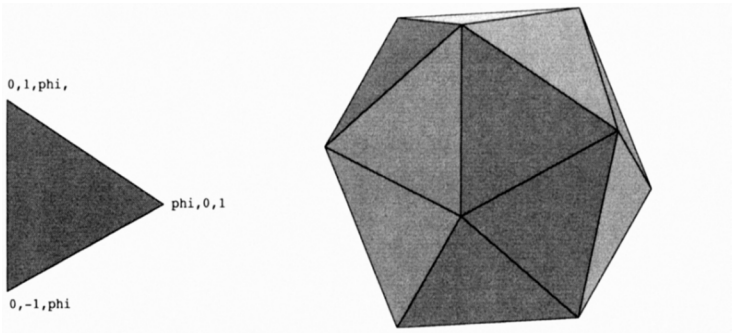


3.4 Boolean operations on two intersecting solids

- use Boolean operations on pairs or groups of objects, e.g. to 'subtract' or add objects from or to each other
- generate complex shapes by programming rather than drawn construction lines, or to set up objects with properties or variables which can be varied by programming to produce new instance of an object or families of new objects: this is called 'parametric design' and has so far been used mainly in engineering design (e.g. to draw bolts with their different diameters and threads), but stairs would be susceptible to the same method
- allow enclosed shapes to be filled with editable 'hatches' to identify the shapes or to code for particular materials (these hatches are different from the bit-mapped fills which some programs provide: they will print at the best resolution of the printer rather than merely at screen resolution)
- set up and name groups of layers or levels for the selective presentation of categories of information
- use a two-dimensional drawing as the base for developing a three-dimensional model
- associate drawn objects with a database to allow for semi-automatic specification, taking-off or measurement
- allow the user while working on one drawing to view another file (called a 'reference' file in *MicroStation,* a 'Ref' file in *AutoCad*) from which information can be taken but which cannot be altered while being so used
- provide facilities for group work across a network

3.2.3
Drawing input

At one time it appeared that the light pen, a pointing device which could be used to 'draw' directly onto the computer's display, might provide a direct analogue to the pencil or pen, but this has not proved to be the case. It may shortly be possible to



One face

```
POLY3D(0,1,phi,  phi,0,1,  0,-1,phi);
```

The whole icosahedron

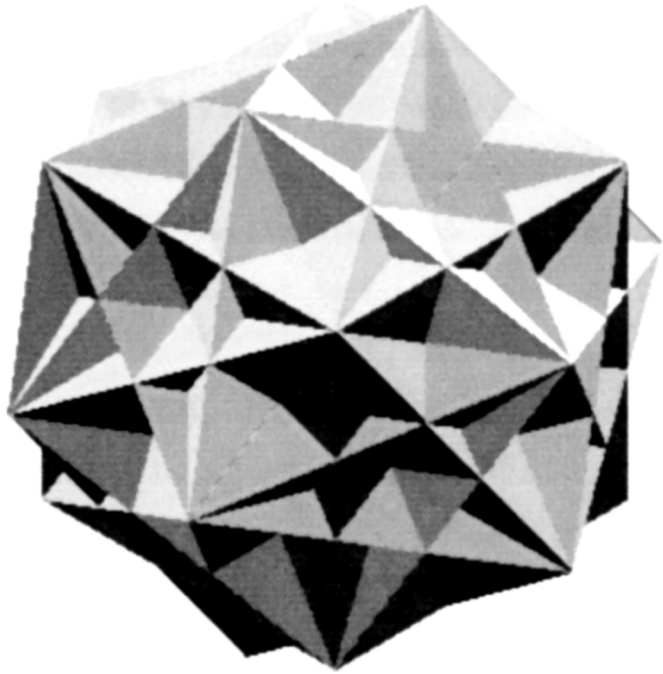
```
Procedure Icos;
CONST
phi=1.618;

BEGIN

CLOSEPOLY;

{1/1} POLY3D(0,1,phi,   phi,0,1,   0,-1,phi);
{1/2} POLY3D(0,-1,phi,  phi,0,1,   1,-phi,0);
{1/3} POLY3D(1,-phi,0,  0,-1,phi,  -1,-phi,0);
{1/4} POLY3D(-1,-phi,0, 1, -phi,0, 0,-1,-phi);

{2/1} POLY3D(0,1,phi,   0,-1,phi,  -phi,0,1);
{2/2} POLY3D(-phi,0,1,  0,-1,phi,  -1,-phi,0);
{2/3} POLY3D(-1,-phi,0, -phi,0,1,  -phi,0,-1);
{2/4} POLY3D(-phi,0,-1, -1,-phi,0, 0,-1,-phi);

{3/1} POLY3D(0,1,phi,   -phi,0,1,  -1,phi,0);
{3/2} POLY3D(-1,phi,0,  -phi,0,1,  -phi,0,-1);
{3/3} POLY3D(-phi,0,-1, -1,phi,0,  0,1,-phi);
{3/4} POLY3D(0,1,-phi,  -phi,0,-1, 0,-1,-phi);

{4/1} POLY3D(0,1,phi,   -1,phi,0,  1,phi,0);
{4/2} POLY3D(1,phi,0,   -1,phi,0,  0,1,-phi);
{4/3} POLY3D(0,1,-phi,  1,phi,0,   phi,0,-1);
{4/3} POLY3D(phi,0,-1,  0,1,-phi,  0,-1,-phi);

{5/1} POLY3D(0,1,phi,   1,phi,0,   phi,0,1);
{5/2} POLY3D(phi,0,1,   1,phi,0,   phi,0,-1);
{5/3} POLY3D(phi,0,-1,  phi,0,1,   1,-phi,0);
{5/4} POLY3D(1,-phi,0,  phi,0,-1,  0,-1,-phi);


DOMENU(1481,NoKey); {'Convert to 3D Polys'}
END;
Run(Icos);
```

3.5a Icosahedron model drawn by programming (MiniPascal), and the program to draw it

interact with a computer using spoken commands, but whether this method will prove convenient for drawing has yet to be tested.

Information about a drawing in preparation is generally now supplied to the computer by means of a keyboard and pointing device. Earlier programs required the use of a graphic or digitizing tablet both to specify information and to choose from a menu of drawing commands. More recent programs now use a graphical interface which permits the selection of commands from menus, palettes, ribbons, toolboxes or toolbars, and the drawn objects themselves, with a mouse, and commands can usually also be carried out by using the keyboard.

The automatic conversion of existing paper drawings by scanning to produce into computer readable files is at present a dream and may remain so. The comparison with the optical character recognition of text is inappropriate: text consists of a



3.5b Ten interlocking cubes in a dodecahedron, programmed in MiniPascal

limited number of shapes to be recognized: there is an infinite number of possible drawing elements.

3.2.4
Organizing a set of drawings

The British Standard for organizing a set of drawings has been discontinued and at present there is no single widely accepted convention for how a 'set' of drawings produced using a computer should be produced: different offices have different customs and these have usually grown up rather than having been designed. This is understandable, as the use of computers makes it possible to reproduce exactly the equivalent of a set of single drawings on paper or to combine the information that such a set is contained in entirely new ways and combinations. In particular, the use of 'layers' or 'levels', while it has analogues in the use for example of copy negatives on which particular categories of information can be placed, suggests new ways of organizing and categorizing drawn information. There is now no particularly strong reason why all the drawn information for a single building of modest size should not all be placed on a single 'drawing' contained in one computer file, and as the capacity of hardware increases why this should not be true of larger buildings. There is no

particular reason why elevations and sections should not be on the same drawing as plans, and similarly there is no strong reason for separating the different floor plans of a single building into separate files; putting them on different layers of the same 'drawing' or file might serve just as well.

Only the bravest practitioner or office would start a new job using the computer for the first time with the aim of producing all the drawings. The most conservative policy for the beginner would be to attempt to make two parallel and identical sets of drawings, the first made manually, the second using the computer. Alternatively, some of the drawings, general arrangements or details might be attempted with the computer, the remainder by hand.

While computers and their modern operating systems and applications do not impose or require systematic thinking or organization, in order to use an application most productively and avoid redundant work, some planning is needed before starting to produce a set of drawings. The following questions should be considered:

- in what form or forms will the drawn information be required and to whom will it be distributed?
- what is the maximum size of drawing which the office can print using its own resources or those of a bureau?
- by what medium will it be distributed, paper prints and post or messenger, files in their original or an interchange format, on disk or via e-mail?
- if files, are those that the office distributes readable by (compatible with) the equipment of the recipient?
- what is the maximum size of file that the office's computer and applications will support?
- if there are fewer files with larger amounts of information, are the files categorized so that redundant or inappropriate information can easily be suppressed?

These questions become most pressing when planning the preparation of computer assisted production information (Stage F) for the first time. Beginners should probably make a conventional schedule of the drawings required and then prepare these using a computer application. This experience will certainly suggest ways in which repetitive tasks like the drawing of grids, of identical components such as door or window frames, or of entire repeating chunks of a building, could be eliminated by copying and pasting and by the increasingly systematic use of component 'libraries' which can be shared by a set of drawings or across different project teams. It will also make clear that some consensus is required on how drawings are constructed, that is, which tools are used to make the lines and other objects which finally constitute what appears on paper or in another form. This will present probably insurmountable difficulties, for modern drawing applications present a very large number of ways in which a particular graphic configuration might be constructed, all of which might look identical on screen or paper. One person might prefer to make skeins of single-line

segments, another elaborate polylines, and so on. (The second will be more productive, and the drawing more adaptable.)

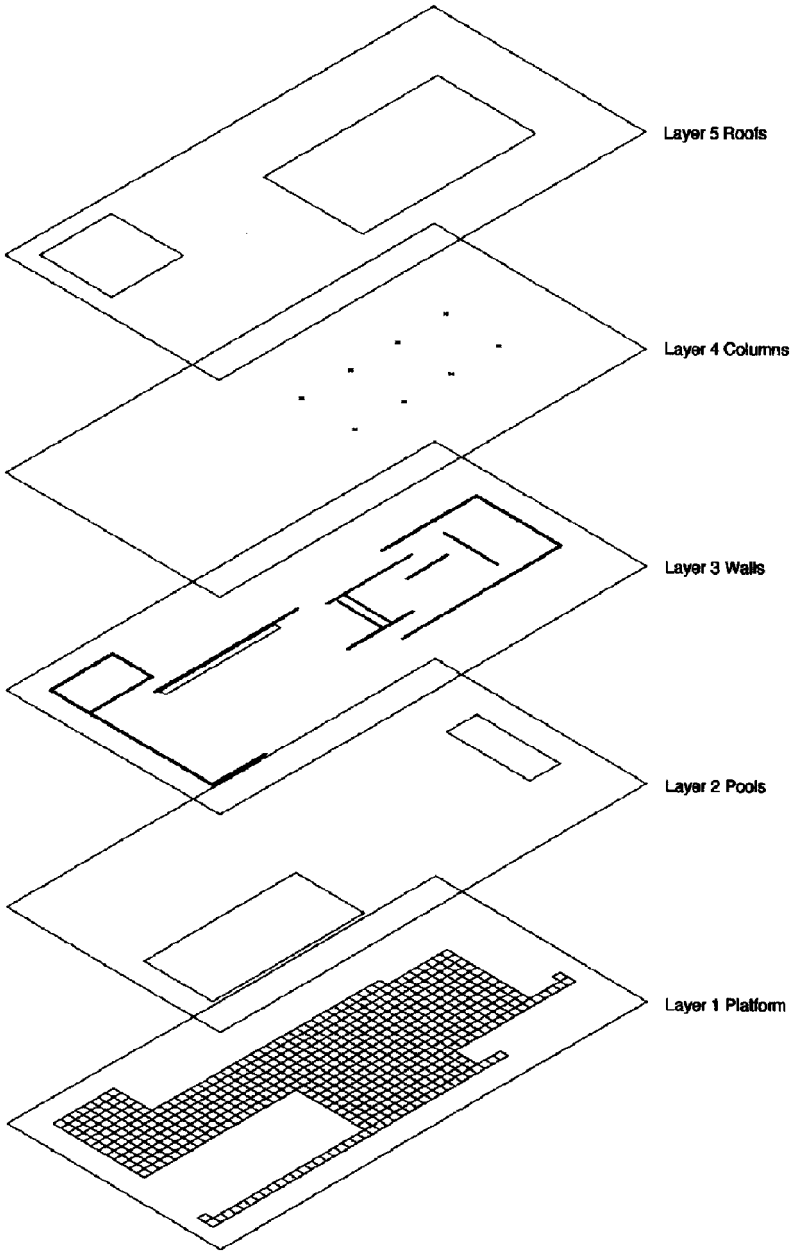
Layers

The most versatile technique for organizing a drawing and one offered by most programs is that of the 'layer'. A layer is analogous to a sheet of transparent acetate on which can be placed a particular category of information which the user determines. A 'drawing' then consists of a stack of such sheets or layers. The versatility arises from the ability to make a layer or group of layers visible or invisible so that a number of different 'drawings' can be produced from a single master drawing or computer file. For example, for a multi-storey building, the elements common to all floors might be placed on a single layer and the specific features of the plans of each of the other floors placed on separate layers. A particular floor plan could then be portrayed by displaying the first layer of common elements with one of the second set. Further layers might show, for example, plumbing layouts, electrical and lighting layouts, floor finishes, furniture, etc. for each floor. Layers can also be used to record alternative proposals on the same drawing or to combine these in different ways. The British Standard for layer conventions, BSI 192 part 5, is under revision (1997).

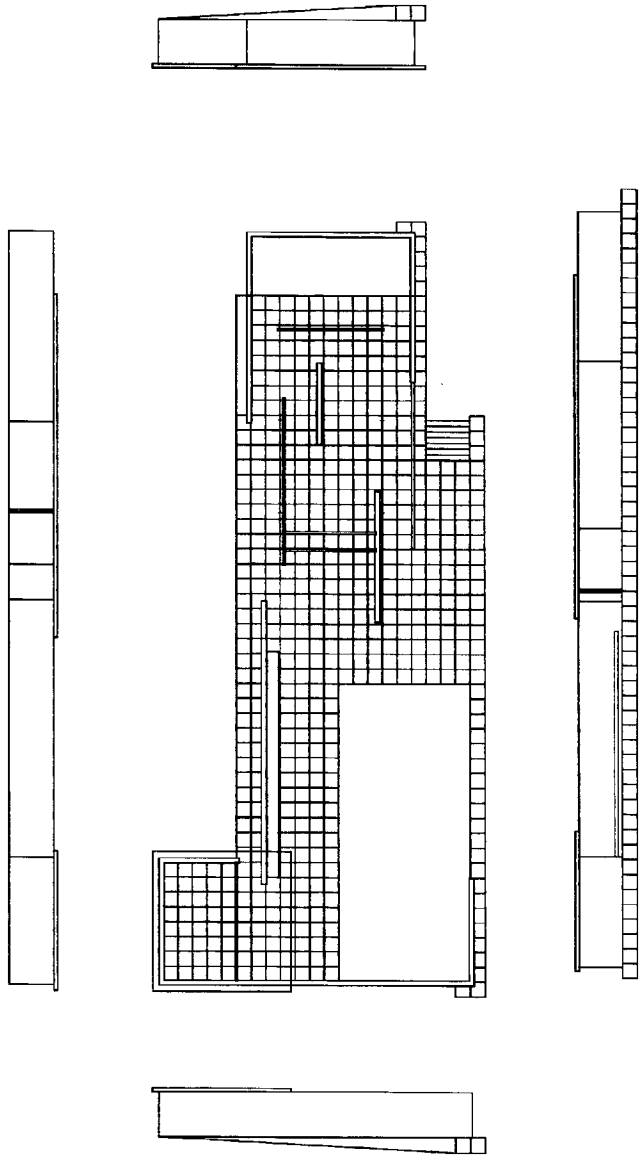
Some programs (e.g. *MiniCad* with its 'classes') offer the facility of further categorizing information within a single layer or across a number of layers. This allows the user to set up a 'three-dimensional' system of categorization beyond the flat 'two-dimensional' system of layers in which it would be possible, for example, to place all of the items of furniture in a building, on whatever layer, in a category and then to select for display all the furniture on a single layer or on some or all of the layers.

There is no reason why sections, drawn on their own layer or series of layers, should not be superimposed on the plans on other layers. This might help setting up the drawing of the section and it might further help check consistency between plan and section. Elevations, conventionally drawn on separate drawings from plans, might be set up underneath or round the plans, again to help setting up, and rotated when they need to be printed.

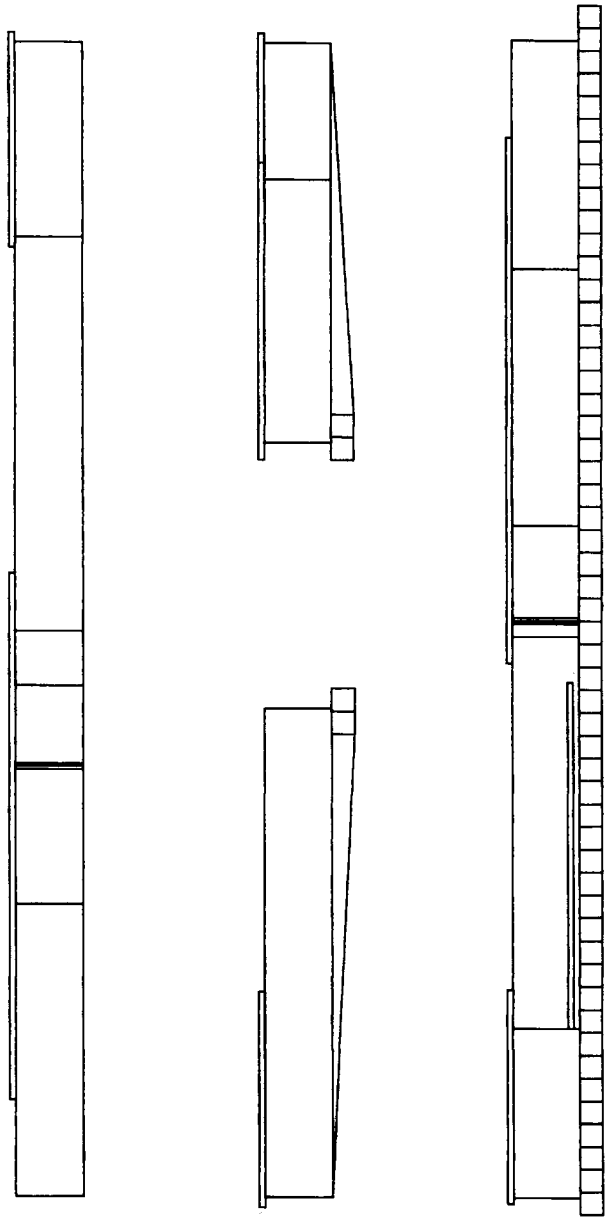
Drawings constructed with layers present particular problems in maintaining a record of issued paper drawings made from them. If multiple views of a particular drawing are feasible, then it is possible that two paper drawings with the same drawing number may show different (but not inconsistent) information: some way must be found to record on the paper drawing which layers are being presented. A simple routine or macro in the application's programming language might be written automatically to place this information in the title box of the drawing when it is printed.



3.6 'Stack' of five layers



3.7a Elevations constructed from the plan



3.7b Elevations constructed independently

Drawing templates or stationery

A second productive use of drawing applications is the setting up of templates: empty drawings which already contain a number of commonly used settings and on which a drawing can be started straight away. The most obvious is the office's standard title box; others might include scale, standard line thicknesses and colours and text sizes, pre-named and coloured layers, access to symbol libraries, etc.

3.2.5 Checklist for drawing software

- are drawings required only in two dimensions, in two and three dimensions with the same program or with separate two- and three-dimensional programs?
- can you afford one of the most expensive and best programs (about £3500 at the time of writing)?
- how are upgrades priced?
- do clients have any views or requirements about particular programs?
- will existing hardware, if any, be adequate for running the chosen program (one can never be too rich or too thin: for drawing one can never have too much memory, a fast enough processor or a big enough monitor)
- does the program have an active user group and is this encouraged by the supplier or manufacturer?
- does the dealer or reseller appear to be familiar with the particular requirements of architectural practice?
- does the dealer offer or know of training courses?
- do you know anyone else who uses the program?
- are the manuals intelligible and attractively produced?
- is it straightforward to print from the program to your existing or intended printer?

3.2.6 Drawing output

Drawings files can be output to the plotters or printers described in Chapter 1. An office may find it convenient to have all the machinery required in-house, or it may use a bureau, especially for printing large drawings or for large sets, or for those where colour is required.

3.3
Three-dimensional drawing: modelling and rendering

3.3.1
What modelling programs do

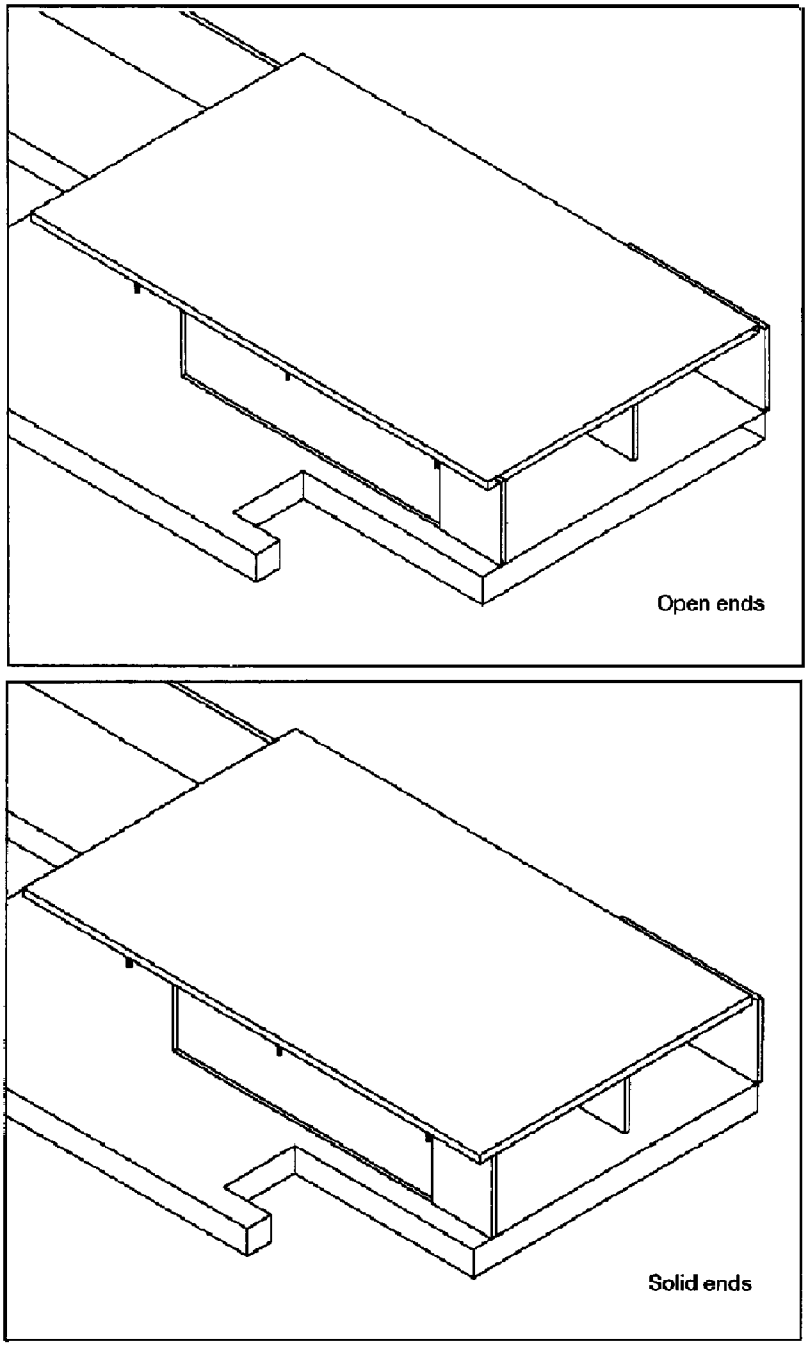
The word 'model' has acquired two meanings in computing terminology: the first as a three-dimensional pictorial representation; the second a database of all the information required for production and construction. The first is being used here.

Single applications are available which may supply facilities for modelling, rendering and animation, but applications are available which do any one, two or all three. Data can be exchanged between applications by different suppliers using one of the common data interchange formats. Prices vary widely, from about £500 to £2000, and there is no necessary correlation between price and ease of use or the powerfulness of the application.

There are three main types of modelling program: the wire-frame or wire-line modeller which is limited to representing objects by their edges. The surface modeller program considers all three-dimensional objects to be assembled from their exterior surfaces. A closed three-dimensional object generated by such a program will, if cut, exhibit its empty interior and the interiors of the faces of which it is composed. Surface modellers are economical in their use of computer resources and setting up a model using one can be simple and quick. They may, however, not allow sections to be cut through the model. It may be difficult or impossible to model complex objects, especially those with holes or on which Boolean operations have been performed. It may be laborious or difficult to convert objects into solid form for use by a rendering program.

A solid modeller allows the construction of a model out of 'solid' objects which, if cut through, will exhibit a new face on the plane of the cut and produce a new 'solid' object. Solid modellers can be used to model objects of arbitrary complexity and the model may be more versatile than one constructed from surfaces. Solid modellers are profligate in their use of computer resources and may run slowly on smaller machines. Setting up the model can be slow, laborious and as difficult to make as a physical one.

Spline-based modellers require the construction of all objects out of uniform or non-uniform B spline curves ('NURBS'), and are capable of producing any arbitrarily curved surface as well as the more common orthogonally specified ones. These applications are rarely required in architectural offices, largely because the shapes it is possible to model would probably be difficult to construct, but if a model of a vehicle is required, it would be possible to produce one using one of these applications. These applications are difficult to use and are liable to produce very large files.



3.8 A solid modeller allows the construction of a model…

Modelling programs will, and some large drawing programs may, enable the creation of three-dimensional objects by:

- extruding a flat, two-dimensional shape or profile into the third dimension to produce a three-dimensional form: simple modellers will only perform the extrusion at right angles ('normal') to the original shape, more sophisticated programs will allow extrusion in any direction; the most powerful programs allow you to extrude along a user-defined path, to produce shapes like bicycle handlebars or complex pipe runs
- lathing a profile to produce objects of rotation: simple modellers perform only a 360° rotation; the more powerful allow rotation through an arbitrary angle
- sweeping: rotating a profile while applying other translations and transformations; this can be used to model for example a ram's horn or a snail's shell
- 'lofting' (US) or 'skinning' a series of profiles to produce a surface: like stretching paper over the wooden struts of a model aeroplane
- offering 'primitive' shapes, the program's repertoire of ready-made objects such as boxes, pyramids, spheres, cylinders and cones
- editing pre-existing shapes by moving their vertices or by scaling

Modellers help the user organize work by providing:

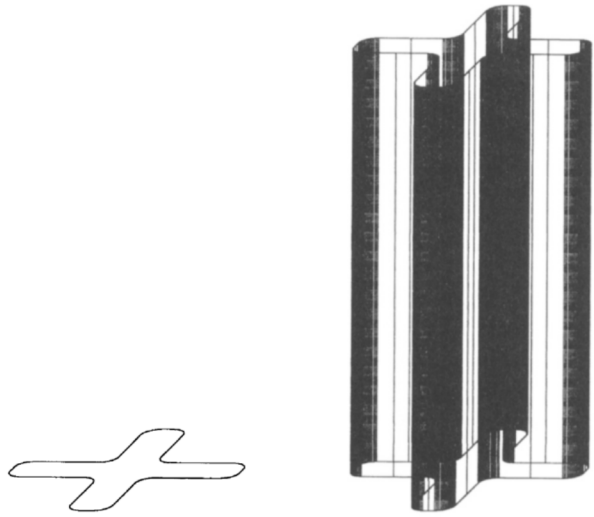
- layers on which different categories of information or alternatives can be placed; the layers can then be selectively edited or viewed
- grids to help the precise setting out and sizing of objects
- working planes chosen or specified by the user on which newly created objects will be created
- a well-designed interface to make a difficult job easier

Modellers allow the user to manipulate and edit the objects in a model by:

- moving, rotating and scaling them
- duplicating them in one-, two- or three-dimensional arrays
- editing a ready-made or newly created object by altering its dimensions or scale, by adding to or subtracting from it, and by moving some or all of its vertices (corners)
- performing Boolean operations on two or more objects to produce the results of union, difference and intersection, e.g. holes, projections and depressions

Modellers allow the user to:

- view the model from a variety of viewpoints and in different projections: orthographic, axonometric, perspective; programs vary greatly in their ability elegantly to define and manipulate viewpoints
- control the lighting of the model by varying the position and intensity of a single light source, perhaps the sun; more elaborate modellers allow you to position additional



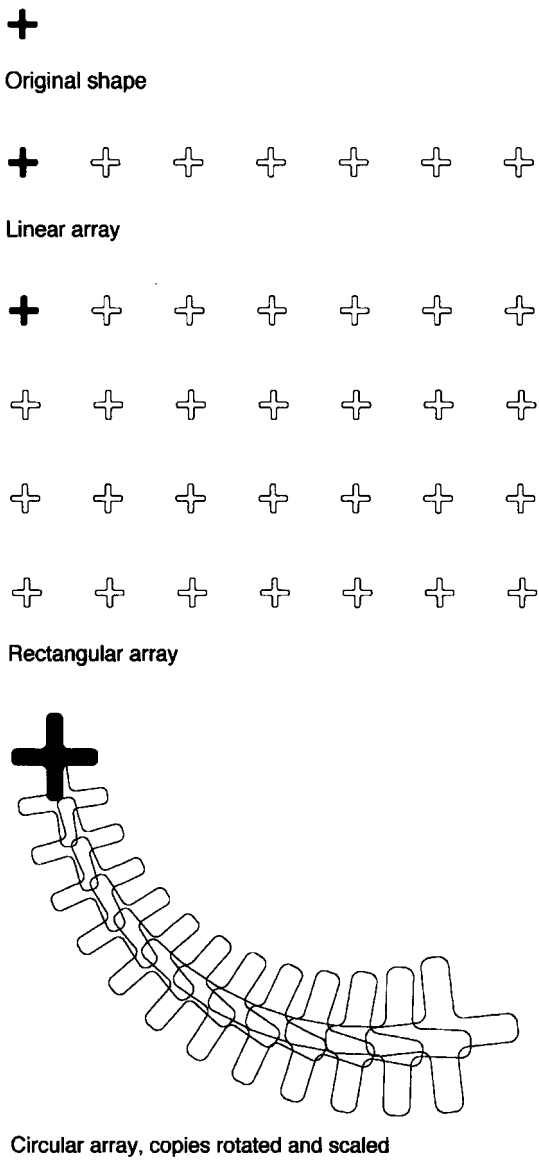
3.9 Extruding and lathing

light sources and to imitate the effects of artificial light; the best are probably those which allow the user to place 'cameras'.

3.3.2
Visualization: rendering and animation

Rendering

Rendering programs allow the user to:



3.10 Arrays

- convert objects constructed as surfaces into solids
- specify information about an object's colour, surface texture and pattern and, for translucent or transparent materials, its colour and refractive qualities

- control light sources and lighting effects more precisely than is possible with simple modellers
- set up precise viewpoints using numerically defined co-ordinates or by placing 'cameras'
- produce pictures of the model using a variety of rendering techniques from the simplest, the 'wire-frame' in which objects are represented only by their edges, to the most realistic, 'raytracing', in which all the attributes of objects and their shadows and reflections can be portrayed
- portray the effect of inter-reflection of light between objects

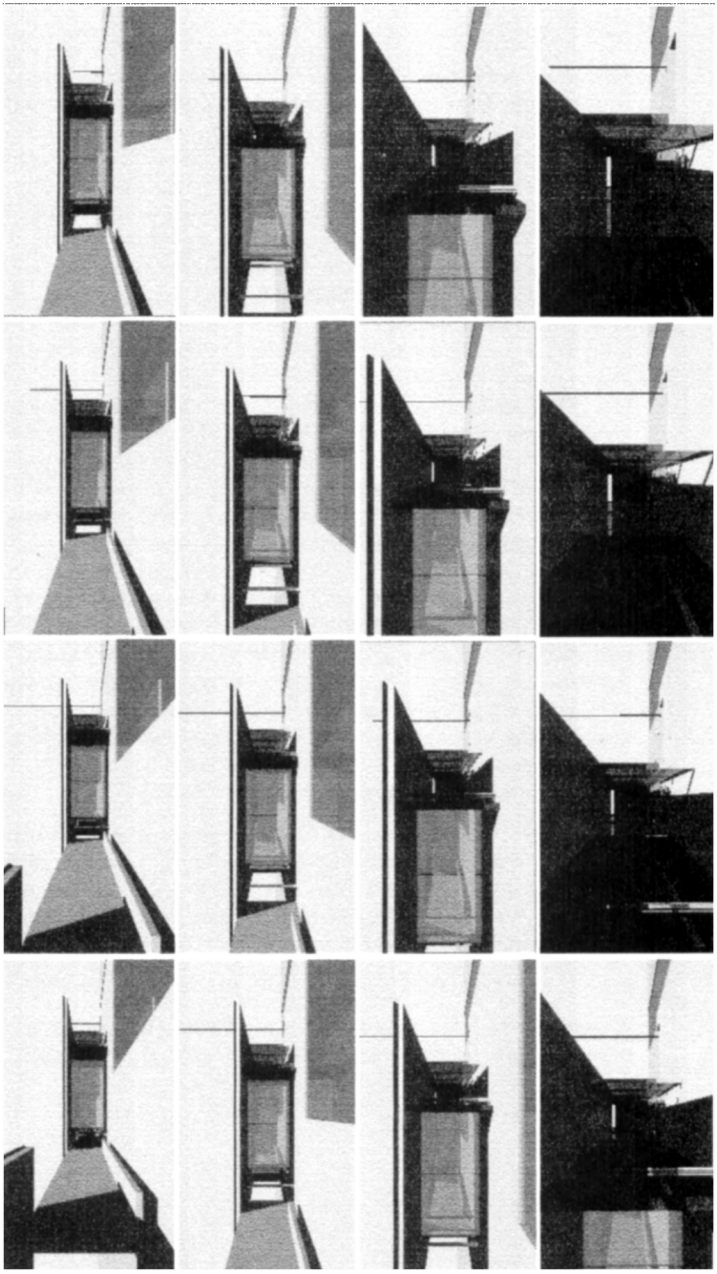
Rendering programs may be bought as stand-alone applications, in which case models made with another program may be imported into it using a file transfer format such as DXF, or the facility may be part of a modelling program.

The raw image produced by any rendering program will, whatever its intended final form, almost certainly need further processing and editing. A 'paint' program such as Adobe's *PhotoShop* is indispensable for sizing and cropping, adjusting brightness and contrast, touching up errors, or more ambitiously for example combining with other images to paste in a different scene or sky as background.

Animation

A particular animation program or the animation facilities of a modelling program can be used to generate a moving picture of the view which would be gained by moving past or through a model of a proposed or existing building. An animation is made up of individually rendered frames which are then presented sequentially on the screen. Such animations might provide valuable insights while developing a design, or they might be used for presenting or marketing a scheme. The production of a movie of professional quality is, while fun, extremely demanding in labour and computer resources: even on the fastest desktop machine, each frame may take hours to generate. It may not be economical to develop the expertise (that of a film director and camera operator) to make them or prepare them within the office: it might be better to employ a specialist firm. A practice might ask whether, for the same cost, a client would prefer a model of the commissioned building in the form of a five-minute video tape, or something physical which can be placed and admired in the boardroom.

While the output from animation programs may usually be viewed on a screen, if animations can be made to respond to the needs or wishes of the spectator, for example to change the direction or position of a viewpoint or the speed of travel, or if the objects of which the model is composed can be moved, they are said to be 'interactive'. Such interactive animations, especially if viewed through immersive headsets, may qualify to be called Virtual reality'.



3.11 Frames from an animation

Apple's *QuickTime* VR and Microsoft's *Surround Video* provide a way of navigating and viewing 360° panoramas produced from photographs. Surround Video requires a photograph taken on a panoramic camera, but Apple's software can generate the panorama by stitching together and applying appropriate cylindrical distortion to a set of discrete photographs, and there is no reason why these images should not have been produced with a rendering program.

Animation programs allow the user to define:

- two or more views of a model and have the program interpolate the series of views or 'frames' between them; the series of frames can then be displayed in sequence to give the effect of an animated film; on currently available and affordable equipment, this process of preparation can be very time-consuming and slow, and the files very large.
- the movement of particular objects such as doors, lifts, cars and planes
- changing lighting conditions, e.g. the path of the sun or the change in position or intensity of artificial light sources

4
Networks and communications

4.1
Introduction

4.1.1
Networks

The first personal computers stood alone like typewriters. Developments over the last fifteen years have led to their being connected together to enable users to share information or peripherals. A network consists of two or more computers connected together so that they can exchange information, or a computer and a peripheral device similarly connected. Networks can be very simple (a computer and a printer), or very complex and extensive.

A local area network (LAN) is a network which connects computers within a small geographical area, such as a building. Computers connected to a LAN are rarely more than a mile apart. A metropolitan area network (MAN) connects LANs in areas such as cities or districts. A wide area network (WAN) connects computers in much larger geographical areas. LANs are private networks, MANs and WANs require the use of public telecoms. Information can be transmitted by cable, telephone line, microwave, satellite or fibre optic cable. The Internet is a WAN that connects computers all over the world.

4.1.2
Uses, advantages and disadvantages

A small network of computers allows its users to:

- share peripherals such as printers, fax machines, modems, scanners and plotters
- access and exchange files with other users more quickly than for example using floppy disks

- access and use single copies of application programs: this may be cheaper than installing individual copies of the program on each user's computer
- use 'workgroup software': special versions of applications which allow several users to work on one project at the same time
- optionally exchange messages with other users via e-mail or a 'mail' application

The disadvantages of networks include:

- initial installation can be expensive: the cost of cabling and connections can be surprisingly high
- installation may be too difficult for a practice to carry out on its own, and a consultant may have to be employed and possibly retained
- any network requires a manager who has the time and ability to maintain the hardware and software and who is responsible for how the network is used, and the security of information held on it

4.1.3 Simple networks

The simplest network consists of a computer connected to a printer. Data for printing is sent out via the computer's serial or parallel port to the printer, and the printer can send messages back to the user of the computer to report, for example, that it has run out of paper. Such simple networks are frequently extended so that several computers can use the same printer or any other peripheral such as a scanner or plotter. These simple networks have no inherent structure or hierarchy: they consist of machines connected together. The network requires hardware: cables to make the connection; electronics inside the computer, perhaps on a card, to send and receive the data; and software, in this simple example the 'printer driver' which converts and sends the file to be printed to the printer.

Macintosh computers can be linked via an interface built into the computer as a standard feature. Here, building a network consists of the installation of simple cabling and connectors, to form a free-standing configuration which allows machines to share, for example, print facilities. This is an example of a *peer-to-peer* network, which is one of the two major types of network; the other is a *client/server* network.

4.1.4 Peer-to-peer networks

Peer-to-peer networks are the most simple way of connecting small LANs. There is no file server (a computer which is dedicated to management or storage of programs on a network) or centralized management. All users are considered equal. The network has the capability of allowing the users of particular computers connected to the network to communicate with each other directly, for example to share files or to

be connected to peripherals. The Macintosh OS provides this by making it possible for the user of one machine to see, for example, the contents of another machine's desktop. The disadvantage of this system is that as files are stored in many different locations, they are difficult to manage and protect.

4.1.5
Client/server networks

The next more elaborate network connects several machines ('clients') to each other via a 'server' (or 'file server'). The functions of the server include: making available files, applications, data or messages to the other machines on the network; monitoring the traffic on the network; and allowing or preventing access to it. This is an efficient use of a network for companies with ten or more computers as large amounts of information can be exchanged and data is easy to manage and protect. In an office or practice, the most important functions of this type of network are:

- to keep single working copies of up-to-date application programs for, e.g., word-processing and drawing for use by individual's computers
- to allow file-sharing, e.g. to enable members of a team to inspect the documentation or drawings of the job on which they are working or to get access to library information: catalogues, specifications
- optionally to provide one central store for all the files the office produces (although alternately the files individuals produce may be stored on their own computers)
- optionally to store a copy of an archive of all the files the office has produced

A LAN may be divided into 'zones' to make it easier to manage and to make it easier for users to find and communicate with another user on the network.

4.1.6
Temporary network

The ability of the user of a remote portable machine to connect via a telephone line to another desktop machine or network is an example of a temporary or ad hoc network and provides 'remote access' for the distant machine.

4.1.7
System manager

Any network requires someone to manage and maintain it: the 'system manager' or 'network administrator'. This job requires familiarity with the hardware and software; knowledge of what the users of the network do and what they need; knowledge of what the network can be expected to do and what it can't; tact in dealing with people who see themselves as 'creative'. The office must establish the respective

responsibilities of the individual user and the system manager. The system manager's job includes:

- maintaining the hardware
- maintaining the software required to administer the network
- maintaining the software the users need and keeping abreast of developments and software updates
- providing a 'help desk'
- managing archiving
- identifying and responding to users' needs

4.2
Connecting machines: hardware and software

The hardware for a network within an office, a local area network or 'LAN', or 'intranet', is similar to the simplest example, above: cables link the machines which may have to be equipped with cards to provide connections for the cables. The software has to supply the visible evidence of the network on the desktops of the various computers, to track and monitor the exchange of data between the machines, and it may offer degrees of authorized access to all the files or folders available throughout the network, allowing or preventing such files being altered or 'written to'.

The implications of network failure must be ascertained as this will affect the type of network to be chosen. The physical layout of the computers has an influence on the possible *topology,* that is the configuration of cables by which the computers are connected and the type of cables that can be used, these, in turn, affect the choice of *protocol*. A protocol is a set of rules that determines the method of communication between computers on a network; these rules dictate characteristics of the network, such as allowed topologies, types of cabling, speed of data transfer and access method.

Networks that rely on a file server may come to a halt if there is a fault on the server. Some configurations of cables are designed to minimize the effect of a cable breakage, whilst in others a broken cable may stop the whole network.

Some operating systems such as UNIX, AIX or Windows NT provide built-in networking, or 'multi-user' capabilities; others like Windows 95 or the MacOS need additional software to supply networking capabilities. Windows and Mac System 7 include software for peer-to-peer networks.

4.2.1
Layout and connections

The number and physical layout of computers should be determined and possible routes for cables considered. Cables vary in size and flexibility and have maximum distances over which a signal can be carried before it needs to be boosted. Decisions must be made about who needs to send what, to whom and how frequently, and should take into account expansion and future requirements.

4.2.2
Topology

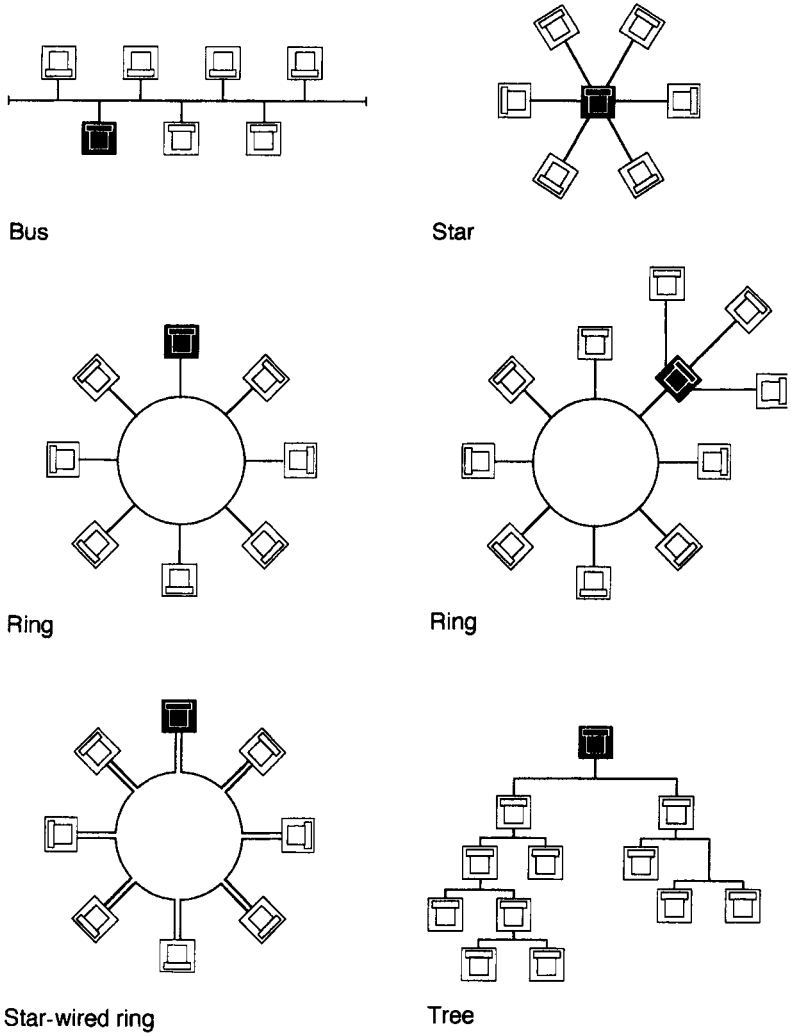
Technical references to networks list generic typologies as *bus, ring* and *star* and some include tree. Further investigation reveal more terms such as 'starwired ring'. Technology is moving very fast, so that products and the terminology used to describe them is bound to vary.

The most simple topology is the *linear bus*. This consists of a main run of cable (a 'backbone') with a terminator at each end. All computer terminals, the file server and peripherals are connected to the backbone. This need not be laid in a straight line. The advantages of this system are that it is easy to connect devices to the backbone and less cable is required than for other topologies. The disadvantages are that a break in the main cable causes shutdown of the system and that it is difficult to identify the problem when this occurs. The maximum length of the cable is determined by the access method, the speed of signalling and the type of cable.

In star topologies each *node* (file server, computer terminal, peripheral) has an individual connection to a central *hub* (see figure 4.1) a device through which all data passes and which controls the function of the network. Star configurations are easy to install and wire, it is easy to detect faults, and the removal of devices does not disrupt the network. The amount of cable required is greater than for a linear bus. If there is a fault in the hub the attached nodes are disabled.

If all the nodes are connected in a circle, without any one having overall control, the topology is a *ring;* if one node has control, then it is a *loop*. As each node is connected to the next the location of damage to the cable structure can be identified quickly. A *star-wired* ring may appear, externally, to be the same as a star, with each node connected to a multistation access unit (MAU). This device contains circuitry that allows data to pass from one node to another in a ring.

A *tree* topology consists of a number of star configurations connected to a linear bus backbone cable. Individual groups of computers can be wired separately, which makes it easier to combine different types of hardware and software.



4.1 Local area network (LAN topologies)

4.2.3
Cables and transmission media

Transmission over networks may be wire, cable or by terrestrial or satellite wireless. Office-based networks are likely to be connected by cable or wire, although it might be necessary to use radio or microwave links where cabling is impossible, say between adjacent buildings. Choice should be made based on the application, the speed requirements and cost. Delivery of 10 MB/s per person have been recommended by

a university network manager. The installation of cabling requires specialized tools and should be carried out by an expert. If the network is large, it may be necessary to employ a technician to maintain it.

- *twisted pair* cables come in two varieties: shielded and unshielded; the cable has four pairs of wires in a jacket; the quality may range from a telephone wire to high-speed cable (100 MB/s); unshielded (UTP) is more widely used in LANs as it is less bulky than STP; however, it is more susceptible to electrical interference; STP is used with Token Ring networks; maximum segment length is 100 m
- *coaxial cables* have a single copper conductor at the centre, which is separated by plastic insulation from a metal shield, all of which is encased in a plastic jacket; the cable is difficult to install, but gives much better protection against interference than twisted pair; thin coaxial cable is about the thickness of a pencil, and is suitable for runs of up to 180 m; thick coaxial cables, which are about the size of a garden hose, were used in the first Ethernet networks; they have an extra protective coating and do not bend easily; they are suitable for runs of up to 500 m and are useful as backbone cable
- *fibre optic* cable has a core of hair-thin glass (usually) strands surrounded by several layers of protective coatings; light signals are transmitted along the core, thus electrical interference is eliminated; transmission rates are about 100 MB/s and it is possible to transmit signals over long distances

Each of these types of cable requires special connectors specific to the cable. Cable layouts should be recorded so that installers of future extensions know what everything is and how, and to what, it is connected. Cables should not be made to turn through right angles and, apart from fibre optic, should be kept as far away as possible from sources of electrical interference. Heat sources may cause damage.

Wireless LANs use high frequency radio signals or infrared light beams to communicate between computer terminals and the file server. Each must be equipped with an antenna to receive and transmit the signal. Microwave dishes can be used for external links. These must be exactly aligned and may be susceptible to snow (cautionary tales about microwaved pigeons are unfounded). Wireless communication can also take place through satellite or cellular phone technology. These networks allow portable computers to be connected to a LAN, they are also useful in buildings where cabling is difficult.

4.2.4 Protocols

A protocol describes the way in which information passing through a network is handled: how it is transmitted by the sender, how it is handled while being transmitted, and how it is received. The most common of the available protocols are *Ethernet, AppleTalk, Token Ring* and *FDDI*.

FDDI (Fibre Distributed Data Interface) is used primarily to interconnect LANs over long distances. It operates on a dual ring topology, over fibre optic cable at speeds of about 100 MB/s. Token Ring networks work by passing a single token (identified piece of data) from computer to computer around the network. To send a file, a computer must wait for the token to reach it, attach the file to the token and return both the file and the token to the network. When the token reaches its intended destination the receiving computer or peripheral removes the file from the token which is then returned to the network so that the process can start again. All users have access to networked peripherals. This protocol requires a star-wired ring using twisted pair or fibre optic cable. It can operate at speeds up to 16 MB/s.

AppleTalk is a protocol that was developed for the Macintosh. Apple-Talk adapters and appropriate twisted pair cables can be used to connect a series of computers, through their serial ports, to establish a peer-to-peer network for which no further software is needed. A client/server network can be set up by the addition of the server version of AppleShare software. The protocol allows for linear bus or star topologies. The disadvantage is the low transmission speed of 0.23 MB/s.

The most widespread hardware currently used in networking small computers is Ethernet, the name of the cable and connectors used to construct the network. An Ethernet network is much faster than for example Apple's *AppleTalk,* and its basic requirements are now built in to many machines.

Ethernet was designed, originally, for coaxial cable using a bus technology. Its remaining defining characteristic is the access protocol. Ethernet systems are now available for bus, star or tree topologies and may be applied to twisted pair, coaxial or fibre optic cable. Speeds range from 10 MB/s to 100 MB/s depending on the topology and the cable.

There are two kinds of Ethernet cable in general use. Thin-wire' is a thin coaxial cable with which machines are connected in a line connected to a continuous cable with T-connectors. A single machine can be mechanically detached from the chain without disrupting the network, but if the main cable is cut then all the machines become disconnected. Adding a machine to the network is simple: the main cable just has to be extended.

The other type of Ethernet is called 10base-T, or twisted pair. This allows for other configurations of the main cable, for example a star and hub, but its connections are more expensive than those of thin-wire.

4.2.5
Network connections

To set up one of the configurations or topologies described above, machines must be connected to cables, and cables to each other. The devices needed to do this include:

- *concentrators/hubs* which pass signals from one device to another, sometimes with amplification
- *repeaters* which boost a signal as it passes through
- *bridges* which allow large networks to be divided into smaller segments; they can be used to connect between different topologies, but not between networks using different protocols
- *routers* translate information between protocols

4.2.6 Software

System software (network operating system) is the logical side of the network, and controls who can use it, when and how. There are two types of system, which operate either with peer-to-peer or with client/server networks. On peer-to-peer networks they use every computer as a server.

Early network operating systems (NOS), which ran on file servers, handled access to files and resources held on a single server; now they run on database or network servers and can provide memory management, network file systems and processing of tasks.

Commonly used software includes Novell NetWare, LAN Manager, AppleTalk and Windows NT.

Network databases

Particular forms of software have been evolved to handle communications on a network, and these may be useful for medium and large offices. The most well known is *Lotus Notes* which performs as a database for documents. The application allows users to send and receive messages or 'notes'. It will run with most established operating systems, Windows, Unix, Macintosh and OS/2, and can therefore be useful in providing seamless communications across a heterogeneous network. Running a network using programs like this, however, requires a skilled manager combining, as it does, the jobs of both system or network and database manager.

4.2.7 Network security

To protect the network it is usual to issue passwords to users, so that they can gain access to the appropriate files. Networks are a primary vehicle for the spread of viruses therefore anti-virus software should be installed on the system and updated frequently. Networks to which access can be obtained from outside should consider additional security measures, such as *fire-walls*. These can be routers that check and filter traffic.

4.3
Connecting people: communications

4.3.1
Modems

Computers can be linked together temporarily via ordinary phone lines when with appropriate software they can behave like an ad hoc network. The small piece of equipment which connects the computer to the phone socket is called a 'modem' (MOdulator/DEModulator) which may have been supplied with and built into the computer or which may be attached to its outside between the machine and a phone socket. It translates the digital impulses of the computer signal into the analogue impulses used by the telephone system and vice versa. The rate of transmission of a modem is expressed in Kilobits per second, Kbps; the current fastest modems which work with ordinary telephone lines have speeds of 33.6 Kbps, and the next generation under development have speeds of twice this. For both internal and external modems there are several transmission rates, it should be possible to set these appropriately as most modems have three or four standards built in.

Computers so linked can be used to exchange messages ('e-mail', 'e' for 'electronic'), or to send or receive fax files. It is possible to link two machines together so that each may inspect the contents of the other's desktop.

Remote access

With a modem and appropriate software it is possible for a user to connect their computer, usually a portable, to any telephone and communicate with the practice's computers or network. They may use this facility to exchange messages, or to consult files to look something up, or to modify files, to change or add information to a file.

4.3.2
ISDN

Exchanging large files like drawings via ordinary phone lines is slow, and a large job may warrant the installation of a dedicated fast digital phone line (ISDN or Integrated Services Digital Network) which can transmit data at up to 64.4 Kbps or 1 MB per minute. A line installation from BT costs about £200, but tariffs are complicated and a two-channel card to connect it costs about £ 1000. A line rental will also be charged, the most expensive at about £1000 per month being for a leased line which provides constant Internet access.

The installation may at present be too expensive for the small or medium office, but ISDN is currently used by large offices to communicate with distant satellite offices or clients.

4.3.3
E-mail

If a practice subscribes to a service provider (SP, Service Provider; ISP Internet Service Provider; or AP, Access Provider) such as the internationally marketed CompuServe or the UK's Demon, or is attached to a large institution such as a university, they can exchange e-mail messages with someone else with similar equipment, either within a practice or outside it. Within a practice, e-mail is now frequently used as a replacement for memos and messages and documents formerly circulated on paper.

For messages sent outside the practice but within one country e-mail has no particular advantage over voice or fax messages except that the call time is charged at local rates, but it may have considerable benefits when used to communicate with a distant country, or where the volume of traffic is high. E-mail messages at present contain no formatting information, although a suggested standard for such information is being prepared.

In addition, the appropriate software makes it possible to 'attach' one or more computer files to an e-mail message. Whether the recipient can make use of the attached file depends on the compatibility of the sender's and receiver's operating systems and software. If these are compatible, then e-mail may be quicker and therefore more economical than sending the same document by fax.

4.3.4
Bulletin boards

Computer users with modems are able to dial into bulletin board systems, which may require registration and which may be free. A bulletin board is a location where users can exchange messages, post notices and upload and download programmes. The additional cost to users is the telephone connect time. The RIBA has set up a bulletin board called RIBANet. Registration is required. This is free to RIBA members and £80 to others. At the time of writing, there are very few subscribers. Information services and commercial databases are accessible to subscribers in a similar way to bulletin boards.

4.3.5
Intranets

An intranet is a network set up to serve one organization: it may be a LAN or, if the organization is spread over a series of locations, a number of linked LANs. Special applications, such as *Lotus Notes* are available to manage such networks. Intranets use the same browsers as the Internet on LANs. As the use of browsers becomes more common, the distinction between an intranet and the Internet becomes blurred,

eventually residing only in the provisions for the privacy and security of transmitted or stored information.

4.3.6
The Internet and the World Wide Web

One LAN can be linked to another which may be in another city, or another country, via a 'gateway', an electronic switch. Such networks can further be linked into arbitrarily complex arrangements of which the Internet is the largest so far.

The Internet originated as a network designed to provide communications between universities and research institutes working on defence contracts in the United States. Information transmitted on it is text-based, and its original UNIX-based interface required the use of an unintuitive command-line to use it. Access to the Internet can only be gained via a commercial service provider: the same service described in section 4.3.3. The Internet has grown by agreement: it is ramshackle and has no formal structure and no controlling agency, and the reliability and comprehensibility of, say, the international telephone service cannot be assumed. In order to search the net, a user needs text-based navigation tool software, such as *Gopher,* which allows keyword searching of electronic databases.

The World Wide Web started as an offshoot of the Internet, but uses a graphic interface and could at first transmit graphic information and now sound and movies. To use the Internet and get access to the Web requires the use of a software 'browser' such as Netscape's *Navigator; Mosaic; WinWeb* or Microsoft's *Internet Explorer*. The user gains access to 'pages' of information residing on servers which may be anywhere in the world. Each server and page is Identified by a unique 'address' or URL (Universal Resource Locator) which begins with 'http://', and access to this can be either by typing the rest of the address or, if the page is written using HTML (HyperText Markup Language), by following 'links' from one site, address or page to another.

The development of the Internet and World Wide Web has been explosive, and there are now doubts about whether the infrastructure will be developed fast enough to meet demand: there is a clear analogy with roadbuilding programmes where the building of new roads stimulates an increase in traffic. It is not clear who should fund such development or if satisfactory mechanisms for charging for its use can be devised. The effect of growing use is to slow down access and transmission times making communication unreliable: overuse has occasionally crashed service providers' computers.

All universities and most government departments, organizations and commercial companies are developing Web sites. There is so much information it is often difficult to determine which is accurate and which is useful. Using a keyword search for a particular topic can produce thousands of references, only a few of which are

relevant. At present, it is possible to obtain information about news, current events, entertainment, government, the arts, science, medicine, industry and commerce.

A practice might use the Internet and World Wide Web in at least three ways:

- as a *source* of information: many professional bodies such as the RIBA, government agencies, manufacturers and libraries have WWW pages which give access to information, codes and standards
- to *exchange* information with, for example, clients, other consultants, contractors and subcontractors
- to *publish* information such as marketing material

4.3.7
Information sources

Information provided by professional bodies or government agencies may be more up-to-date than its equivalent printed form. Some agencies may charge for access to the information either by subscription or by time charge. If the source of information is unknown, 'search engine' software can be used to produce a list of references. Practices with jobs abroad may find otherwise unobtainable information from the web pages of organizations and agencies in the visited city or country.

The RIBA has set up a web site; the address is **http://www.riba.org** and RIBA Companies have a site at **http://www.ribac.co.uk.** The Yorkshire Region of the RIBA established the first RIBA site at **http://www.demon.co.uk/yorkriba.** The contents of these sites are (or will be) useful not only to architects but to members of the public wanting to find out about or appoint an architect, either on the basis of region or specialism. All of these sites provide hypertext links to sites with related relevant information, such as the Construction Industry Gateway (CIG) and the Building Information Warehouse (BIW).

4.3.8
Marketing on the Internet

The smallest practice might consider setting up a site on the Internet which at its humblest would be the equivalent of a 'shop window' or an entry in a practice register or the Yellow Pages. It may seem doubtful whether the predominantly young, well-educated and well-off Internet users at present include many potential clients and patrons (in Europe in 1996 half the users were between 18 and 29 years old, 1. 1% between 50 and 59), but the way in which large telecommunication companies are now selling access to the Internet to businesses suggests that it may eventually. Establishing a WWW site and combined e-mail address with a service provider need be no more expensive than other forms of small scale advertising, and no print medium has the equivalent of the Internet's worldwide coverage. If a practice decides

to set up a site and e-mail, then these addresses should be included as part of the practice's logo or letter-heading, and should always be cited along with the postal address and telephone number.

Practice name
Postal address:
Telephone number:
Fax number:
World Wide Web: http://www.a.practice.co.uk
email: a.practice@service_provider.co.uk

While programs exist which allow an individual to set up an Internet site, learning how to do it properly will be time consuming: it is better to employ a specialist firm to do this. The simplest site might consist of the equivalent of the practice's printed brochure and include both text and pictures, and contact details, and might go on to invite a user to ask for more information via phone or e-mail. A small practice which finds itself daunted by the difficulty or expense of setting up on the Web might consider combining with others to develop a site, or to develop a local chapter or regional site.

The information on a site and its style should form part of the practice's general marketing strategy: the World Wide Web is just another medium.

A site should be appealing but simple, and any information it contains should not take a long time to download: attention spans are limited and the whole process of access already takes too long.

A site must be kept up-to-date: a job for the office's marketing person.

There are companies that offer Web services to architects, and will design and set up Web pages and provide space on the Internet. It is usual to charge a fee for the design of pages and rent for the space. The following list of companies that provide such services is taken from *RIBA Connect,* November 1996.

7.Net	http://www.seven.net.co.uk
Archinet	http://www.archinet.co.uk
CocoNet	http://www.coconet.co.uk
Mark Pringle's Web site	http://www.pringco.co.uk/pringco
Slumbering Giant	http://www.giant.co.uk

4.3.9
Internet telephone services

Some firms offer the equivalent of rudimentary telephone conversations using the Internet and a browser as interface. The sender's and receiver's computers must of course be equipped with microphones. The technology is not very developed, but the main advantage is that international calls will only be charged at local rates.

4.3.10
Conferencing

Some large practices with jobs abroad already use 'conferencing' where the participants in a 'meeting' are in different places but linked by sound and vision via computers linked by ordinary phone line or other means such as satellites. While such arrangements are at present cumbersome and very expensive, their cost may be offset by savings in time and the costs of travel and accommodation. The simplest conferencing facility makes huge demands on computer hardware which must be large and fast. Primitive software is available for setting up simple text-based 'conferencing' using the Internet, and more sophisticated software is being developed to link the output from miniature television cameras to conference software. 'Whiteboarding', the ability for users remote from each other to 'draw' or sketch on the same window, is becoming available as an adjunct to conferencing.

5
Futures

5.1
Introduction

The future of computing in architectural practice is difficult to predict; 'cultural lag' determines that people and their ways of working tend to change more slowly than developments in information technology. It is also difficult to guess which technical developments will be adopted, as this depends on a large number of factors including chance, timeliness and market forces. It is not always the most attractive, clever or innovative systems that succeed to become the *de facto* standards for however short a time. The floppy disk for example, in spite of its comparatively small storage capacity, continued to be used for at least ten years and has only recently been challenged by devices with up to a hundred times the capacity.

5.2
Students and education

Many students considering university courses now make their initial choice of institution by investigation of Web pages. An increasing number arrive with their own computers. All students expect, and most now have, their own e-mail addresses. As libraries are short of finance and the latest editions of books are not available on demand, much up-to-date information is obtained from Web sites rather than from literature. Universities are providing access via networks to external information sources. Local networks, or intranets, provide access to lecture notes, noticeboards and local information sites. Student coursework is wordprocessed and frequently sent by e-mail to the tutor.

Students of architecture make even greater demands. They expect to be able to take advantage of the most up-to-date technology; to be able to experiment with visualizing buildings; to produce animations; to predict the performance of their virtual buildings. Economic constraints are leading to institutions providing networking, peripherals and software, but expecting students to have their own computers.

Several schools are experimenting with the virtual crit or tutorial. Video conferencing between students or tutors or both is expensive but increasingly commonplace.

Students expect to be able to produce their portfolio on a CD-ROM and to be able to e-mail seductive parts of their portfolio to prospective employers. (What the prospective employers will think about a proliferation of 'junk' 'e-mail is open to conjecture.) In some universities students have their own Web sites. Students now leaving universities have used computers and expect to continue to use them in increasingly innovative ways.

5.3
The client and the construction industry

The future of computers in architectural practice is bound up with the future of the profession. It seems likely that the 'curdling' of the profession into very large, both capital and labour intensive and increasingly international practices on the one hand, and small one or two person practices on the other will be accelerated by the use of increasingly more powerful computers.

Clients, especially corporate ones, are becoming increasingly demanding, but whether any new ways of commissioning, designing or producing buildings will emerge soon as a result of ever more powerful computing power is uncertain. The development of software that allows unambiguous transfer of data between those involved in design and construction has been slow, mainly because of conflict of interest, questions about the ownership of data, indemnity, the confrontational nature of the 'traditional' procurement process and the professional identity of those within it. Work is in progress on 'Industry Foundation Classes', data 'objects' which can contain all the information about a given component or assembly in a standard form. Both research teams and industrial consortia are trying to develop models of the process in which all the information about a building, both graphic and of specification and quantities can be contained within a single relational database in the hope that this can be contributed to and interrogated by client, consultants and contractors. Who would own and administer such a database is at present still open. It is probable, however, that any benefits from the integrated model approach will be more than offset by the increasingly numerous and cumbersome layers of computer-aided 'project management' which corporate clients employ. The speed with which any industry-wide model might be adopted, if ever, is uncertain. Whatever happened to SfB?

In the manufacturing industry, prototypes are built and tested before they are commissioned. In the construction industry, the designer must convince the client of future reality. Much research by the multinational defence, entertainment and games industries is making the possibility of Virtual reality' at least available to consumers, although preparing the material for such 'worlds' is no more easy than making a physical model. Clients, clearly, need the best possible prediction of how a proposed

building will look and feel, how long it will take to be completed, how much it will cost and how it will perform. The relative certainty of developers' 'pattern book'architecture which the widespread use of computers encourages is perhaps a reason for its ubiquity.

In the UK, the Department of the Environment, BT, some major contractors, architects, academic institutions and other bodies are involved in research into the identification of IT technologies that will promote changes in the procurement of buildings. The aim is to improve customer satisfaction, project communications, the building process and the performance of completed building.

It would be possible to produce an integrated 'object-oriented' project model which would be common to, and worked on by, all those involved in the design and construction of a building. The model would become an electronic prototype. It would be built of components selected from a construction industry common database and using it would inhibit the consideration of tailor-made or crafted components. This would have the effect of bringing design and construction together and require the early involvement of suppliers and manufacturers. The need for paper drawings would be reduced, and the nature of drawings would change to become assembly instructions. Construction sites would become assembly sites.

An attempt at such a process is the Genesis project for the British Airports Authority, where contractors, architects and suppliers are working on Heathrow, Terminal 5. The eventual outcome will be interesting.

The notion of 'who is the designer?' will change fundamentally. The person who has overall control of the model will have overall control of the project: the 'model master'. This *could* be the architect.

Doom-mongers argue that there will be no more architects and that the industry and the environment will be taken over by design and build companies, who will 'walk' clients through generic building types, alter them in real-time, allow the client to choose fixtures and finishes, and provide accurate costs and order components from suppliers.

5.4
On the other hand

One role of the architect is to have new ideas, to create visions of the future and new ways of living, and to redefine the possible. The same technology that may seem to threaten the role of the architect may serve to enhance it by allowing designers to imagine and experience new 'virtual' realities and then to realize them.

The design process developed by Frank O.Gehry, originally based on physical modelling in a range of scales up to the full-size mock-up now uses expensive computing facilities beyond the means of most small and medium sized architectural practices. Gehry works with complex geometric shapes which are sketched and then developed by the manipulation of physical models. These models explore both the

sculptural and functional aspects of the project in a medium which is understood by both designers and laypeople. Until 1990, one of the main difficulties in the transformation of three-dimensional shapes into buildings was the reliance on two-dimensional drawings. Gehry's staff used to measure models and prepare laborious, time-consuming and costly drawings which were difficult for contractors to interpret accurately. After a search for suitable software the practice chose IBM and Dassault's *CATIA-CADCAM* (Computer-graphics Aided Three-dimensional Interactive Application/Computer Aided Design, Computer Aided Manufacturing). This system could define surfaces using geometric mathematical formulae. The design model was scanned using an optical digitizing system, the resulting *x, y, z* co-ordinates were fed into CATIA. The surfaces could be rationalized to achieve repetition without the sacrifice of form. A physical model could then be milled, using CAD/CAM, that was the compared with the cardboard original and adjusted where necessary. The output from CATIA can be used by steel fabricators, component manufacturers and builders. Everyone works to the CATIA model, and the practice thus increases its responsibility.

Gehry says 'If I do a lot of buildings with curves, and people enjoy them, then clients will begin demanding them, and more architects may follow' (http://www.catia.ibm.com/custsucc/sufran.html).

5.5
Likely developments in hardware and software

5.5.1
Equipment

Of the equipment that the smaller practice can afford, the following predictions can safely be made:

- CPUs will get faster, their abilities matching those of today's workstations; more may incorporate multiple processors
- the boxes housing equipment will become smaller
- memory will get cheaper and computers will need more of it
- the flat displays at present used in portable computers may become widespread on the desktop and as affordable and as bright as CRTs; alternatively, these may be superseded by projected video displays
- the capacities of hard disks and other storage media will increase
- printers may reach the 2500 dots per inch resolution of current professional imagesetters, and will then need very large amounts of memory to hold the images and very fast processors to drive them
- peripheral buses will become faster and new standards will emerge, e.g. SCSI 2 and 'Firewire'

- mice may be superseded by wireless, remote, pointing devices
- headsets developed to allow immersive experiences while playing computer games may find incidental uses in displaying models of architectural proposals
- the 'network computer' (what we used to call the 'dumb terminal' with no internal storage and getting its software from a remote server or from the Internet) may replace the more expensive PCs presently used in larger organizations

5.5.2 Operating systems

Operating systems may become based on the Internet so that the user's desktop is the World Wide Web, and every personal computer is linked to the Internet. Such OSs will contain the facilities for these connections. Alternatively, and for single users rather than groups, practices or offices the 'network computer' which may become widespread would not need the apparatus of a conventional operating system. It would download applications on demand from a remote server and its user interface would consist of a version of today's 'browsers' such as *Netscape*. Such a service assumes in addition to ownership of the machine, providers whose subscribers would have to pay for the service.

5.5.3 Input

Voice input using microphones and software that can convert speech to text may become common both for dictating text and for controlling computers, possibly largely replacing the keyboard as a method of text entry. It may though always remain difficult or cumbersome to render instructions about the elements of a drawing in anything like natural language.

5.5.4 Software

For the main tasks which architects carry out, it is unlikely that any new paradigms or metaphors will be invented, but the drawing may be superseded as one of the main means of exchange of contract information.

The attempt to develop 'component' or 'document-centred' software, small programs which do particular tasks but which can work together and share information between each other, may be successful and evolve to replace today's very large single-purpose programs.

5.5.5
Networks and communications

The Internet may become the main channel for all communications in all media: correspondence, files containing graphic information, voice messages. At present no one knows whether the continuing development of the Internet and World Wide Web will completely change the way the developed world goes about its business, so that it may no longer need either new buildings or architects to design them, or whether the Web will collapse under an increasing weight of traffic and soon go away like Citizens' Band radio. Its slowness and different display standards may always prevent its integration with the domestic television set. Alternatively, it may develop into another utility with providers who charge for their services and subscribers who pay. A new tax on the transfer of information, a 'bit tax', has been proposed by a radical Dutch economist. This would augment the otherwise declining tax base of the developed economies, and capture the multinational companies who can at present arrange their tax affairs to pay least.

Although the western world is being equipped with underground cables which will enable the high bandwidth communications the Internet really needs, wireless communications may prove crucial in the development of the Virtual practice' in which the members of the practice or project team need never meet face to face: they can communicate by computer, modem and phone line, from wherever they happen to be, including their homes. For this vision to be realized, machinery and the telephone system would have to have achieved unlikely levels of portability and reliability. The recent development of the combined mobile telephone and 'palmtop' computer suggests, however, that powerful manufacturing interests are working to make it happen.

5.6
What we should like to see

Developments the authors would like to see include:

- true working compatibility between software and hardware
- properly written and edited manuals which do not need a month to decipher
- a windows-type interface that is consistent, easy to operate and even more 'transparent' than the Mac OS or Windows
- thin display screens which could be laid flat instead of vertically and which could then be used more like paper, perhaps with a pointing device applied to the screen
- from the broadsheet newspaper correspondents of information technology, less reckless descriptions of what computers are likely to be able to do and clearer descriptions of what is actually possible
- fewer wires and simpler connections between machines and peripherals
- reliable 'plug and play'

- 'filters' on the World Wide Web: not censorship, but better searching and indexing: the capabilities provided by a good research assistant carried out by a software 'agent'
- better industrial and graphic design, and machinery available in colours other than beige or grey, perhaps the range in which cars are at present obtainable: racy red, smart silver, and why not pink?

Appendix A
Glossary

2D	two-dimensional, applied to drafting systems
3D	three-dimensional, applied to modelling systems
8-bit, 16-bit, 32-bit	the size of 'word' handles by the CPU; a measure of the precision at which the CPU works and the amount of memory it can address
68020, 68030, 68040	Motorola's names for its processors, now superseded by the PowerPC range 603, 604 etc.
8088, 8086, 80286, 80386, 80486, Pentium (80586), Pentium Pro (80686)	Intel microprocessors used in PCs: the higher the number, the faster
ACIS	American Committee for Interoperable Systems: originators of a widely used object-oriented standard for 3D modelling in CAD/CAM
Address location	where data is stored in memory
Algol	a programming language for scientific applications
Algorithm	a list of instructions for the solution of a specific problem
Alphanumeric	the twenty-six letters of the alphabet and the numeric digits 0 to 9
ALU	arithmetic and logic unit: the part of the processor that does the 'thinking' and counting
Analogue (US analog)	a smoothly changing physical state which can be used to measure another (like the hands on a clockwork watch)
Animation	making moving pictures
Applications software	software produced to carry out specific tasks, e.g. word-processing
ASCII	American Standard Code for Information Interchange: 256 unique identifiers for alphanumeric and other symbols
Assembly language	a low-level language which converts a programming language to machine code
ATM	Asynchronous Transfer Mode (communications)
Back-up	copies of software and data kept for security purposes
BASIC	Beginners' All-purpose Symbolic Instruction Code: one of the most commonly used programming languages for non-specialist applications
Batch	data which is processed in one go

Baud rate	the rate at which data is transmitted between computers or via a modem (not the same as bits per second (bps)); V21 is 300 baud, V22 is 1200 baud, V22 bis is 2400 baud
Binary	a number system based on powers of two, and using two digits, 0 and 1; e.g. 10 in binary=2^1=2 in decimal; 1000=2^3=8 in decimal
Bit	Blnary digiT: the smallest unit of information
Bit-map	a way of recording images (pictures) in digital form which gives a description of every pixel (picture unit) on the screen
Block	a group of data items or instructions transferred as a whole; in word-processing and DTP a piece of text identified and in one format; in some drafting a group of entities
Board	a circuit board or ‘card’ on which computer components are mounted; extra boards can be added to the expansion slots in a computer to improve storage or performance, or otherwise enhance its capabilities
bps	bits per second: a data transfer rate; see also Baud rate
Brown-out (US)	a voltage drop in mains electricity
Buffer	an area of memory which acts as temporary storage space
Bug	a fault in software or hardware
Bulletin board	an electronic noticeboard that is accessed using a modem
Bus	a ‘route’ along which data is transferred between the various parts of a computer; also a type of network topology
Byte	eight bits
C	a programming language commonly used in conjunction with the UNIX operating system
C++	an object-oriented version of the C programming language
CAAD	Computer Aided Architectural Design
Cache	an area of temporary memory reserved to store frequently used instructions for the CPU
CAD	either Computer-Aided Drafting or Computer-Aided Design
Card	see Board
Cassette	a slow and obsolete data storage medium similar to an audio cassette; may still be used in old home computers

CD-ROM	Compact Disc—Read Only Memory: a compact disc which a computer can write to or read from
Cell	a unique area of a spreadsheet where data, text or formulae can be inserted
Centronix	a proprietary name for a commonly used connector; a parallel interface
CGA	Colour Graphics Adapter: the first colour graphics standard produced by IBM for screens used with the PC
Character	the smallest addressable block of information processed as a unit, usually 8 bits
Chip	a small slice of silicon or other material on which a circuit has been printed
CICA	Construction Industry Computer Association: an independent consultancy based in Cambridge
CISC	Complex Instruction Set Computer; *c.f.* RISC
Clock	a quartz crystal whose oscillations control the speed, measured in MHz (megahertz), at which the central processor operates
Clone	a computer that is meant to be 100% compatible with a standard
COBOL	COmmon Business Oriented Language: a programming language for business applications
Code (vb and noun)	the activity of coding, making lists of instructions; the results of such activity
Column	a vertical column of cells on a spreadsheet; a vertical column of text in word-processing or DTP
Communications	the means by which computers can communicate remotely
Compatibility	the ability of computer systems to work together; the ability to transfer data from one computer or peripheral to another
Compiler	a program which converts high-level languages into machine code
Consultant	someone who professes computer expertise and is paid for their services
Control	unit the part of the central processing unit which controls its operations
Co-processor	a second CPU added to speed up a computer's performance
Copy	a function in computer software which allows software, text, drawings or files to be replicated

CP/M	Control Program for Microcomputers: one of the operating systems commonly found on 8-bit machines
cps	characters per second, one measure of the rate at which printers print
CPU	Central Processing Unit: the part of the computer which does the 'thinking'; contains a control unit, arithmetic and logic unit; usually mounted on a 'motherboard'
Cursor	cross-hairs, flashing dot, or other symbol on a screen which enables points to be located
Cut and paste	to delete part of a document and insert it elsewhere
Daisy wheel	a type of printer where letters are produced by the impact of characters arranged around the spokes of a wheel against a ribbon to produce letter quality output, but no graphics (obs)
Data	information in digital form
Database	an electronic filing system which allows files to be cross-referenced and searched
Data glove	an input device which allows hand movements to be digitally encoded
Data helmet	an output device, an alternative to a monitor, which presents small images to each eye and an input device which may allow eye movements to be detected
Data Protection Act	legislation under which computer users should register if they keep personal details of individuals on a computer system
DBMS	DataBase Management System: software which allows a database to be set up and operated
Debug	search and destroy bugs
Denary	the decimal numeric notation: the one with which we are all familiar
DIF	Data Interchange Format: one of several formats which allow data to be transferred between different databases
Digital	consisting of or operating with binary digits
Digitizer	a flat tablet which allows digital transfer of points, and thus lines, (vectors) to a computer
Directory	a collection of files on a computer system
Disk	(not 'disc') a storage device: data are recorded as magnetized spots on concentric rings called tracks
Disk drive	a mechanism for reading data on disks
Dongle	a hardware device to stop software (programs) being used by unauthorized people or those who have not

	paid for it; dongles may be plugged into one of the computer ports
Dot matrix	a type of printer where characters are formed by impact, by heat, or electrostatically from an array of pins
Drafting system	a computer system for drafting
DRAM	Dynamic Random Access Memory
Drum plotter	a plotter, usually A1 or A0, where the paper rolls over a drum and the pens move from side to side
DTP	Desktop publishing: software which allows pages of text and illustrations to be set up with full typographical control
Duplex	duplex data transmission between computers means that data can be transmitted in both directions simultaneously
DXF	drawing exchange format: one of several formats for the transfer of drawing files
EDM	Electronic Document Management
EDO RAM	Enhanced Data Output Random Access Memory
EGA	Enhanced Graphics Adapter: the improved version of CGA, gives a screen resolution of (typically) 640×350 and an enhanced palette of colours
E-mail	electronic mail: transmitted directly between computers without a paper version
Entity	a file in some databases; a drawing element in some drafting and modelling systems
Expert system	a program which allows a body of information to be built up within a system which can the be interrogated logically; used for, e.g., medical diagnosis
FAQ	Frequently Asked Question(s)
Field	area of data within a record (database terminology); category of information
File	a collection of related data stored or handled as a unit
Filer	an electronic card index containing a number of records (cards) and which can be searched by field (category of information required)
Firmware	software that is built into a computer
Fixed-point notation	numbers expressed as digits with the decimal point in the correct place, e.g. 162.34673; the number of digits handled in fixed-point notation is limited by the computer; see *also* Floating-point notation
Flat-bed plotter	a plotter on which a number of pens produce drawings on a horizontal sheet of paper; sizes vary from A3 to A0

Floating-point notation	(Scientific notation): numbers are expressed as a fractional value (mantissa) followed by an integer (exponent) of the base, e.g. 472100 could be expressed as 0.4721×10^6 or 0.4721 E6; this enables very large numbers to be expressed with a limited number of digits; clearly there is some loss of precision; see also Fixed-point notation
Floppy disk	a storage medium used by microcomputers and minicomputers; disks are commonly 3-inch, 3.5-inch, 5.25-inch and 8-inch, single or double sided, single or double density; they must be the correct size and formatted for use on a specific computer
Flow chart	a chart which shows the logical sequence of processes or events; used in programming and in project management
Font (fount)	the computer user's name for a typeface: a size and style of lettering, e.g. Times 12 pt or Helvetica 8 pt, etc.
Foot print	the space computer kit takes up on a surface
Format	the way in which data is organized; the process of organizing a disk so that it can be read by a particular computer; formatting a disk destroys all existing data
Fortran	FORmula TRANslation: a programming language for scientific applications
G	Giga=1 000 000 000
Gantt chart	a bar chart which shows the relationship between tasks and timescales; used in project management
GEM	Digital Research's Graphic Environment Manager: uses screen menus and icons
Glitch	a surge or spike on the mains electricity supply which may cause loss or corruption of data in active memory
Graphics	drawing and production of pictures rather than drafting
Hacker	an expert and dedicated person whose hobby it is to gain access to other people's computers: usually harmless unless careless, malicious or criminal
Hard copy	paper copies of data that has been produced on a computer
Hard disk	a non-removable disk inside the computer or in a separate external unit)
Hardware	all the physical computer kit
Head	a read/write device for transferring data to and from a disk, analogous to a pick-up on a record player

Head crash	a mechanical or electronic failure, where a disk's read/write head damages a disk or corrupts data on it
Hertz	a measure of frequency measured in cycles per second, used as a measure of clock speed: e.g. Hz, KHz, MHz
Hex	hexadecimal notation: numbers are expressed to a base of 16:1 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, 10, etc; e.g. '11' in hex is '17' in denary, '100' hex is 16^2 ='256' denary; this notation is useful in computer programming
High-level language	an English-like programming language
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
IBM	International Business Machines
IBM compatible	a computer that should be able to run the same software as an IBM PC
Icon	a picture of that which it represents: used in GUIs to indicate objects such as applications, files or printers
IGES	Initial Graphics Exchange Specification: a format for the transfer of drawing files
Information	anything with a defined meaning
Ink jet	a printer where characters are formed by spots of black or coloured ink
Input device	a device for converting information to digital signals
Integer	a whole number
Integrated circuit	an electronic circuit transferred by chemical and physical means to the surface of a silicon chip
Integrated design system	a suite of interactive programs allowing a range of drafting, modelling and forecasting
Integrated package	a software package combining several different applications, commonly word-processing, database, spreadsheet, graphics and communications
Interface	a boundary, physical or logical, between two physical or logical systems; e.g. a person and a computer
Interference	electrical or magnetic fluctuations, or radio signals disturbing the proper operation of a computer; signals caused by a computer that disturb other electrical equipment
Internet	an anarchic and uncontrolled agglomeration of connected LANs
Interpreter	a program which translates a high-level language, line by line, into machine code during the course of operation

Java	a programming language developed by Sun Microsystems for use with the Internet and which will run on many different platforms
Joystick	an input device which allows movement of a control through 360 degrees and usually used for games
JPEG	Joint Photographic Expert Group: a compression format for bit-mapped images
K	Kilo=1000
Keyboard	the most common input device, resembles a typewriter keyboard with extra, often programmable, function keys
LAN	Local Area Network: computers that are physically joined together on the same site or neighbouring sites
Languages	sets of grammar and syntax used to write programs
Laser disk	a high-capacity storage disk which is read using a laser
Laser printer	a printer which works on the same principle as a copying machine: the quality of output (up to 1200 dots per inch) is currently better than other printers
Layer	used to categorize information in a drafting system (known also as a 'level' or 'view')
Library	stored, organized information or data
Light pen	an input device for locating points on the screen of a VDU
M	Mega=1 000 000
Machine code	binary code: the lowest-level programming language
MAC OS	Apple's Macintosh Operating System
Macro	a program that reduces a commonly used series of instructions to a single command
Mail merge	a way of producing standard letters with varying addressees or paragraphs, e.g. addresses (word-processing terminology)
Mainframe	a very big computer supporting many users who share data
Maintenance	the upkeep of hardware and software: this will probably cost 15% of the capital cost per annum
MAN	Metropolitan Area Network
MCA	Micro Channel Architecture: an internal design used by IBM in its PS/2 range
Megabyte	10^6 bytes
Memory	the 'space' in the computer where data are temporarily stored, problems are handled and solved, 'RAM'; the contents of this active memory are lost

	when the computer is switched off; may specify the capacity of storage devices
Menu items	commands shown on a screen for selection by a cursor or key-stroke
Microcomputer	a stand-alone computer; microcomputers cannot share data unless networked
MIME	Multipurpose Internet Mail Extensions: a way of specifying what sort of data is being transmitted via the Internet or e-mail
Minicomputer	a computer larger than a microcomputer which can share data and which can support a number of users
M-JPEG	Motion JPEG (Joint Photographic Expert Group): a compression format for moving images
Modem	Modulator/DEModulator: a communications device which converts digital data to analogue signal and vice versa on telephone lines, allowing communications between remote computers
Motherboard	the board within the computer on which the CPU and other components are mounted
Mouse	an input device which moves the screen cursor in relation to its movement on a horizontal surface
MS DOS	Microsoft Disk Operating System: an operating system
Multi-tasking	the ability to load and run several programs. simultaneously
Multi-user	a computer system or network that can be used by more than one user at the same time
NCC	National Computer Centre: independent consultants, based in Manchester
Network	two or more computers linked to share data or peripherals
Notation	ways of representing numbers
OCR	Optical Character Recognition: the function of a program which receives scanned or faxed text and processes it into a computer-editable text file
OLE	Object Linking and Embedding: Microsoft's name for its method of allowing data to be shared by applications and moved from one application to another
OLR	Off Line Reader: program used to download information from a network while connected to it, and then to read the information when disconnected
Online	directly connected to a computer system

Operating system	program or programs by means of which the method of operation of a computer is organized; it is usually bought with the computer and installed by the supplier
OS/2	an operating system developed by IBM to run on 80286(AT) and 80386 based machines; will support multi-tasking
Outage (US)	a mains power failure
Output	data which comes out of a computer
Output device	a piece of equipment which converts digital data from a computer to a form which is understandable; this may be transitory on a VDU, stored on a disk or produced as hard copy
Paddle	an input device used for games
Paint	the ability to colour areas of the screen selectively; a program which enables this
Parallel data transfer	8 bits at a time
Parallel port	a plug or socket which allows data transfer in parallel
Parity	(communications terminology) an error check when data is transferred; an extra bit is added to each character in binary notation so that the sum of the Is in the string is always even or always odd
Pascal	a programming language named after Blaise Pascal and devised by Nikolaus Wirth
Path	the route from the top directory of an operating system's filing system via sub-directories to a file; the complete name of a file
PC	personal computer: an IBM clone
PC-DOS	an operating system: IBM's version of MS-DOS
PDA	Personal Digital Assistant: a very small hand-held computer useful for taking notes, making calculations, scheduling and, optionally, communications
PDL	Page Description Language: software used by laser printers and some others to describe a full page of illustrations and text
Peripheral	hardware devices connected to a computer
PERT	(project management) Program Evaluation and Review Technique: a PERT chart is used for project planning and critical path analysis
Photo-CD	Kodak's name for its proprietary method of recording digital photographic images on a CD
Pitch	(word-processing and DTP) the spacing of printed characters

Pixel	picture element: one of the dots which makes up a screen image; the smallest piece of graphic information
Point	(word-processing and DTP) the size of a printed character; 1/72 inch
PRAM	Parameter RAM: maintained by battery power and containing information which the computer needs on start-up such as the date and time
Primitive	(draughting and modelling) one of the basic elements from which a drawing or model is built up
Printer	an output device which can produce text and/or graphics
Program	a set of instructions for a computer
Programming language	a code to convert a logical problem to one which can be handled by a computer
Proportional spacing	(DTP) spacing of characters that takes account of the actual width of each letter; as opposed to 'monopitch' where each character occupies the same width
PS/2	IBM's range of personal computers using microchannel architecture and intended to support the OS/2 operating system
Public domain software	software that may be distributed freely; should be used with care as it is an easy way to spread viruses
Quality Assurance Criteria	set out in BS 5750; a management process to provide reasonable assurance that the services or product to be provided are in accordance with predetermined standards, and will reach those standards
QWERTY	standard keyboard layout in English-speaking countries, from the letters on the first six left-most keys on the top row
RAM	Random Access Memory: measured in kilobytes or megabytes (e.g. 32 MB for a PC): active memory which determines the size of program and data that can be handled, and whose contents disappear when the computer is switched off
Raster	a type of screen display when the screen is scanned many times per second
Raster graphics	bit-mapped graphics
Real time	data is processed immediately, or for however long it takes, so that output can be provided which will influence subsequent input
Record	(database) an individual 'card' in an electronic card index

Resolution	the number of pixels on a screen, or the number of dots per unit length which a printer produces; the greater the number of pixels per inch, the better the resolution
RIP	Raster Image Processor
RISC	Reduced Instruction Set Computer: a generic term used to describe a powerful range of computer processors; *c.f.* CISC
Roller ball	an input device used for moving a screen cursor
ROM	Read Only Memory: chips which contain pre-set data, which control the internal operation of the computer
RS232	a commonly used serial interface; plug or socket
Scanner	an input device for converting text, pictures and photographs to digital data
Scientific notation	see Floating-point notation
Screen	the television-like device (VDU)
Security disk	a floppy disk that must be inserted into a floppy disk drive before proprietary software can be run
Serial data transmission	one bit after another
Serial port	a plug or socket which allows serial data transmission
Shareware	public domain software for which the author may expect to be paid a small sum
Shelfware	software that has been bought and rarely, if ever, used
Snap	(draughting) the ability to lock on to features of drawings
Software	programs of instructions that tell a computer what to do
Solid modelling	(modelling) modelling in which solid objects are defined, and physical attributes can be assigned to them
Spreadsheet	software which allows text, numbers and formulae to be entered in a grid of 'cells' and then manipulated
Stand-alone	a computer that is not connected to another
STEP	STandard for the Exchange of Product data: a data exchange format developed by car manufacturers for CAD/CAM and being developed by ISO for all industries including building
Storage	means of storing programs and data, commonly hard or floppy disk
Surface model	a model which is composed of infinitely thin planes, used for visualization
SVGA	super VGA screen resolution on PCs
Tablet	a digitizer
Tape	a storage medium

Tape-streamer	a high-capacity back-up storage device
TCP	Transmission Control Protocol (networks)
Terminal	aVDU and keyboard linked to a multi-user computer
Thermal printer	a dot matrix printer which prints with heated pins on heat sensitive paper
Toggle	a switch used to flip between functions on a computer
Topology	the way in which cables are laid out in a network
Touch screen	an input device: touching the VDU screen can be used for the selection of menu items
Tracker-ball	an input device similar to a roller-ball
Turnkey	a computer or computer system provided and operated by an outside firm
UNIX	a multi-tasking, multi-user operating system
Updates	software developments provided under a maintenance contract
URL	Universal Resource Locator: a full World Wide Web address
USB	Universal Serial Bus: a specification for the way computers send information to peripherals and vice versa
User-friendly	an interface which is easy to use
Vapourware	software which resides in the brain of a systems analyst or programmer and for which you are waiting
VDU	Visual Display Unit
Vector	a line defined by length and direction; output from draughting systems may be defined by vectors, i.e. the co-ordinates of the beginning and end points of lines
VGA	Video Graphics Array: the standard for screen resolution on PCs; commonly 640×480 using from 16 to 256 colours
View	(draughting and modelling terminology) either simply a view of an object, or a layer or level
Virtual memory	where there is not enough memory in RAM for a program's needs, it may use parts of the hard disk as virtual memory, exchanging data between memory and disk as necessary
Virtual reality	software systems that allow the user to interact with a computer environment
Virus	a destructive program which attaches itself to a file frequently used by the operating system; they are contagious and self-replicating, and can be 'caught' from unauthorized software and from floppy disks of dubious origin; they can be transmitted over the Internet

Visualization	modelling (or enhanced draughting) programs that allow models to be viewed from many directions and lighting effects and other physical attributes to be applied
Voice recognition	a combination of hardware (e.g. microphone) and software that can recognize and digitize human speech
VRAM	Video Random Access Memory
WAN	Wide Area Network
WIMP	Window, Icon, Mouse, Pull-down menu, or Window, Icon, Menu, Pointing-device: an attempt to produce a user-friendly interface, often applied to graphic environments like Digital Research's GEM, the Macintosh graphic user interface and Microsoft's Windows
Winchester disk	the early name for hard disk technology
Window	a variable-size box on the screen which can be used to display portions of text and drawing for editing, or an area of the screen where one program can be run at the same time as another
Windows	Microsoft Corporation's graphic user interface
Wire-line/wire-frame model	(modelling) a 3D model built up of lines representing the intersection of planes
Workstation	a computer dedicated to fast graphics, draughting and/or modelling; or a minicomputer using, usually, the UNIX operating system
WORM	(optical disk and drive) Write Once, Read Many (times)
WWW	World Wide Web: graphics and multimedia on the Internet
WYSIWYG	What You See (on the screen) Is What You Get (on the printer)

Appendix B
A selection of software and suppliers

The relative price of a particular program is indicated by the number of '£' signs. '(£)' means that the program is available free or as shareware.

Chapter 2
Office and job management

Word-processing programs

Accent Professional	Accent Software, 01923 208435	££
Claris Works	Claris Corp., US 408 727 8227	£
Fine Words	TopLevel, 01453 753955	
Lotus Word Pro	Lotus Development, 01784 455445	££
Microsoft Word	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	££
Microsoft Works	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	
Word Express	The Thompson Partnershlp, 01889 564601	£
WordPerfect	Corel, 0800 973189	££
WordStar	Softkey, 0181 2464000	£

Page layout programs

Calamus 95	Jaks Graphic Design & Print, 0114 248 3420	£
Corel Ventura Publisher	Channel Market Makers, 01703 814142	££
FrameMaker	Adobe, 0181 606 4000, sales 0131 451 6888	££
GSP Pressworks	GSP, 01480 496575	£
PageMaker	Adobe, 0181 606 4000, sales 0131 451 6888	££
PSF Publisher	Softkey, 0181 789 2000	£
Publisher	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	£

Quark Xpress	Quark Systems, 01483 454397	££
Serif PagePlus	Serif, 0115 942 1502	£

Spreadsheets

Excel	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	££
Works (Claris)	Claris Corp., US 408 727 8227	£
Works (Microsoft)	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	£

Accounting, job costing and office management

Arena	Arena Online Systems Ltd, 163 Cambridge Science Park, Cambridge CB4 4GP, 01223 420225	££
Modulus Silver	Modulus Software	£
M.Y.O.B	Best! Ware UK Ltd	£
Sage	Sage Ltd, NEI House, Regent Centre, Gosforth, Newcastle NE3 3DS, 0191 213 1555	££

File management systems and databases

4D	ACI US Inc., http://www.aci-4D.com	££
Access	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	££
FileMaker Pro	Claris Corp., US 408 727 8227	£
Helix Express	Helix Technologies, US 708 465 0242	
Works (Claris)	Claris Corp., US 408 727 8227	£
Works (Microsoft)	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	£

Hypertext

HyperCard	Claris Corp., US 408 727 8227	
SuperCard	Allegiant Technologies, US 619 587 0500	££

Project management software

Acos Compact	D & L Computer Services 01775 768287	££

Asta Power Project	Asta Developments Corporation 01844 261700	£££
CA-Super Project	Computer Associates 01753 679679	££
Microsoft Project	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	££
Open Plan Professional	Welcome Software Technology, 0171 401 2626	£££££
Prlmavera Project Planner	Primavera Systems, 0181 748 7300	£££
Project Scheduler for Windows	Tekware, 01384 392121	££
Project Workbench PMW	ABT International, 01727 888000	£££
Schedule Publisher	Advanced Management Solutions, 01491 4119666	£££
SureTrak	Primavera Systems, 0181 748 7300	££
Timeline	Deepak Sareen Systems, 0181 423 8855	££

Speech recognition software

DragonDictate for Windows 1.0	Dragon Systems 01242 678581	£££
IBM Voice Type Dictation for Windows 1.1	IBM 01705 49249, IBM Enquiry Desk 01329 242949	£££

Chapter 3
Drawing, modelling and rendering

Drawing (illustration programs)

Adobe Illustrator	Adobe, 0181 6064000	££
CorelDraw	Corel, 0800 973189	££
Macromedia FreeHand	Computers Unlimited, 0181 358 5857	££

Image editing and photograph manipulation programs

CorelDraw	Corel, 0800 973189	££
Fractal Design Painter	Fractal Design Corp., US 408 688 8800	££
PhotoShop	Adobe, 0181 6064000	££
PixelPaint Pro	Pixel Resources, US 404 449 4947	££

2D and 3D drawing programs

3D Studio	Autodesk, 01483 303322, fax 01483 304556	£££
AutoCAD	Autodesk, 01483 303322	£££
ArchiCad	CAD Unlimited, The Technology Park, Colindeep Lane, London SW9 6DU, 0181 200 8282, US 415 703 9777, http://www.graphisoft.com	£££
Architrion	Codec, 3 Newbold Street, Leamington Spa, Warwick CV32 4HN, 01926 330112	£££
Arkey	Waltec, Lindum Lodge, 311 Manningham Lane, Bradford BD8 7NA, 01274 491341	£££
AutoCAD LT	Autodesk, 01483 303322, fax 01483 304556	££
Autosketch	Autodesk, 01483 303322, fax 01483 304556	£
Blueprint	Gomark, 10 Hurlingham Business Park, Sullivan Road, London SW6 3DU, 0171 731 7930, http://www.graphsoft.com	££
Caddie	Caddie Vector Graphic Systems, 01727 830551, fax 01727 843010	££
Corel Visual CADD	FastCad Europe, 26 Greenhill Crescent, Watford Business Park, Watford, 01923 495496	££
CorelCAD	Corel, 0800 973189	££
DeltaCAD	Midnight Software, US 800 242 4775	(£)
DesignCAD	Burgess Video Group, 01874 611633	£
Design Reality	Vellum, Ashlar, US 408 746 1800, http://www.ashlar.com	
Drafix CAD Professional	Roderick Manhattan, 0181 875 4444	£
Drafix QuickCAD	Roderick Manhattan, 0181 875 4444	£
Drawing Express	Trial Systems, 9 Pebble Close Business Village, Amington, Tamworth B77 4RD, 01827 59669	££

EasyCAD Windows	FastCad Europe, 26 Greenhill Crescent, Watford Business Park, Watford, 01923 495496	££
Fastcad	FastCad Europe, 26 Greenhill Crescent, Watford Business Park, Watford, 01923 495496	££
FormZ	autodessys, US 614 488 9777	££
Imagineer	Intergraph, Delta Business Park, Great Western Way, Swindon SN5 7XP, 01483 619999	££
Infini-D	Specular International, US 413 253 3100	££
MacroMedia Extreme 3D	Computers Unlimited, 0181 200 8282	££
MicroGDS Drafter/Professional	Graphic Data Systems, 01483 725225	££/£££
MicroStation	Bentley Europe, L'Avenir, Opladen Way, Bracknell, Berks RG12 3PE, 01344 412233, http://www.bentley.com/	£££
MiniCad	Gomark, 10 Hurlingham Business Park, Sullivan Road, London SW6 3DU, 0171 731 7930, http://www.graphsoft.com	££
Modeller	Bentley Europe, L'Avenir, Opladen Way, Bracknell, Berks RG12 3PE, 01344 412233	£££
ModelShop	Gomark, 10 Hurlingham Business Park, Sullivan Road, London SW6 3DU, 0171 731 7930	££
Powerdraft	Bentley Europe, L'Avenir, Opladen Way, Bracknell, Berks RG12 3PE, 01344 412233, http://www.bentley.com/	£££
Ray Dream Designer	US 415 960 0765	££
Review	Bentley Europe, L'Avenir, Opladen Way, Bracknell, Berks RG12 3PE, 01344 412233, http://www.bentley.com/	££
Speedikon	Intergraph, Delta Business Park, Great Western Way, Swindon SN5 7XP, 01483 619999	£££-£££

Spirit	Spirit, Bau House, 26 Leicester Road, Ibstock, Leics LE67 6HH, 01530 261211	£££
Star	Codec, 3 Newbold Street, Leamington Spa, Warwick CV32 4HN, 01926 330112	££££
Studio Pro	Strata, US 801 628 5218	££
Swivel	(Macromedia) Computers Unlimited, 0181 2008282	££
TommySoft CAD	Thompson Partnership, 01923 246427	(£)
TurboCAD	IMSI, 0181 581 2000	£
Vellum	Vellum, Bishop Bateman Court, Thompson's Lane, Cambridge CB5 8AQ, 01223 300943, http://www.ashlar.com	££
XCad	Digital Multimedia, 0181 893 4000	££

Animation and multimedia

Aimtech CBT Express	Aimtech, 0171 702 1575	£££
Asymetrix Multimedia Toolbox	ICS, 01256 469460	£££
GL Pro	Computers Unlimited, 0181 200 8282	££££
Icon Author	Aimtech, 0171 702 1575	££££
Illuminatus	Digital Workshop, 01295 258335	£££
Macromedia Director	Computers Unlimited, 0181 200 8282	

Chapter 4
Networks and communications

LANs only

AppleTalk	Apple Computer, 6 Roundwood Avenue, Stockley Park, Uxbridge, MDDX UBII IBB, 0181 569 1199
BrightWorks	McAfee Associates
Frye Utilities for Networks	Frye Computer Systems
LANDesk Management Suite	Intel
Netware	Novell
Notes	Lotus, Lotus park, The Causeway, Staines, MDDXTW18 3AG, 01784 455455

Windows NT	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/ 0345 002000	

LANs and WANs

Norton Administrator for Networks	Symantec (UK) Ltd, MKA House, 36 King Street, Maidenhead, Berkshire SL6 IEF, 01584 481181	
Systems Management Server	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	

Net browsers

Microsoft Explorer	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	(£)
Mosaic	ftp.ncsa.uiuc.edu	(£)
Netscape Navigator	http://www.netscape.com	(£)

E-mail

Claris Mail	Claris Corp., US 408 727 8227
Eudora	Qualcomm
Microsoft Mail	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000

Web authoring

Corel Web.Designer	Channel Market Makers, 01703 814142	£
Hot Dog	Fourth Net, 01252 345441, www.fourthnet.co.uk/ softpage.html	(£)
InContet Spider	Channel Market Makers, 01703 814142	£
Microsoft Front Page	Microsoft, Microsoft Place, Winnersh, Wokingham, Berkshire RG11 5TP, 01734 270000/0345 002000	££
PageMill	Adobe Systems, 0181 606 4000	££

Further reading

General

Fist, S. (1996) *The Informatics Handbook,* Chapman & Hall.
McCullough, M., Mitchell.WJ. and Purcell, R (eds) (1990) *The Electronic Design Studio,* MIT Press.
Ralston, A. and Reilly, E.D. (eds) (1993) *Encyclopedia of Computer Science,* 3rd edn, VNR.

Chapter 1
Getting started

Carter, R. (1991) *Information Technology,* Butterworth-Heinemann.
Howes, J. (1990) *Computers Count,* RIBA Publications.
Maran, R. (1995) *Computers Simplified,* 2nd edn, IDG.

Chapter 2
Office and job management

—— (1994) *Using Microsoft Office,* QUE Corporation.
Szymanski, R.A., Szymanski, D.P., Morris, N.A. and Pulschen, D.M. (1991) *Introduction to Computers and Information Systems,* Macmillan.
—— (1967) *Hart's Rules for Compositors and Readers at the Oxford University Press,* 37th edn, Oxford University Press.
—— (1982) *Chicago Manual of Style,* University of Chicago Press.

Chapter 3
Drawing, modelling and visualization

There are numerous guides to leading systems

Chapter 4
Networks and communications

Hodson, R (1992) *Local Areo Networks,* DPP.

Chapter 5
Futures

Zampi, G. and Lloyd Morgan, C. (1995) *Virtual Architecture,* BT Batsford Ltd.
Cringley, R.X. (1996) *Accidental Empires,* Penguin

Web sites

http://www.sandybay.com/	'Webopaedia'
http://www.apple.com/	Apple facts
http://www.uce.com/machist.html	Macintosh history
http://www.fcit.coedu.usf.edu/network/	networks
http://www.bell-atl.com/federal/nile.htm	networks
http://www.ncc.co.uk/	National Computer Centre

Magazines and periodicals

General

Architects' Journal
Building Design
Building
RIBAConnect, Nov. 1996
RIBA Journal, Practice Section 1994–6
The Times 'Interface' supplement 1995–6

Computing

Business Computing
Byte: good technical articles on the whole range of computing, both hardware and software
Computer Shopper
Macworld (US): useful for Macintosh developments, most of which take place in the United States
Macuser: well-written and designed; good for what's available in the UK; has good advertising and small ads for buying or selling second-hand equipment
Palmtop
PC User
Personal Computer World: useful guide to UK PC computing; huge number of advertisements for mail order prices
Popular Computing
Practical Computing

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