Psychiatric Bulletin (1992), **16**, 703–708

Computers in psychiatry

1. Basics and purchasing tips

BANKOLE A. JOHNSON, Wellcome Research Fellow, University of Oxford Department of Psychiatry, MRC Psychopharmacology Unit, Littlemore Hospital, Littlemore, Oxford OX4 4XN; and LYNDA T. WELLS, Registrar, Department of Anaesthetics, John Radcliffe Hospital, Oxford OX3 9DX

Computers are essential tools for medical research, communication and management. Informed choices require a basic knowledge of computers. Many doctors have, however, been frustrated by unnecessary jargon.

We compare International Business Machine (IBM) compatibles with the Macintosh (Mac), explain the three components of a complete computer set-up, the microprocessor itself (hardware), the programmes needed to run it (software) and the printer, and give purchasing tips.

IBM or Macintosh

The design philosophy of Mac and IBM compatibles is different. Commands are usually typed on IBM compatibles. The Mac and its clones (Archimedes, Atari ST and Commodore Amiga) use a Graphical User Interface (GUI). GUIs present options as small pictures (icons) which are selected by clicking a mouse, a small device whose movements are mimicked on the computer screen. When there are too many options to be displayed as icons "pop-down" menus or a list of alternatives are provided. Macs are easy to use, and their ability to exchange information with IBM compatibles has improved. Their significantly greater cost compared with IBM compatibles of similar performance and a smaller but more expensive range of software are, however, obvious disadvantages. Software packages such as Microsoft Windows offer Mac-like presentation on IBM compatibles.

Hardware

Microprocessors

The microprocessor or Central Processing Unit (CPU), miniature transistors arranged into integrated circuits on a single silicon chip, is located on the main circuit board or motherboard. The CPU is the computer's brain; it controls all its functions, and assesses and executes the software's instructions. Some computers have a maths co-processor to help the CPU with mathematical calculations.

The CPU sends and receives messages from software programmes using binary code (0 = off and 1 = on). Each on or off state (1 or 0) is called a bit, and eight bits make a byte. Messages are carried along two main systems of wires called buses: the input/output bus communicates with the computer's peripherals such as the printer, and the CPU bus with its memory. Binary words, which can be 8, 16 or 32 bits in size (bus widths), refer to the amount of information, in ascending order, the computer can process at a time (see Fig. 1).

Clock speed

The CPU uses vibrations from a source such as a quartz crystal to regulate its speed (i.e. clock speed). Clock speed is measured in Megahertz (MHz); one MHz equals a million cycles per second, and the higher it is the faster the processor. If the CPU cannot get information from the memory chips as fast as its clockspeed dictates it has to wait. These wait-states reduce the computer's overall performance. Fast computers have their memory chips and circuits designed to have zero wait states. In sum, three factors are directly related to the processing power of a microprocessor: bus width, clock speed and wait-state.

Memory

There are two main types of memory: Read Only Memory (ROM) and Random Access Memory (RAM). ROM contains the programmes required to start the computers and looks to the disk drive or operating system for further instructions; it is permanent memory. These programmes, the Basic Input-Output System (BIOS), reside in the reserved memory area for the Disk Operating System (DOS). In contrast, RAM chips, capacitors located on the motherboard, store information as electrical charges. Because capacitors leak charge they have to be refreshed constantly by electrical current to retain the information stored in them; thus, information

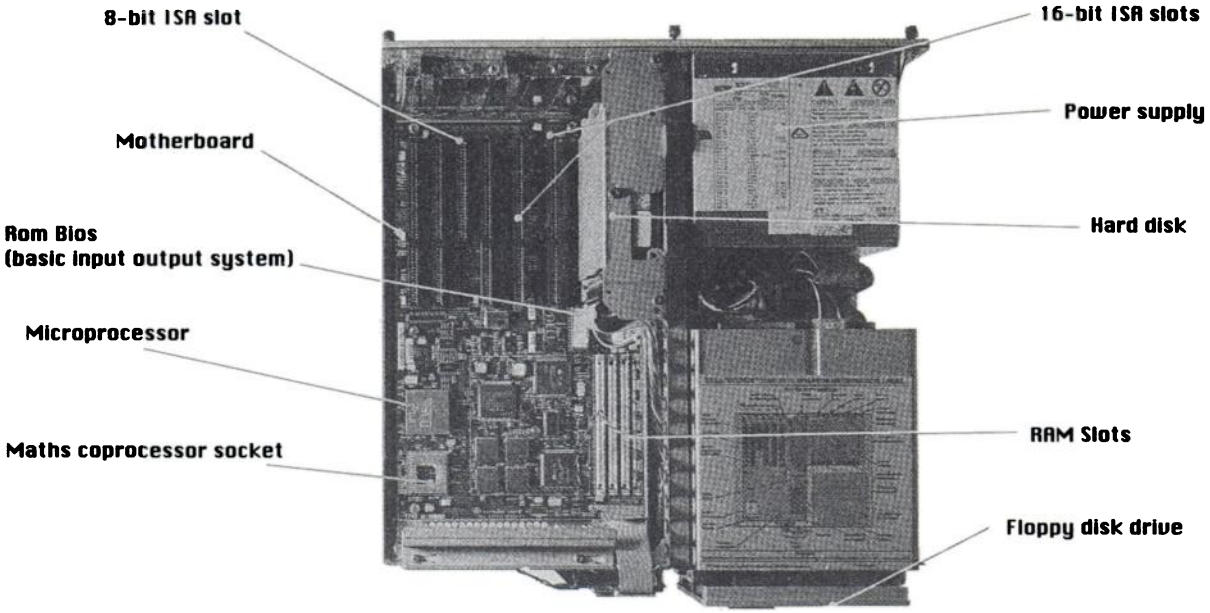

FIG. 1. Inside your computer. By courtesy of *What Micro*?

stored in RAM is temporary as it is lost when the computer is switched off.

Each byte of RAM stores one character, and a kilobyte (KB) and megabyte (MB)[1] correspond to one thousand and one million bytes respectively. Each byte has its own memory address, a specific code number (between 0 and 255) that designates its location. Without these addresses the computer will be unable to locate the information it needs to call up (load) the programme.

RAM is subdivided into three parts: conventional (base), extended and expanded memory. Conventional memory uses the fixed address space between 0 and 640 KB; it is reserved for DOS and other programmes. Between 640 and 1024 KB lies the reserved memory area. It is not usually available to software applications; thus, in a 1 MB machine the extra 384 KB is configured as extended memory. Expanded Memory Specification (EMS) allows sections of expanded memory (pages) to be exchanged with unused portions of the reserved memory area address (page frames); typically, each page and page-frame is 16 and 64 KB in size respectively, as each page is filled with data the page frame moves on to another page. An EMS card can range from 2 to 32 MB, and is controlled by a device driver which allows programmes to request pages for use and to select between them. Most software programmes will work with EMS (See Fig. 2).

[1]Bytes are counted in powers of two; thus, 1 KB = 1024 bytes and 1 MB = 1,048,576 bytes.

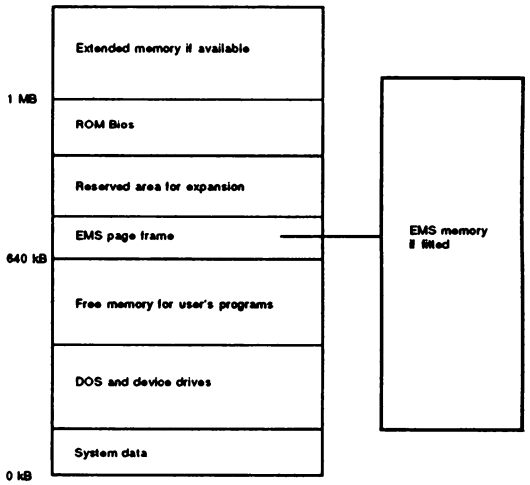

FIG. 2. Memory map.

Some advanced computers use: (a) virtual memory to extend the effective RAM size by exchanging information with unused areas of the hard disk and (b) a special type of memory (CPU cache), which resides in static RAM and does not need memory signals to refresh it, to reduce the performance impairment of wait-states. CPU cache can be a deciding factor when choosing between two computers with similar wait-states. Slower dynamic RAM chips are used mainly by the CPU's main memory.

https://doi.org/10.1192/pb.16.11.703 Published online by Cambridge University Press

Expansion slots

Memory boards or cards, which contain additional RAM chips, can be installed onto the motherboard via its expansion slots. A computer with free expansion slots, preferably of Industry Standard Architecture (ISA), is adequate. Users on networks may, however, also require an Extended Industry Standard Architecture (EISA) slot. The EISA, unlike the 8 or 16 bit ISA, is a 32 bit design and is therefore capable of transmitting at higher speed. EISA cards or bus masters, independent units which can access various parts of the system without taking up CPU time, enhance the computer performance. Micro Channel Architecture (MCA) slots are only recommended to those wishing to access large networks.

What microprocessor in what computer?

Microprocessors, in increasing order of power, as categorised by the Intel Corporation include: 8088, 80296, 80386 SX, 80386, 80486 SX and 80486; machines using the new P5 chip are due out shortly. The 8088 or XT (extended) introduced in 1979 was one of the first microprocessors. It had 29,00 transistors, a bus width of 8 bits, 1 MB of addressable memory and a clock speed of 4.77 top 10 MHz; XTs are now practically obsolete. In 1982, the 80286 or AT (Advanced Technology) was launched. It had 130,000 transistors, a bus width of 16 bits, up to 16 MB of addressable memory and a clock speed of 12 MHz. In 1985, the 80386 was created which featured 275,000 transistors, a bus width of 32, an addressable and virtual memory of up to 4 billion (giga) and 64 trillion bytes respectively, and a clock speed of between 16 and 40 MHz. The 80386 SX is a scaled down 80386; while it can internally process 32 bits it can only transfer 16. The 80486, manufactured in 1989, had 1.2 million transistors, a similar bus width and real and virtual memory to the 80386, a clock speed of between 25 to 50 MHz, and a maths co-processor. Importantly, because the 80486 has a more integrated microprocessor – the Reduced Instruction Set Chip (RISC) which speeds up data transfer because its instructions are processed more easily – CPU cache and a maths co-processor it is more powerful at its slowest clockspeed (25 MHz) than an 80386 at its quickest (40 MHz).

Floppy and hard disks

Computers store information on floppy or hard magnetic disks. Floppy disks are 3 1/2 or 5 1/4 inches in diameter with a maximum storage capacity of 1.44 MB and 1.2 MB respectively; three and a half inch disks are comparatively more robust and have better performance. Floppy disks must be formatted in two stages before use; both stages are initiated sequentially by the format command in DOS. First, the disk is partitioned into concentric rings (tracks). Each track is subdivided into an equal number of divisions (sectors); a sector can store 512 bytes of data. Secondly, information is set-up in various sectors for DOS to store files on. Computers with only floppy disks for storage (i.e. no hard disk) are not recommended because of both poor performance and inability to use modern software.

The hard disk drive stores data magnetically on a metallic disk (platter) inside the computer rotating at about 3,600 rpm (revolutions per minute). Documents saved to the computer's hard disk are translated into binary code. The binary code, a stream of on or off pulses, flows into the disk drive's read/write head which is an electromagnet. Thus, the document is recorded by the read/write head magnetizing the platter. Hard disks are about four times more efficient than floppy disks and can hold up to 600 MB. Most computers have 40 MB hard disks. Nevertheless, because software packages are increasing in size an 80 or 120 MB disk is more practical. Additionally, the larger the hard disk the more closely information is packed into each track; thus, the microprocessor takes less time (access time) to retrieve it. Computers with hard disk access times of greater than 80 milliseconds (ms) should not be considered; the average is 28 ms. The type of disk is also important. For most users a computer with an International Drive Electronics (IDE) disk is adequate. While demanding applications such as Computer Aided Design (CAD) will benefit from an Enhanced Small Device Interface (ESDI) disk the Small Computer System Interface (SCSI) disk is usually the best choice. Machines with ST506/412 disks should be avoided. Less important factors affecting disk performance include: its rate of spin, the number of separate recording heads, the speed at which the heads move to a new position, and the density at which the data is recorded. Institutions with a large number of computers should consider purchasing a tape streamer, a device for rapidly making copies (backing up) of hard disks.

Interfaces

An interface (port) is a socket into which a cable or device may be plugged. There are two types: parallel (centronics) and serial (RS 232). Parallel ports use multiple wires or signals to carry all of the bits in a byte at once and are intrinsically faster than serial ones where the bits in a byte are sent one after another down a single wire or signal. Computer devices usually specify whether they can be accessed by either a parallel or serial port, or both. Parallel ports are used mainly to connect the computer to a printer, and in some cases one computer to another for file transfer; up to three of these ports, referred to under DOS as LPT1, LPT2 and LPT3, may be available. A computer with two serial ports is essential if a mouse and modem are to be utilised simultaneously.

Monitors

Colour Visual Graphics Array (VGA) is now the standard. Its resolution is 640 × 480 pixels (picture cells or dots). Monochrome VGA (Hercules standard display) is available for those on a tight budget. For GUI orientated programmes like Windows the extra resolution of a Super Visual Graphics Array (SVGA), 800 × 600 or 1024 × 768, is advantageous. A graphics card will enhance the quality and speed of the images.

While gas plasma screens were formerly popular with mains operated portables because of speed and all-round viewing angle their high power consumption, bulkiness, and inability to show more than 16 grey scales has made them less suitable for small battery dependent portables (notebooks).

Liquid Crystal Displays (LCD) are commonly seen in notebooks because of their power consumption, flatness, and ability to display 64 grey scales. Nevertheless, they are slow and can suffer from poor contrast and sharpness with certain viewing angles. To overcome this some displays are "back-lit", or may feature an improved arrangement such as Super Twist LCD; laptops with these attributes are much sought after. Notebooks with colour monitors are rapidly falling in price; though those with Thin Film Transistor (TFT) screens are more costly than passive matrix displays, their sharper and more distinct images make them the best buy for anyone wishing to operate a GUI.

Modems

A modem (*mo*dulator-*dem*odulator) is a device for transmitting data across telephone lines. It is used for electronic mail, viewing data systems such as Prestel, accessing on-line databases, and file and information transfer. The modem translates ongoing data into audible tones. At the receiving end another modem converts received tones back into data. Modems can be installed inside the computer or plugged into a serial port. Internal modems are usually cheaper, but are not transferable between computers. External modems often have indicator lights to monitor transmissions, and this can make them a better choice. Both internal and external modems can be plugged directly into a telephone socket. Some also work via an acoustic coupler which can be attached to the cups of the handset; this permits transmission from countries with non standard sockets. Modems are controlled by the computer; commands from the communications software, which authorise the computer to make and receive calls automatically, almost universally comply with the Hayes standard. Thus, it would be unwise to purchase a non-Hayes-compatible modem. Also, it is easy to pay too much for a standard modem; the Armstrad MC/SM 2400 or Dataflex PC Professional are good value.

Protocols set down by the Comité Consultatatif International Telegraphique et Telephonique (CCITT) – an international telecommunications standards body – define transfer speed, data compression and type of error correction. Transfer speed and data compression are important: shorter transmission time means lower telephone bills. The most popular speeds are V22 bis and V32 bis – 2,400 bps (bits per second) and 9,600 bps respectively; modems with speeds less than 1,200 bps should be avoided. Error correction devices minimise transmission problems over noisy telephone lines; MNP4 and V42 are the best choices. Most users opt for MNP5 data compression and V22 bis; this configuration can achieve effective transmission speeds of 4,800 bps.

Only modems which carry BABT (British Approval Board for Telecommunications) approval can be plugged legally into the public telephone system. This includes Mercury and Cellular networks. Paradoxically, because the sale of an unapproved modem is legal do not buy one without the green sticker or the message BABT approved.

Modem transfers offer the possibility of an efficient paperless office. For instance, articles to journals could be sent in this way and assessors could simply download these files into their computers; replies could be returned by a similar mechanism. We estimate this would halve our department's use of paper.

Networks

The term network usually refers to a Local Area Network (LAN). This allows special interface cards and software to link computers within a department or building. Depending on its sophistication, a network can provide some or all of the following four services. First, centralised data and programme storage: because disks and directories can be accessed by all the users of a network department-wide information can be kept up-to-date. A file server is a computer whose disks are available to other machines. Secondly, file exchange and electronic mail: rather than telephoning or sending memos users can communicate via their computer terminals. Thirdly, multi-user operation: with suitable software more than one user can work on the same project. Fourthly, appliances such as modems and printers can be shared. Networks can be cheaper than providing everyone with a computer, and allows users to work interactively.

Desktop, laptop, notebook, or palmtop

Laptops, originally designed to reduce the bulk of conventional desktop computers, have been superseded by the more portable notebooks. Notebooks are usually about the size of an A4 sheet of paper, two to three inches thick, and should, ideally, weigh less

than eight pounds. Recent advances are making them lighter, and competition between manufacturers is driving prices down; on average they cost between 30 to 40% more than desktops of similar performance. For most users they would serve well as the only machine. Features which should constitute a check-list for potential purchasers include a well laid out and responsive key board, an adequate size of hard disk (40 MB or more), both a parallel and serial port, a "backlit" LCD, Super Twist LCD or VGA compatible monitor which can drive an external colour monitor, space for an internal modem, a battery life of more than two hours, and energy conserving measures such as a sleep mode. Because notebooks need to withstand the rigours of travelling, those produced by leading exponents of the technology like Compaq, Dell, Sanyo, Tandon, Toshiba and Zeos are the safest buys. Palmtops (hand held computers) are relatively expensive and remain underdeveloped for serious computing; they do, however, make excellent personal organisers.

Upgrades

Computer technology is developing rapidly. Because it is impractical to continually replace machines it is important to purchase one which can be easily upgraded; the Acerpower 486 SX, Dell 486D and Viglen Genie 486 are built specifically with this in mind. Fitting a maths co-processor is an economical way of upgrading a computer's performance. Recently, so called "overdrive" chips have become available which double the internal clock speed of the computer.

Software

Operating systems

Most computers are sold with an operating system: software which allows the computer to start programmes and act as a platform for other applications. DOS is the standard. Others include Operating System 2 (OS/2) which has, as yet, failed to replace DOS, and UNIX[2] which is widely used by large networks.

GUI

Windows, a GUI for IBM compatibles, is loaded on top of DOS. Its advantages include: ease of use; multitasking – working on an application while another is running in the background; object linking – displaying one application in another – for example, a spreadsheet in a word processor; and dynamic data exchange – linking programmes so that changes in one allow the other to be updated – for example, each time a spreadsheet associated with a graph changes the graph is adjusted automatically. Windows does, however, make considerable demands and hardware and a 20 MHz 80386 SX with at least 2 MB of RAM (4 MB is recommended) is needed to take full advantage of its potential.

[2]Unix is a trade name of Unix System Laboratories Inc., USA.

Applications

It is beyond the scope of this article to discuss software packages in any detail. There are, however, five important points to consider: make sure it meets your requirements in terms of facilities and ease of use; ensure the software is compatible with your computer – it would be wise to decide on the packages you wish to run and to base then decision of which computer to buy on this rather than the other way round; find out what help is available locally for the programme; enquire about the likely cost of upgrades; and remember that integrated packages such as Microsoft Works or Spinnaker's PFS: Window Works are usually a fraction of the cost of buying separate packages, and offer a word processor, spreadsheet, database, address book, charts and communication – all most users need.

Printers

There are four main types of printer: daisy wheel, dot matrix, ink-jet and laser.

Daisy wheels, which work similarly to electronic typewriters, produce high quality print but are relatively expensive, slow and inflexible.

Dot matrix printers work by hitting pins (9 or 24) against a ribbon. Though fast, robust, and cheap to run and maintain they are noisy, and the machines which produce good quality print are similar in price to ink-jets and cheaper laser printers.

Ink-jets use a special print head to fire droplets of ink onto the paper. They are quiet, produce good quality print and graphics, and portable models can be powered by batteries. Like dot matrix printers their performance is given in characters per second; interestingly, quoted speeds refer to burst speed which is 25% higher than normal printing speed. Ink-jets with colour facilities are increasing in popularity due to their relative low cost.

Laser printers resemble photocopiers mechanically. They are quiet, produce high quality text and graphics, and can print several pages a minute. Two standards (laserjet or postscript), both of which take advantage of a wide range of typefaces (fonts), are available. Due to recent price reductions many laser printers are now only marginally more expensive than ink-jets; nevertheless, accessories such as RAM memory, which allows the computer to download all the documents in one go so that it can attend other

tasks, and additional typefaces, can significantly increase cost.

Purchasing tips

Discounts

The computer market is very competitive. Recommended selling prices (RSP) quoted by dealers should be treated only as a guide and discounts of between 10 and 20% are easily negotiated. Most manufacturers will allow even greater reductions if the machines are education purchases. Educational purchases do not normally attract Value Added Tax (VAT). Those who are not eligible for educational discounts can achieve savings by purchasing their computers directly from companies who offer a mail order facility such as Dell, or who advertise in magazines like *PC Direct* and *Computer Shopper*. A budget of £600 and £900 for an 80386 SX and 80486 respectively would be realistic; however, prices are still falling.

An interesting alternative to consider would be a weekend in the United States where comparable machines can be as little as half the United Kingdom price, and come with a world-wide guarantee. Last year the best bargains were in New York and Los Angeles. Notebooks are, perhaps, the best buy because they almost invariably come with transformers designed to accept between 100 and 240 mains voltage. It really is possible to have a holiday and buy a computer for less than you would pay a UK dealer.

Warranty

Most computers come with a one year warranty. Computers which come with on-site service and some day call-out facilities are preferable to those which have to be returned to the manufacturer for repairs. Many manufacturers also offer telephone support. Check the price of extending the warranty beyond a year before you commit yourself; it could be costly.

Help

Joining the appropriate users' group is recommended. A comprehensive list can be obtained by sending a stamped addressed envelope to the Secretary, British Association of Computer Clubs (BACC), 14 Bron-y Glyn, Bronwdd, Carmarthen, SA33 6JB. Most universities offer a micro advisory service. Additionally, the College has a specialist section in computing.

Future developments

The most interesting developments on the horizon include: more powerful microprocessors which will actually carry the operating system environment; computers which can be controlled by special pens; modem communications via cellular telephone networks, and most exciting of all multimedia – the integration of moving graphical images such as full-motion videos with sound – in short, virtual reality[3].

Further reading

NEIBAUR, A. R. (1990) *The Hand-Me-Down PC Handbook*. London: Pitman Publishing.

[3]This technology may eventually produce the type of images seen on the holodeck of the Starship Enterprise.

https://doi.org/10.1192/pb.16.11.703 Published online by Cambridge University Press