How PCs Work

Today's microcomputers are incredible achievements of engineering. A generation ago, equivalent computers would have taken entire laboratory floors and armies of technicians just to keep them running. By comparison, the microcomputer's unassuming size and relative reliability can lull people into thinking of it as just another household appliance. They are definitely more complex than the average blender. It would take volumes to completely explain how every component works on a computer, but here are a few details. Simply put, the computer is a system of physical parts (hardware) that performs actions when it is given electronic instructions (software). Sets of electronic instructions are called programs; they tell the computer how to do different things. If you think of software as music, then programs are songs, and computers are the instruments that play them. The more powerful the computer, the more complex the songs' it can play, and the faster it can play. Computers take input, work with it, and provide output. The individual operations they do are very simple, but they can do millions of them in one second. It's this processing speed that makes computers such powerful tools.

If you flip open the top of a modern PC to see the contents, what are the major components you'd be able to identify?

The "Box" The "tower", or box portion of a computer, constitutes the container for components making up the PC. Electrical, electronic, and mechanical parts are combined in this unit. The power supply converts alternating current (AC) power into direct current (DC) voltages used to power various devices and provide positive and negative logic signals for the system unit's motherboard, or main circuit board.

The motherboard Also called a system board or circuit board, this is the most important part of the system. This is the heart of the computer, upon which are installed all of the electrical connections among various building blocks of the computer, including the CPU, ROM, and RAM.

The processor. The "brains" of the computer are microprocessors, matchbook-sized devices that process digital, or discrete, information. Microprocessors, which have names such as 601 and Pentium and are sometimes called central processing units, contain hundreds of thousands of electronic switches that can be turned "on" or "off" to represent 1s and 0s. The PC uses combinations of these two electronic states to represent all data. The CPU is responsible for processing instructions and carrying out users' commands. Other parts of the computer are accessed by the microprocessor for specific input/output tasks. The microprocessor or Central Processing Unit (CPU) and its attendant chips are located on the motherboard and execute the CPU's instructions in the programs stored in memory. The CPU sits on a Zero Insertion Force (ZIF) socket, which allows for the easy removal and upgrade of the CPU.

Memory: RAM. After you input data into the PC or retrieve it from storage on the hard drive or diskette drive, the computer temporarily holds the information in random-access memory, or RAM, chips. The PC moves data in and out of RAM as it processes it. The abundance of random-access memory (e.g. 32 MB? 512 MB?) determines how many applications programs (like Excel, Visual Basic and Photoshop) can fit on your desktop at one time. When you run a program, it is loaded from your hard drive into RAM. The more RAM provided, the more programs and files that can be open at the same time Work to be kept must be stored on a hard drive or diskette because whatever is in RAM gets erased when the computer is turned off. RAM chips are grouped in rows called SIMMs or DIMMs (single or dual in-line memory modules). SIMMs containing DRAM (dynamic RAM) chips can be added to sockets provided in this region of the motherboard. When the CPU has been unable to find data it needs in either the internal or external caches, it checks RAM These modules are small bars, usually containing eight or nine smaller chips. Adding more memory to the

computer involves plugging in one or more of these. A memory chip is the integrated circuit that actually contains the RAM.

Internal Cache memory These high-speed memory circuits are built into the CPU. Data recently used by the CPU is stored here; the internal cache is the first place the CPU looks when it needs to retrieve data. Data retrieval from the internal cache is faster than from the external cache or RAM.

External Cache memory Residing on the motherboard itself, the external cache also stores data recently used by the CPU Data retrieval is much faster than RAM.

Memory: ROM. Low-level instructions for the computer's operation are contained in its read-only memory (ROM) chips. These instructions form the basic input output system (BIOS). Early computers could only upgrade BIOS by replacing the ROM chips. Now, BIOS chips can be updated from a diskette containing the new BIOS file. ROM contains the commands your computer needs to activate itself when the power is first turned on, and, unlike RAM, its contents are retained even when the power is off.

Input Devices including the keyboard, mouse and joystick, allow you to provide input to the computer and to control its operation. When you give the computer instructions using input devices such as the keyboard, the mouse, and a microphone, the computer provides results using output devices such as monitors, printers, and speakers. No matter what input device you use, the information must be translated into a digital form before your computer can act on it. Input devices such as the mouse and a joystick translate a user's left-right and up-down hand motions into a corresponding action on the computer's display. Buttons associated with the input device can command programs to perform predetermined actions.

The keyboard Each keyboard contains a microprocessor that is dedicated to the not-so-simple job of interpreting keyboard input. This microprocessor, called a keyboard controller, monitors the push-button switches hidden under the keyboard's keys. Each key press sends coded signals to the computer's microprocessor. These keyboard signals are called scan codes. For instance, the scan code for a lowercase letter “a” is the hexadecimal number 1EH. To send the scan code for a capital “A”, the user can press the left SHIFT key (scan code 2AH) and then the letter “a”. The keyboard controller can store a limited number of keystrokes, or scan codes, in a small amount of memory in the keyboard called a type-ahead buffer. This buffer stores scan codes until the computer is able to process them. You'll hear a chirping from the computer when the type-ahead buffer has been filled and the computer is unable to process additional keystrokes.

The Display. A desktop computer's monitor is able to show program output in characters or in graphical output. The monitor performs its chores by turning microscopic spots on the screen called pixels into a wide variety of colors. A 640-by-480 pixel (640 x 480) screen, for example, contains 307,200 pixels that can form detailed pictures, while a 768 by 1,024 pixel screen contains 706,432 pixels and can display a more detailed image. A pixel can change colors between 50 and 70 times a second. This corresponds to the monitor's scan rate and is measured in hertz, the number of times the signal changes in one second. The higher a monitor's scan rate, the more steady animation and video appear.

The Port. External devices, including keyboards and monitors, are connected to your computer with multipin connectors called ports. A mouse may use a PS/2 port, or a serial port. A joystick may plug into a sound card's joystick port, or into a serial port. I/O (Input/Output) ports allow the computer to exchange data with other external devices such as external modems or printers. Information flows to and from the serial and parallel ports much more slowly than it does within the computer.

The Floppy Disk Drive. If you want to store the information that appears on the monitor, you "save" the information. Usually that is done by storing the data magnetically on a diskette or hard drive

contained in the system unit. The “floppy” diskette drive reads and writes information on diskettes that usually hold 1,440,000 characters. Since diskettes can be removed and replaced from the drive, a diskette drive allows access to a virtually unlimited collection of data. (Older machines may have a 5.25" floppy drive also, an earlier bulkier storage medium with lower storage capacity.)

The Hard Drive Besides storing programs and data in the RAM of your computer, a hard drive (or hard disk or fixed disk) acts as a computer’s secondary storage device. A hard drive, though more expensive than a diskette, allows the most rapid access to your programs and data and can store billions of characters.

Expansion Slots These are openings on the motherboard into which a board or card can be inserted, expanding the capability of the computer. An expansion card is a circuit board that slides into an expansion slot.

Circuit boards Common expansion cards include sound boards and Ethernet interfaces. These boards can add features such as sound or 3-D graphics or high speed Ethernet connectivity to the computer. A sound card is an expansion card that lets a computer generate high quality (CD-equivalent) sound. Examples of practical uses for sound capabilities include games, music applications, and interactive educational software. Sound cards commonly are also equipped with a game port for a controller such as a joystick.

Bus Special electronic paths called buses route data and control signals between these chips and RAM and data storage devices such as hard drives, diskette drives, or compact disc read-only memory (CD-ROM) drives. These buses are designed to simultaneously move groups of ones and zeros. In modern computers, 32 ones or zeros, called bits, can be moved at one time between the microprocessor and RAM. Data moving to some types of expansion cards and internal components is routed to 16-bit paths. Peripheral Component Interconnect (PCI) buses connect devices that support the Plug-and-Play standard. PCI buses are generally used for data transfer to such devices as network cards, SCSI adapters, and graphics accelerators.

CD-ROM. Compact Disc Read-Only Memory, a non-volatile optical data storage medium using the same format as audio compact discs; popular for distributing large software application packages and very large databases. Speed factor rated relative to audio disc speed requirements (1x = about 150 kilobytes/sec). CD-ROM drives may connect to IDE or SCSI interface or a proprietary interface; ISO 9660 defines the file system format. Typical digital storage capacity is 760 MB. Newer computers may have a high speed DVD drive capable of reading video discs, or a CD-RW drive capable of writing CDs. DVD-RWs are also available but cannot write DVD player-compatible discs… yet.

CD-RW: a rewritable version of a CD-ROM; a CD-RW drive can write once to a CD-R disc or an unlimited number of times to CD-RW media.

DVD Digital Video Disc or Digital Versatile Disc, an optical storage medium with greater bandwidth and storage capacity than the CD (4.7 to 8.5 GB instead of 0.76 GB). Computers equipped with the necessary MPEG-decompression file software can be used to view movies and videos from the monitor screen.